July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

Filed March 3, 1932 7 Sheets-Sheet 1

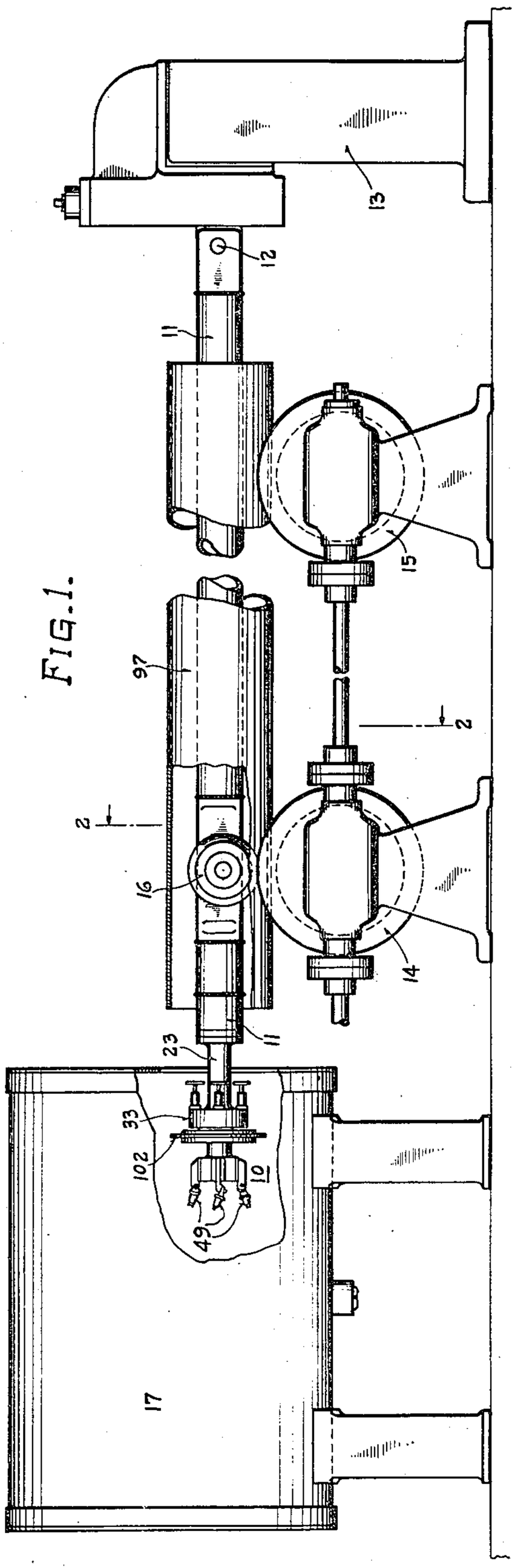

FIG. 1.

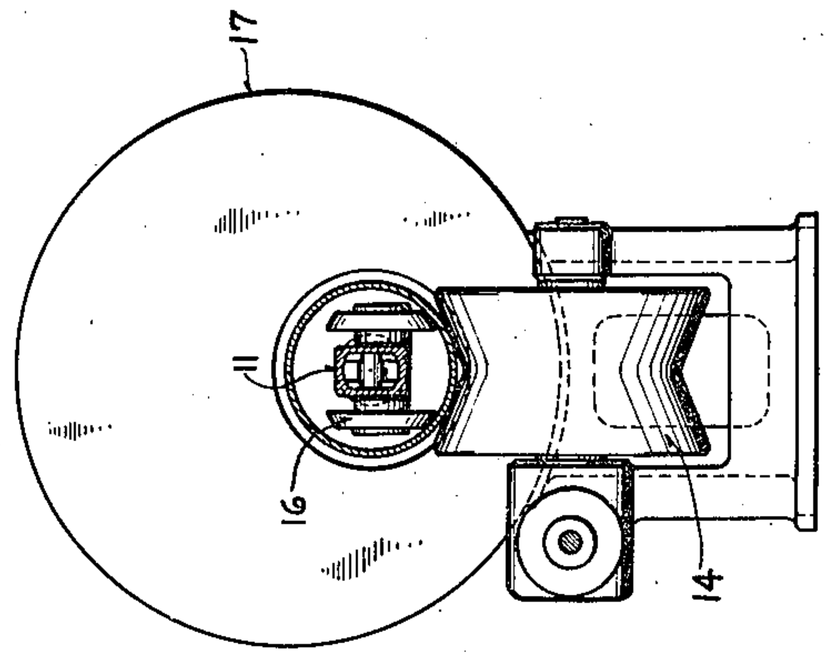

FIG. 2.

INVENTORS:
Adam Ziska
James Keith Marshall

BY Pierce & Andrus

ATTORNEY.

July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

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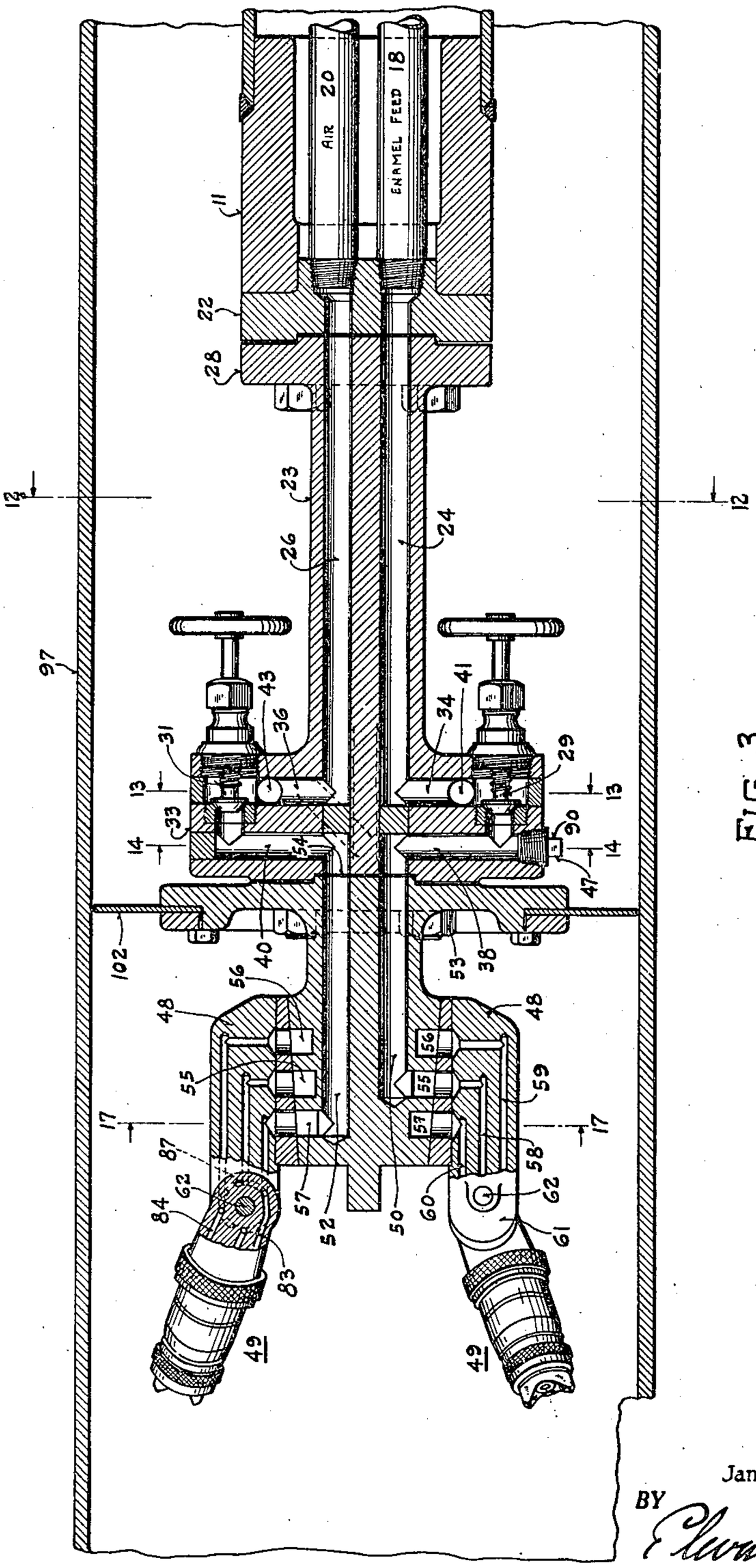

FIG. 3.

INVENTORS:
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July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

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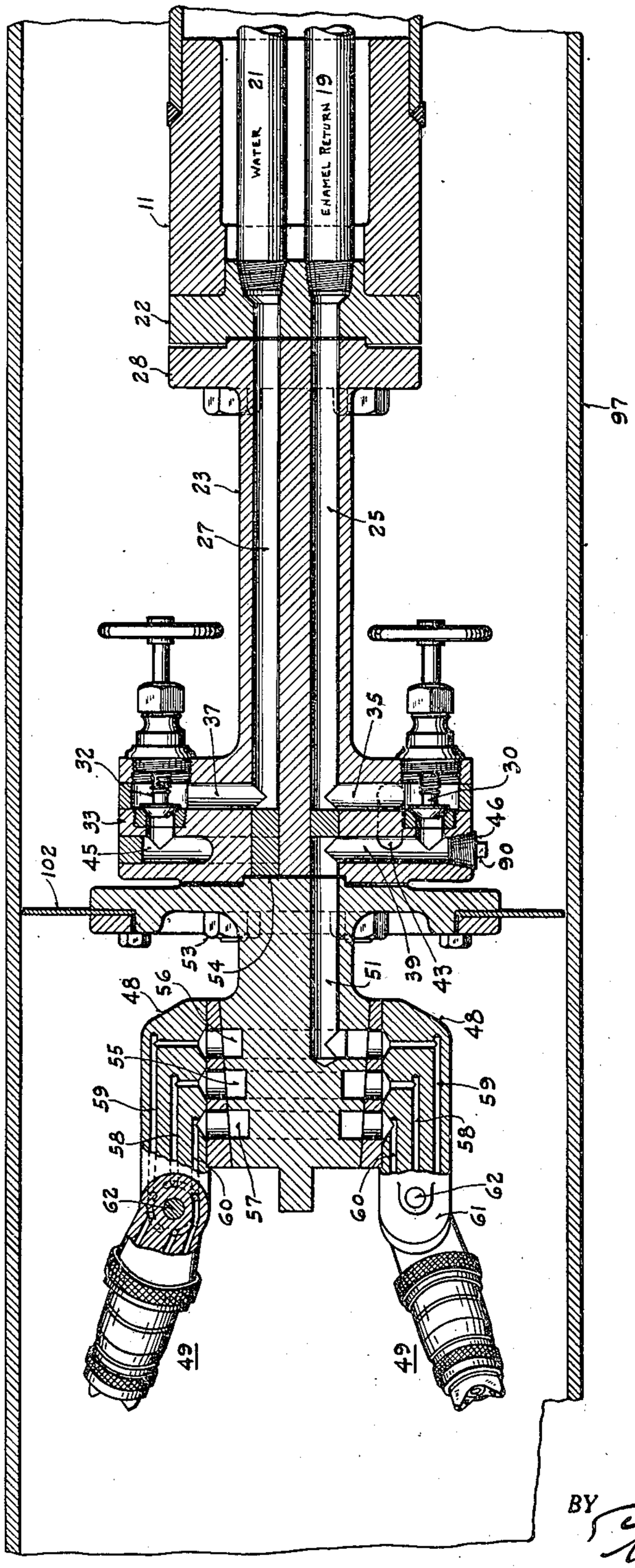

FIG. 4.

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July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

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FIG. 5.

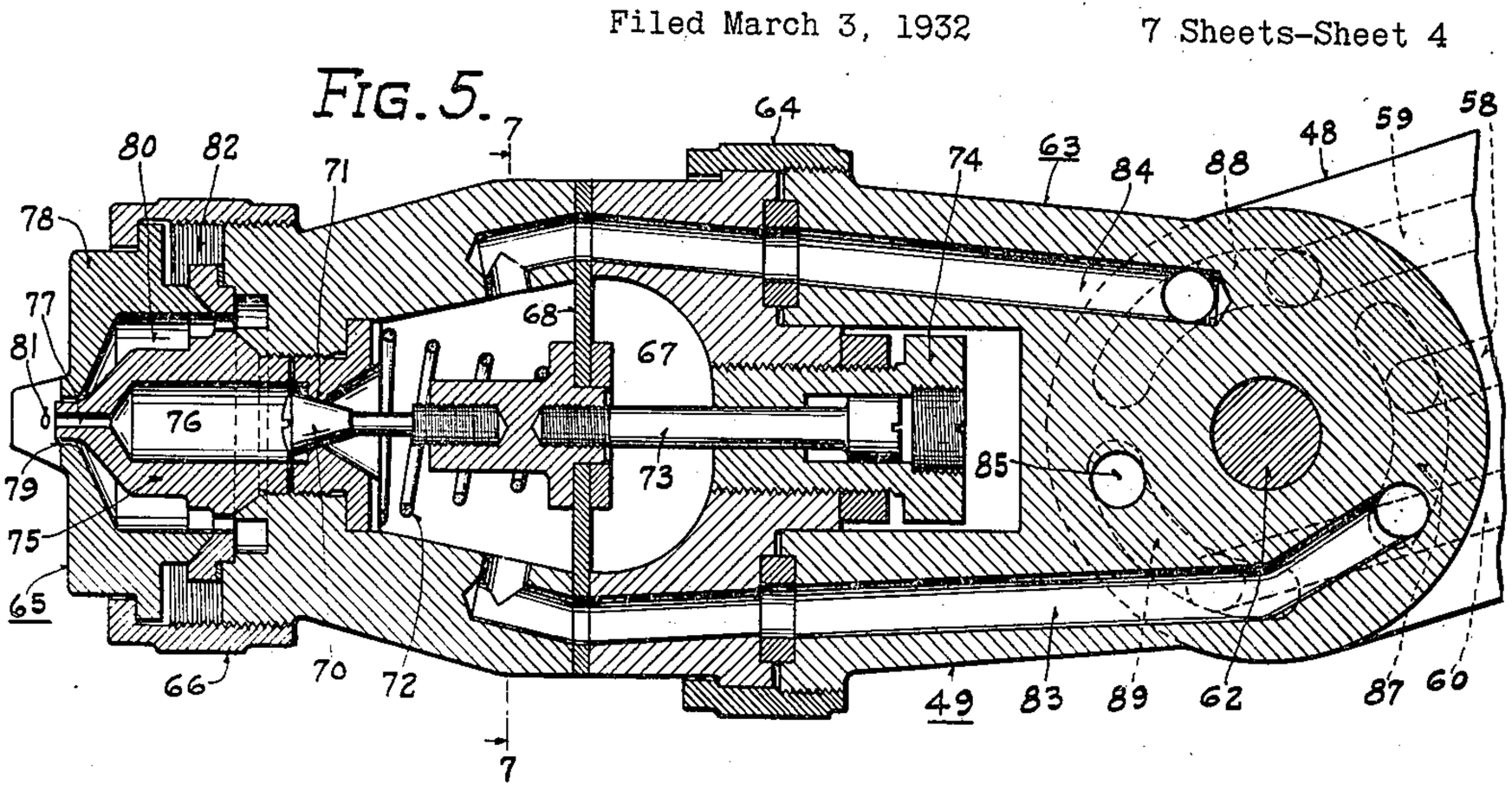
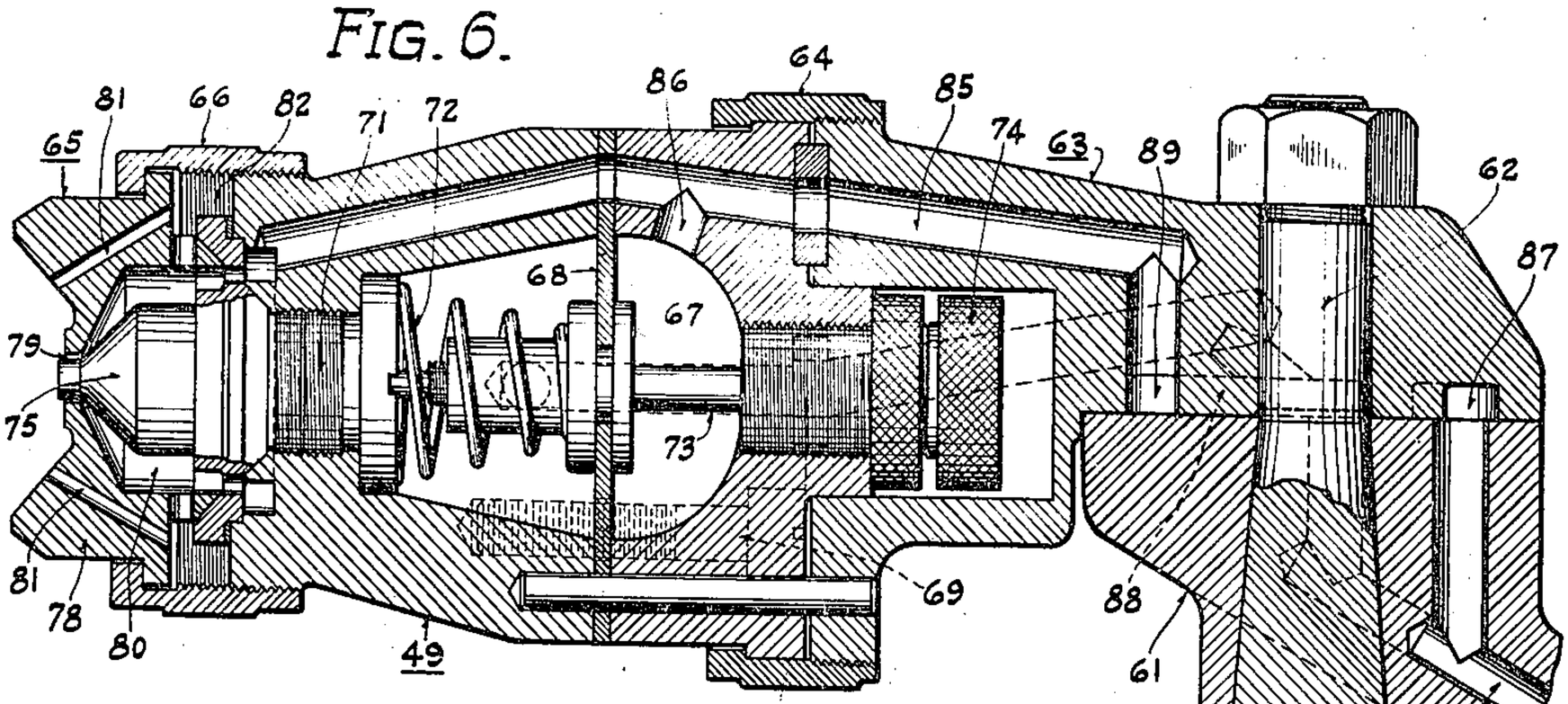


FIG. 6.



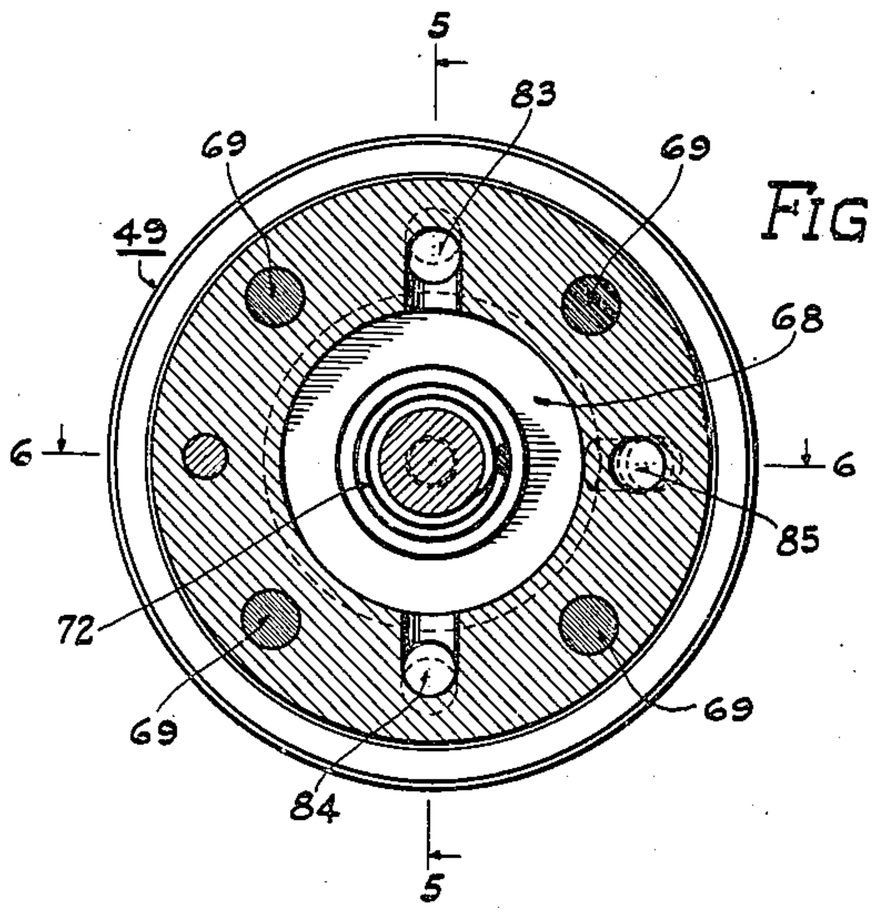


FIG. 7.

INVENTORS:
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July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

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FIG. 8.

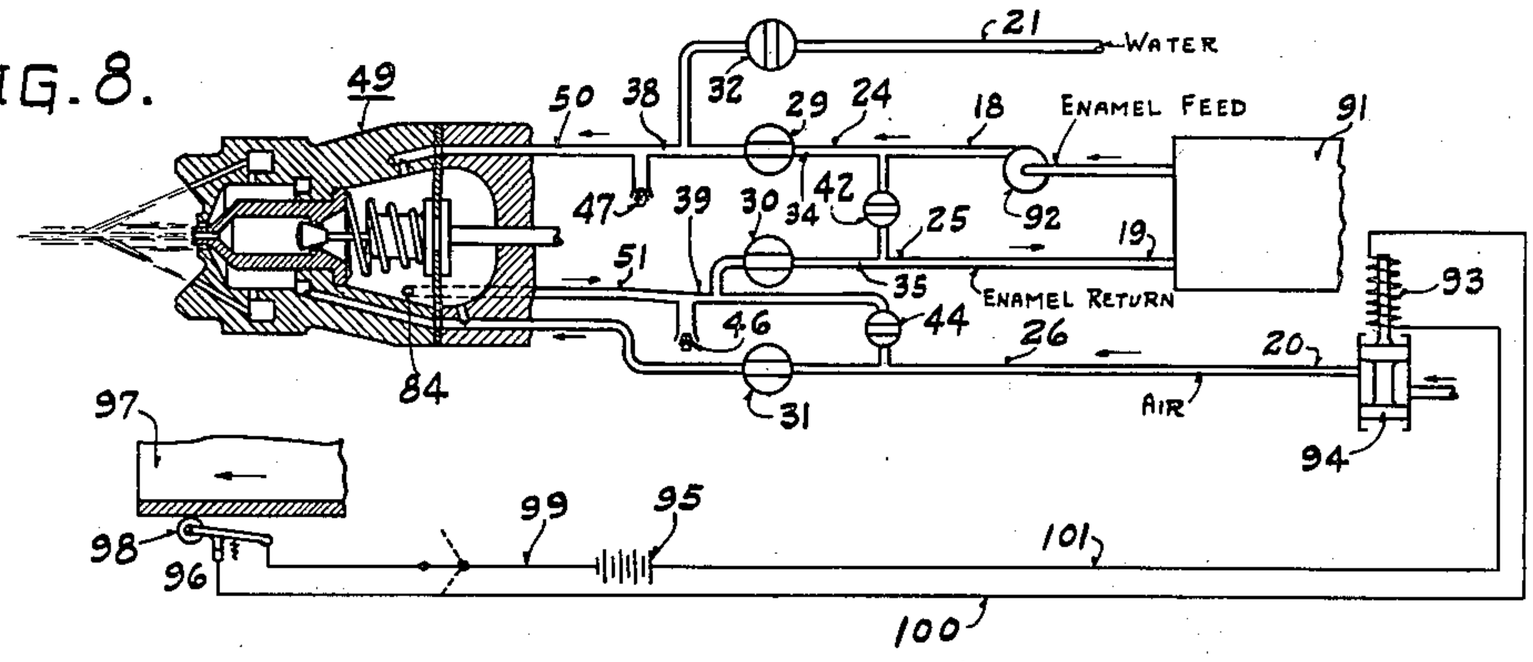


FIG. 9.

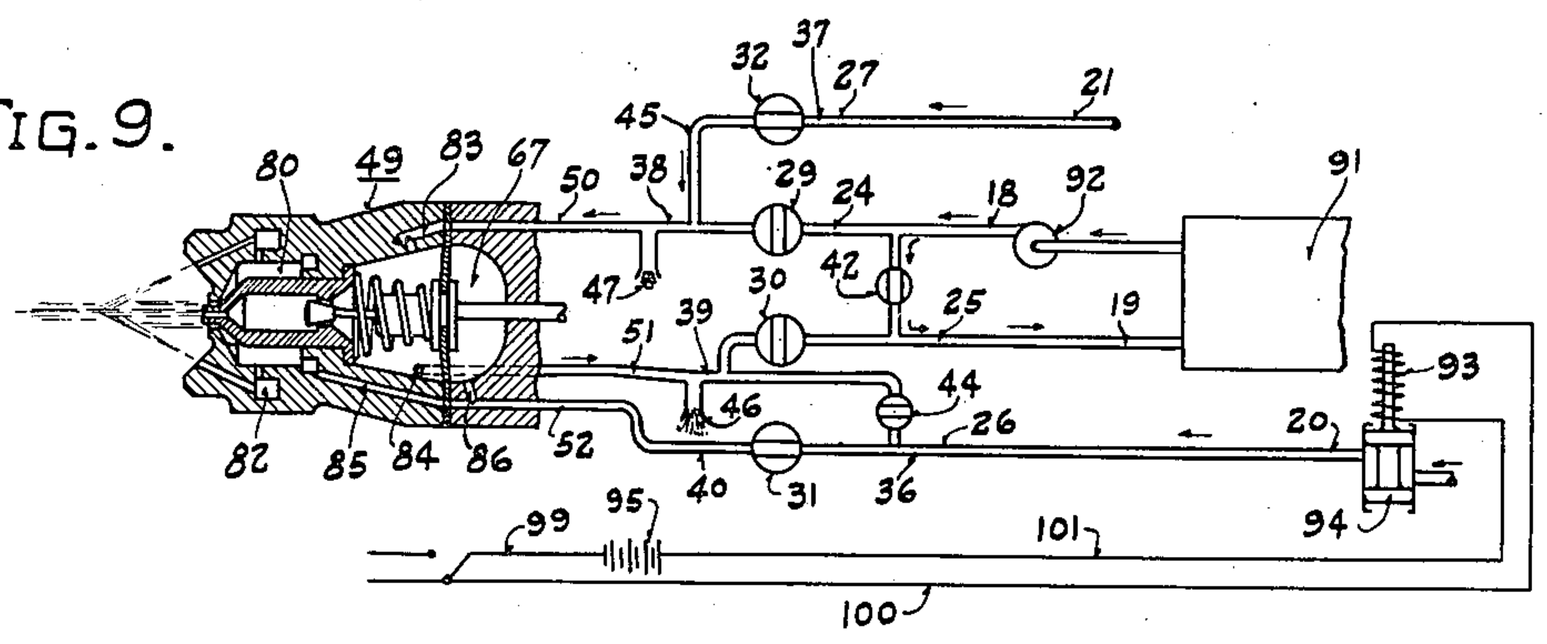


FIG. 10.

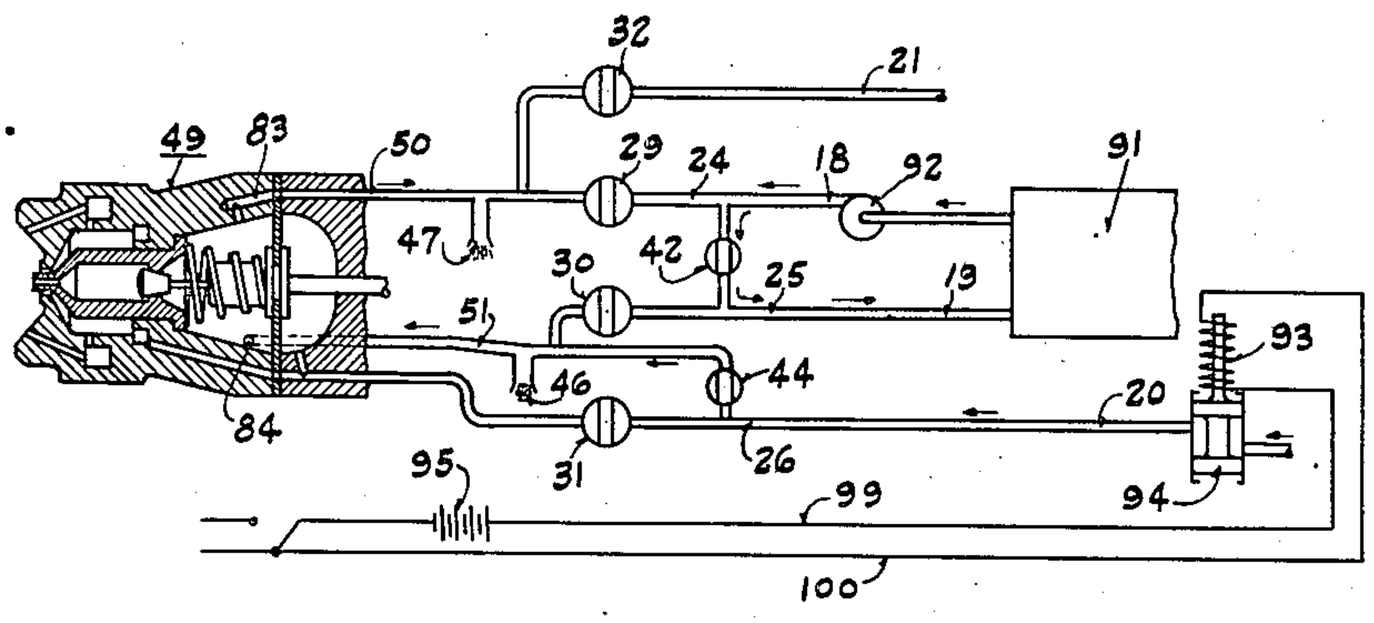
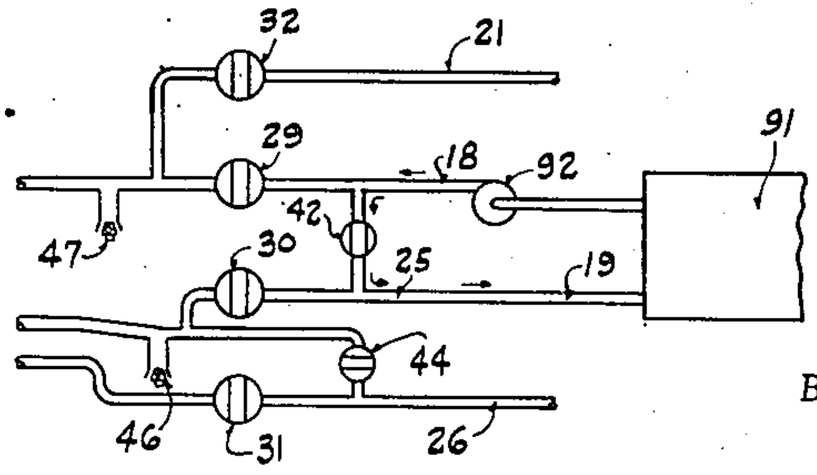


FIG. 11.



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July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

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FIG. 12.

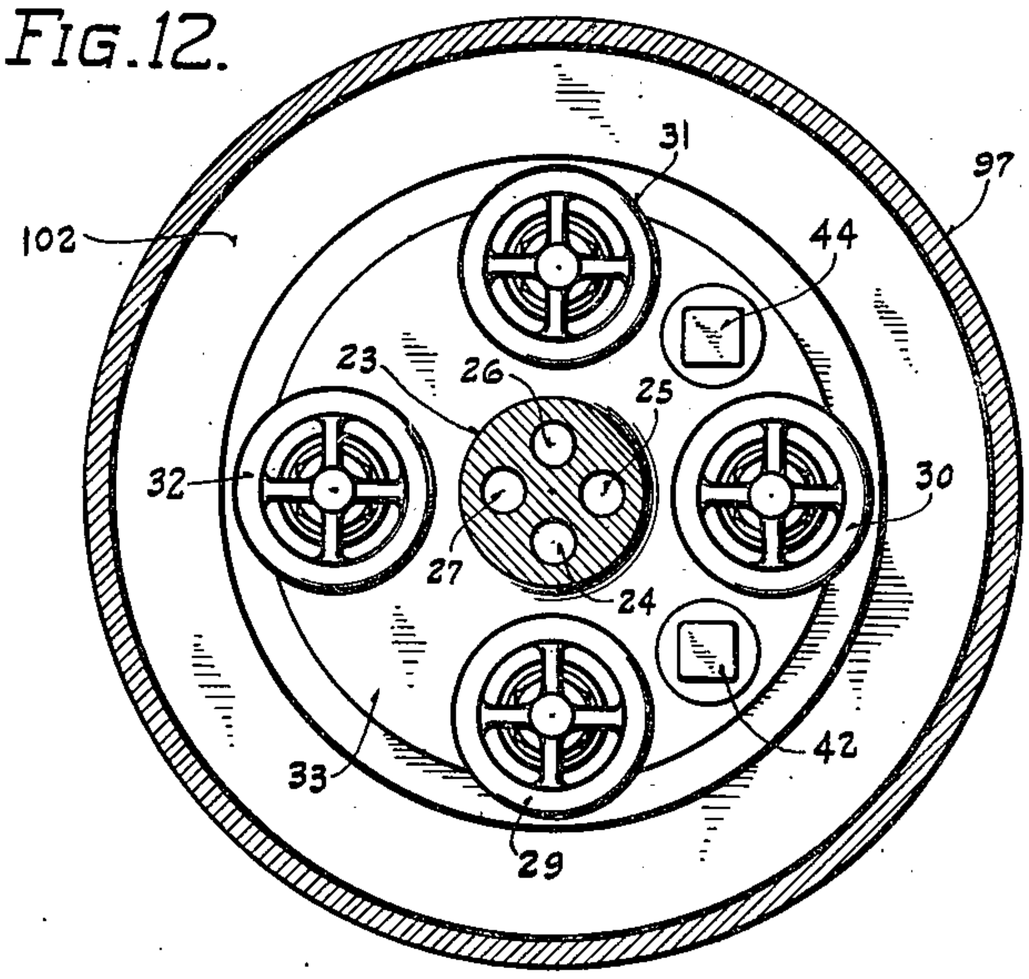


FIG. 13.

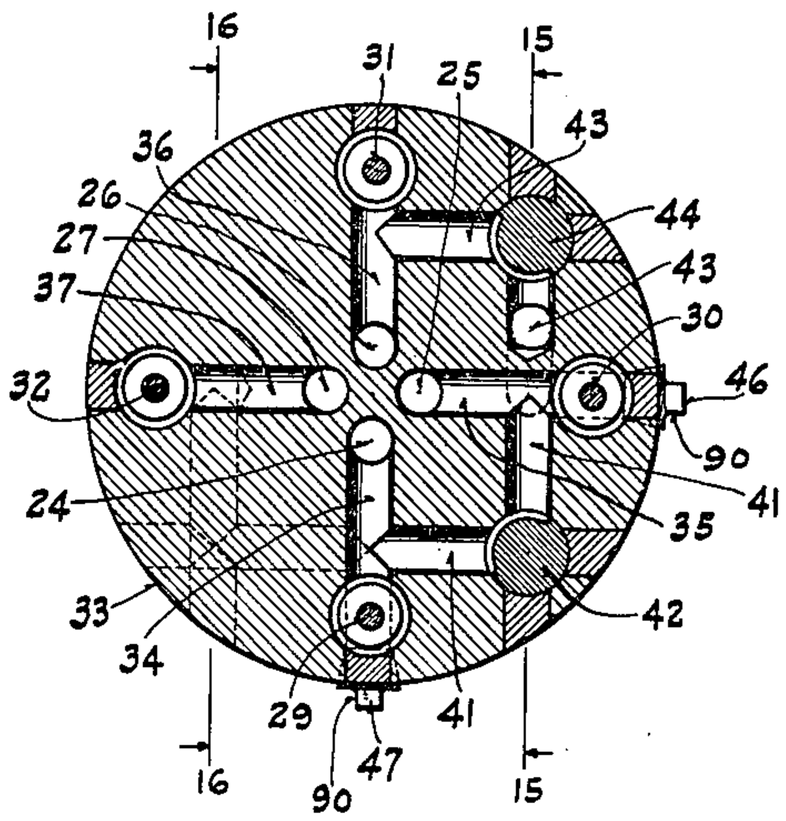
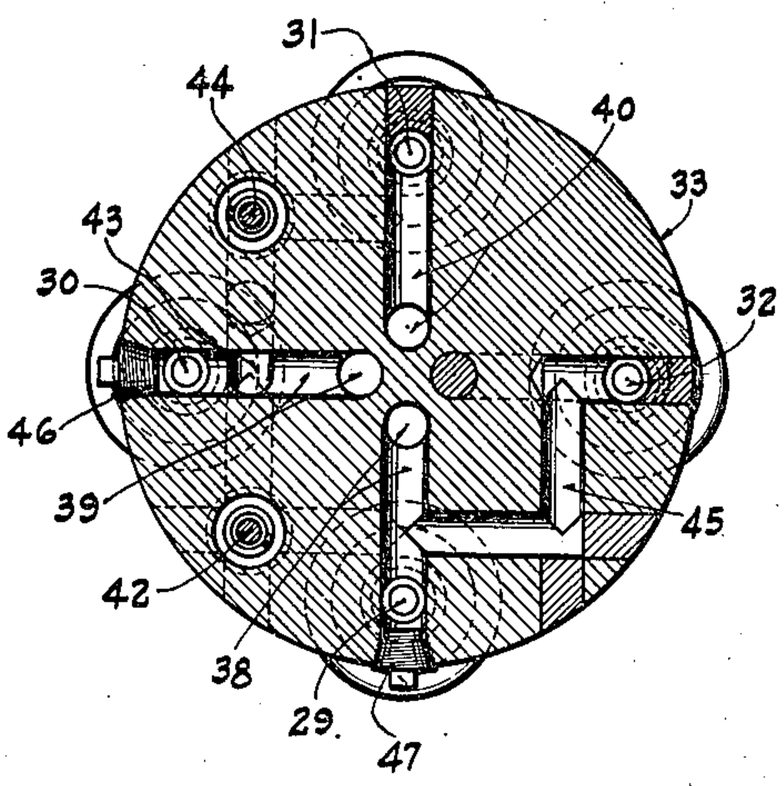


FIG. 14.



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July 28, 1936. A. ZISKA ET AL 2,048,912

ENAMEL SPRAYING APPARATUS

Filed March 3, 1932 7 Sheets-Sheet 7

FIG. 15.

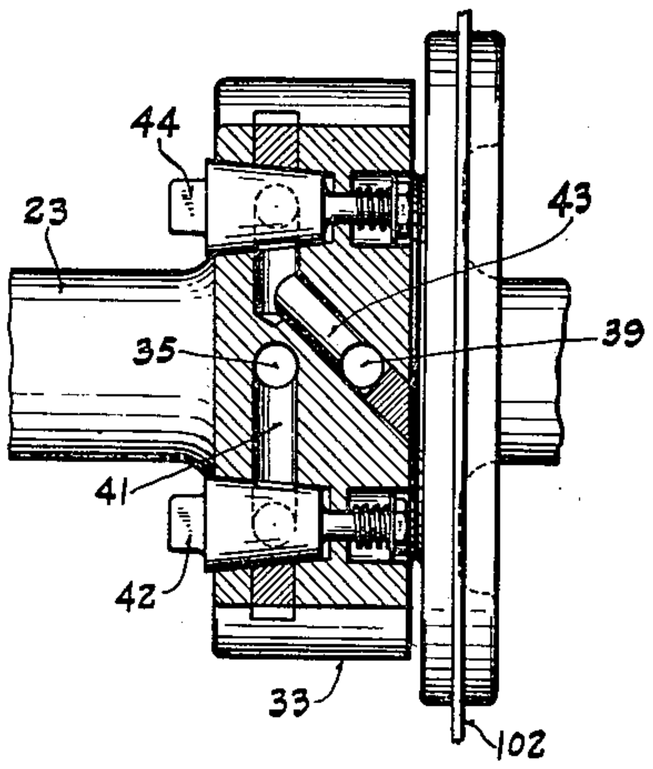


FIG. 16.

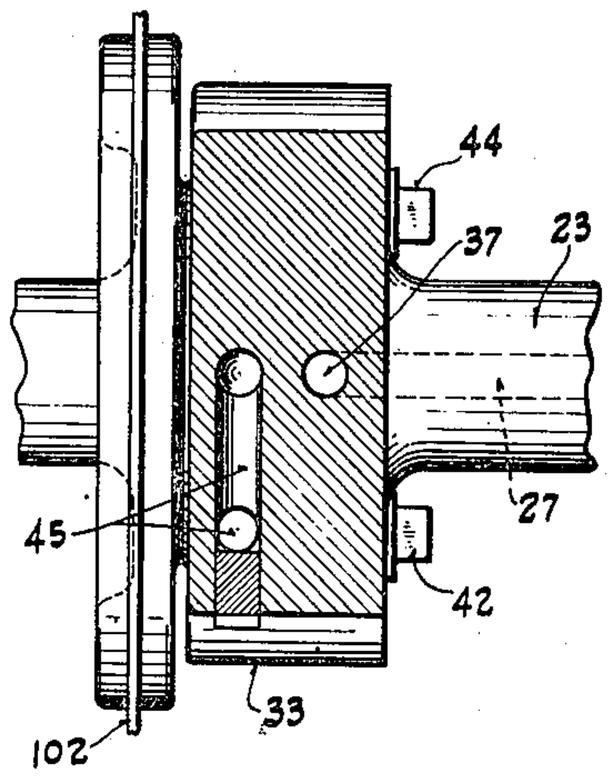
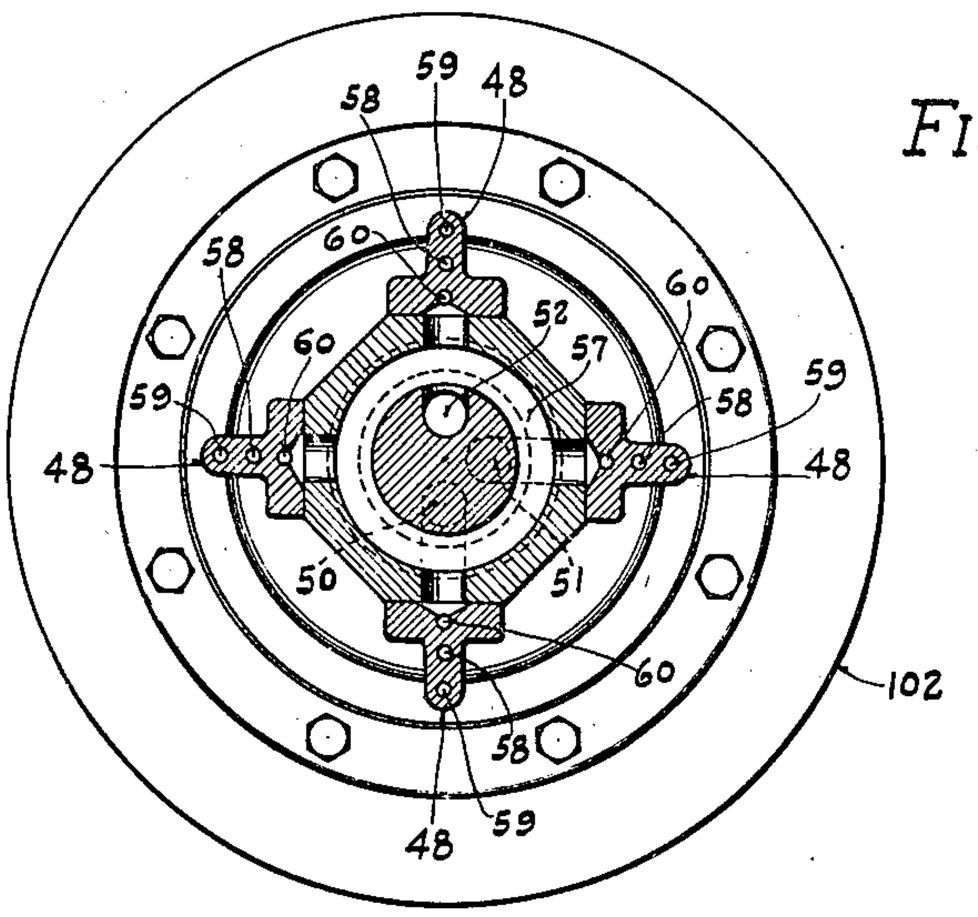


FIG. 17.



INVENTORS:
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BY Elvin C. Lindsay
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Patented July 28, 1936

2,048,912

UNITED STATES PATENT OFFICE

2,048,912

ENAMEL SPRAYING APPARATUS

Adam Ziska, Wauwatosa, and James Keith Marshall, Milwaukee, Wis., assignors to A. O. Smith Corporation, Milwaukee, Wis., a corporation of New York

Application March 3, 1932, Serial No. 596,504

15 Claims. (Cl. 91—45)

The present invention relates generally to enamel spraying apparatus and particularly to an internal enamel spraying apparatus.

An object of the invention is to provide for spraying enamel uniformly over the interior surface of a pipe or other cylindrical member.

A further object of the invention is to provide for circulating an enamel mixture continuously within the spraying apparatus to prevent settling of the solid particles and the clogging of the conduits when spraying operations have been interrupted.

Another object is to provide for flushing the enamel carrying passageways of the spraying apparatus to remove obstructions caused by the settling of the solids out of the enamel mixture.

Another object of the invention is to provide for imparting a swirling motion to the atomized enamel mixture as it leaves the spraying apparatus to insure complete and uniform coating of the interior surface of the pipe.

Another object is to provide a spray gun through which the enamel mixture may be circulated between the spraying operations.

Other objects will be apparent from the following description and claims when read in conjunction with the accompanying drawings, in which:

Figure 1 is a view in side elevation of spraying apparatus constructed in accordance with the invention, with parts broken away to show details of the structure;

Fig. 2 is a view in end elevation of the spraying apparatus illustrated in Fig. 1;

Fig. 3 is a view partly in longitudinal section and partly in side elevation of enamel spraying apparatus constructed in accordance with this invention;

Fig. 4 is a view partly in longitudinal section and partly in side elevation, the section being at right angles to the section in Fig. 3;

Figs. 5 and 6 are views partly in section and partly in side elevation taken generally on the line 5—5 and 6—6 of Fig. 7, respectively, showing details of the nozzle structure;

Fig. 7 is a transverse sectional view taken on the line 7—7 of Fig. 5;

Figs. 8, 9, 10, and 11 are diagrammatic views of the circulatory systems showing the paths taken by the enamel mixture during spraying operations and when spraying operations have been interrupted;

Fig. 12 is a transverse sectional view of the spray neck taken on a line 12—12 of Fig. 3;

Fig. 13 is a cross-sectional view taken on the line 13—13 of Fig. 3;

Fig. 14 is a transverse sectional view of the spray neck taken on the line 14—14 of Fig. 3;

Fig. 15 is a longitudinal sectional view of the spray neck taken on the line 15—15 of Fig. 13;

Fig. 16 is a sectional view taken on the line 16—16 of Fig. 13; and

Fig. 17 is a transverse sectional view of the spray head taken on the line 17—17 of Fig. 3.

In coating gas and oil transmission pipe with vitreous enamel coatings, the enamel mixture is applied to the pipe in a manner which will cause it to adhere, and then the enamel is fused to form a glazed, protective coating.

The ingredients from which the enamel is prepared are usually ground into a fine powder, which is mixed with a binder and water to provide an enamel mixture that may be readily applied to any article by spraying. Since the enamel as prepared is a mechanical mixture, the fine particles of solids are merely held in suspension and if allowed to stand the solids will settle forming hard masses. When the enamel mixture is allowed to stand in spraying apparatus, the solid ingredients will settle and block the openings and passageways.

Therefore when using apparatus for applying an enamel coating, it is of importance to keep the solids in suspension at all times.

The present structure is designed so that there are no "dead" spaces and provision is made for keeping the enamel mixture in circulation.

The enamel is applied to the surface of the pipe by means of a number of spray guns which atomize the enamel mixture and spread it upon the surface in a uniform layer. Since the spray guns are compact, the passages for enamel are correspondingly small and it is important that clogging of these passages be avoided. Since spraying operations are intermittent, provision is made for continuously circulating the enamel mixture in the spray gun to prevent settling and keep the passages open.

Referring now to the drawings, the spraying apparatus illustrated in Figs. 1 and 2 comprises a spraying head 10 carried by an arm 11 which is pivotally connected at 12 to a hollow pedestal 13. The arm 11 which is tubular is pivotally connected to the pedestal to permit a certain amount of movement of the spraying head to accommodate it to different spraying conditions. In order to adapt the apparatus to different sizes of pipe provision may be made for adjusting the arm up or down at the pedestal.

In order to move the pipe or other tubular article to be enameled relative to the spraying head 10, a plurality of power driven V-shaped rollers 14 and 15 are provided. The V-shaped rollers are suitable for different sizes of pipe and when set may serve nearly any operating condition. However, to meet exceptional conditions, the rollers may be changed readily.

For the spraying of pipe, the arm 11 is made long enough to accomodate pipe sections forty feet long. When the supporting arm is made of a length to accommodate such long pipes, it is necessary to provide some means for supporting it near the forward end. In this particular instance, a carrier 16 is provided on the arm 11 and disposed directly above the roller 14. The carriage 16 may be changed for different sizes of pipe.

It will be readily appreciated that when a spraying operation on a pipe has been completed, it is withdrawn from the spraying head. In order to catch the sprayed enamel when the spraying operation on one pipe is completed, a drum 17 is disposed to enclose the spraying head. As shown, this drum may be supported on suitable trestles which may be moved relative to the spraying head.

In performing enameling operations, there is a circulation of enamel from and to an enamel reservoir, and a supply of water under pressure is provided for washing out or flushing the spraying apparatus and air under pressure is provided to cooperate in the delivery of the enamel stream in the proper manner and for clearing the spraying apparatus of water after washing operations. The circulation of enamel and the delivery of water and air to the spraying head is effected through a plurality of pipes or hoses 18 to 21, inclusive, which extend through the hollow supporting arm 11. The outer ends of the pipes 18 to 21, inclusive, are threaded and supported in threaded openings provided in a plate 22 which is mounted at the end of the supporting arm 11.

The spraying head 10 comprises two sections, a neck 23 and a spray gun unit attached to the neck. The neck is provided with four passageways 24 to 27, inclusive, and it terminates at one end in the flange 28 which is shaped to register with the plate 22 on the end of the supporting arm 11. In this manner the neck may be tightly connected to the supporting arm 11 with the passageways 24 to 27, inclusive, in alignment with the pipes 18 to 21, inclusive, respectively. In order to make air and water tight joints, a packing may be disposed between the plates 22 and 28. However, methods of making tight joints so as to conduct air and water are well known and any suitable method may be adopted.

In order to control the circulation of the enamel and the delivery of water and air to the spraying head, a plurality of valves 29 to 32, inclusive, are provided for controlling the passageways 24 to 27, inclusive, respectively. Since it is desired to use this spraying apparatus for enameling pipes of varying diameters, its over-all transverse dimensions must be made as small as commensurate with good mechanical construction. Therefore instead of mounting the valves with their stems extending at right angles to the longitudinal passageways 24 to 27, inclusive, they are mounted with their stems extending parallel to the axis of the neck. In order to permit the mounting of the valves in this manner, the outer end of the neck is provided with a block 33 which extends outwardly in the manner of a flange.

The valves 29 to 32, inclusive, are mounted in valve receiving chambers machined in the block 33. These valves may be of any well known type, and in this instance valves having frusto-conical heads for engaging in machined valve seats are provided. The valve heads are disposed to be actuated by hand wheels which are directly connected thereto. As shown in Figs. 3 and 4, the body of the valve is threaded to engage in threads provided in the machined valve chambers.

The passageways 24 to 27, inclusive, are connected with the valve chambers provided for the valves 29 to 32, inclusive, respectively, by radially extending ducts 34 to 37, inclusive. Three substantially Z-shaped ducts 38 to 40, inclusive, are provided in the outer portion of the block 33 which extend radially inwardly and communicate with the chamber provided for valves 29 to 31, inclusive. The inner portions of the Z-shaped ducts 38 to 40, inclusive, extend in line with the passageways 24 to 26, inclusive, and are really continuations of these passageways.

Referring now to Figs. 8 to 11, inclusive, and 13, it will be observed that an L-shaped duct 41 extends between the ducts 34 and 35 connecting the passageways 24 and 25. A valve 42 is disposed in the block 33 of the spraying apparatus to control the circulation of enamel through the duct 41. Another duct 43 extending transversely and longitudinally of the block 33 connects the ducts 36 and 39 by-passing the valve 30 which permits air to be delivered to the duct 39 in advance of the valve 31. A valve 44 is provided for controlling the flow of fluid through the duct 43.

Since there is no need of water in the enameling process, the water is not carried forward of the neck in a separate passageway. The purpose of the water supply is for flushing the spraying head after the enameling operations have been stopped, and it is fed into the passageway through which the enamel is supplied. In order to deliver the water from the water supply passageway 27, to the enamel carrying channels, an L-shaped duct 45 is provided which leads to the duct 38.

As shown in Fig. 14, a drain passageway closed by the drain plug 46 communicates with the duct 39. This drain passageway is disposed to be utilized when flushing the spraying apparatus with water. Referring to Fig. 14, another drain passageway closed by the drain plug 47 communicates with the duct 38. This drain passageway permits the blowing of air through the forward portion of the spraying apparatus to drive out all the water after flushing has been completed.

As illustrated in Figs. 3 and 4, the head of the spraying apparatus is provided with brackets 48 on which a plurality of enameling spray guns 49 are pivotally mounted. In order to circulate the enamel and deliver the air to the spray guns, three passageways 50 to 52, inclusive, extending longitudinally of the head are provided. These passageways 50 to 52, inclusive, register with the ducts 38 to 40, inclusive, respectively, and are in alignment with the passageways 24 to 26, inclusive, respectively.

The spray gun unit 10 may be mounted on the neck 23 of the spraying apparatus in any suitable manner. In this embodiment of the invention, it is shown mounted by means of bolts 53. Packing 54 is placed between the head and neck to make air and enamel tight joints.

As shown in Figs. 3 and 4, a plurality of enamel chambers or manifolds 55 to 57, inclusive, are provided in the head 10 and disposed to communicate with the passageways 50 to 52, in-

clusive, respectively. As illustrated in Figs. 3, 4, and 17, passageways 58 to 60, inclusive, lead from the manifolds 55 to 57, inclusive, respectively, to the spray guns 49.

A plurality of lugs 61 are provided on the brackets 48 and it is through these lugs that the passageways 58 to 60, inclusive, communicate with the spray guns 49. In the lugs, the passageways 58 to 60 are turned through a right angle to terminate in a face of the lug.

The faces of the lugs 61 in which the passageways terminate are machined to provide bearing faces for receiving corresponding machined faces provided on the spray guns 49. The bearing faces provided on the spray guns 49 are best shown in Fig. 6. As pointed out hereinbefore, the spray guns 49 are pivotally mounted on the lugs 61. This may be accomplished in any suitable manner and, as shown in Figs. 5 and 6, pins 62 are provided which extend through the lugs and the flattened ends of the spray guns.

The spray gun structure is best shown in Figs. 5 and 6, and each gun comprises a two-part casing 63 which is held together by a coupling 64 and a nozzle 65 which is mounted on the outer section of the casing by a coupling 66. As shown, a chamber 67 is provided in the outer portion of the casing. A diaphragm 68 extends transversely of the chamber 67. The diaphragm may be mounted in any suitable manner and in this instance it is shown clamped between portions of the outer section of the casing 63 which are held together by screws 69.

A needle valve 70 is carried by the diaphragm 68. The head of the valve is frusto-conical in shape and is so disposed with relation to the valve seat 71 that when it is projected outwardly, the valve is opened. A spring 72 is interposed between the valve seat 71 and the diaphragm and biases the needle valve to its closed position.

In order to provide for limiting the movement of the needle valve head 70, a screw 73 is disposed with its threaded end making engagement with the mounting provided for supporting the valve head on the diaphragm and its head slidably mounted as a piston in a cylinder 74, which is adjustably mounted in the casing 63. Therefore the screw may be adjusted relative to the mounting for the valve head carried by the diaphragm and the cylinder 74 may be adjusted relative to the casing in order to limit the longitudinal movement of the needle valve.

The valve seat 71 is threaded and makes engagement with an opening provided in the outer end of the outer casing section. As illustrated in Fig. 5, the valve seat has a conical depression leading to the valve orifice. The threading of the valve seat facilitates its mounting.

Referring now to Fig. 5 in particular, the nozzle 65 comprises a member 75 resembling a bell jar in shape which is mounted in alignment with valve seat 71 providing a chamber 76 into which the needle valve opens. The outer end of the chamber converges into an enamel discharge opening 77 which extends through the outer end of the bell jar shaped member 75. Extending forward, encircling the outer end of the member 76, and spaced therefrom is a ring 78 forming with the former an annular orifice 79. The space 80 between the member 75 and ring 78 constitutes an air chamber from which air may be discharged in an annular jet around the enamel discharge opening 77.

When an enamel mixture is delivered through the discharge opening 77 and air under pressure through the orifice 79, a spray of atomized enamel mixture is projected outwardly. As stated hereinbefore, the spray guns 49 are pivotally mounted on the head so that they may be set at any predetermined angle to the axis of the spraying head. In such manner, the angle at which the spray of atomized enamel mixture is caused to impinge on the wall of the pipe may be changed as required. The guns 49 are also arranged on the head at an angle to the transverse axis of the head so that the enamel is delivered to the pipe with a swirling movement, the path of the enamel within the pipe simulating a helix.

In this embodiment of the invention, provision is made for giving the spray of enamel a predetermined shape. The shape preferred for the spray is that of a fan, and to produce such a shape, two discharge openings 81 are provided in the ring 78 which communicates with an annular air chamber 82 outside of the air chamber 80. The discharge openings 81 are disposed on opposite sides of the enamel discharge opening 77 and inclined inwardly so as to project jets of air against the stream of the atomized mixture.

As shown in Fig. 5, the chamber 67 is divided into two parts by the diaphragm 68. The outer or left hand portion is for enamel while the inner or right hand portion is for air. Two passageways 83 and 84 are provided in the wall of the casing 63 which extend from the base of the spray gun to the upper portion of the chamber 67. These passageways are provided for delivering the enamel mixture to the upper portion of the chamber for discharge through the needle valve and discharge opening 77. As illustrated in Fig. 6, a passageway 85 leads from the base of the casing 63 to the air chambers 80 and 82 and it is through this passageway that compressed air is supplied for the spraying operations.

In order to actuate the needle valve, a duct 86 is provided which leads from the passageway 85 to the inner portion of the chamber 67. In such manner compressed air may be supplied for biasing the diaphragm and needle valve outwardly opening the latter to permit a flow of the enamel mixture from the outer portion of the chamber 67.

As pointed out hereinbefore, the spray gun is provided at its base with a machined face for engaging the lugs 61 of the head of the spraying apparatus. Further, it is pointed out that the spray guns are disposed for pivotal movement about the pins 62. In order to maintain communication between the passageways 58 to 60, inclusive, and 83 to 85, inclusive, when the nozzle is rotated about its pivot point, arcuate-shaped ports 87 to 89, inclusive, are provided in the machined face of the gun. These ports extend through an angle of about 90°. This will permit ample movement of the guns to set them in any desired position for delivering the spray of enamel mixture to the pipe at the proper angle.

When the spray guns are mounted by means of the pin 62, communication will be established between the passageways 58 to 60, inclusive, and 83 to 85, inclusive, respectively, which communicate with the ports 87 to 89, inclusive, respectively. In this manner controlled passageways are provided which extend from the pipes 18, 19, and 20, inclusive, to the spray guns 49.

Drain plugs 46 and 47 have been referred to for controlling the flushing of the head 10 of the spraying apparatus by water and air, respectively. The outer ends of the plugs are provided with

heads 90 which are square in cross-section to receive a wrench or other device that may be available for rotating them.

In order to set the screw 73 to limit the movement of the needle valve, the nozzle head may be taken apart by the removal of the coupling 64. As will be readily apparent from an examination of Figs. 5 and 6, the removal of the coupling may be effected through the use of pipe wrenches or the like.

The enamel mixture for the spraying apparatus may be supplied from any suitable tank shown generally at 91 in Figs. 8 to 11, inclusive, a pump 92 being provided for effecting the circulation. Water for the flushing operations may be obtained from any pressure source preferably a water main, not shown. The supply of air may also be obtained from any suitable compressed air reservoir such as are commonly available and which, in the interest of simplicity in the drawing, is not illustrated.

A baffle 102 of flexible material is disposed behind the spray head to prevent the syphoning of the air from the pipe as propelled by the spray guns. Unless the baffle is used, the enamel tends to blow out the end of the pipe and greatly reduces the amount of atomized enamel mixture which is deposited.

The operation of the spraying head will be described generally, reference being had to Figs. 3 to 6, inclusive, and 8 to 11, inclusive. Assuming now that the spraying apparatus stands in its shut-down condition with all the valves closed and that the required source of enamel mixture, air, and water have been connected to the apparatus, then in order to start spraying operations the valves 29 to 31, inclusive, are opened and enamel is pumped through the pipe 18, passageway 24, valve 29, passageways 38 and 50, manifold 55, passageway 58, port 87, passageway 83, to the enamel chamber which is the outer portion of the chamber 67. If the needle valve 70 has not been opened as the result of the admission of air or if there is a greater volume of the enamel mixture being pumped into the enamel chamber than can escape through the valve, then all of the enamel mixture or a portion thereof will be returned to the reservoir 91. The return path of the enamel will be through the passageway 84, port 88, passageway 59, manifold 56, passageways 51 and 39, valve 30, passageways 35 and 25, and through the pipe 19 of the reservoir.

Upon the opening of the air valve 31, air under pressure is delivered through pipe 20, into passageways 26 and 36, and flows through air valve 31, passageways 40 and 52, manifold 57, passageway 60, port 89, passageway 85 from which it may flow through the duct 86 to the inner portion of the chamber 67 or to both of the annular air chambers 80 and 82.

The air that enters the inner portion of the chamber 67 builds up a pressure which will effect an outward movement of the diaphragm 68, lifting the needle valve 70 from its seat. The air pressure built up in the inner compartment of the chamber 67 for actuating the diaphragm will be determined by the operator. By changing the pressure, the extent to which the valve is opened may be controlled within limits, which depend on the setting of the screw 73.

The air delivered to the air chamber 80 flows through the annular orifice 79 around the discharge opening 77 and cooperates in the atomizing of the stream of enamel which flows outwardly at a speed which will depend upon the pressure applied to the enamel stream. The air which flows into the chamber 82 is discharged through the channels 81. These jets of air flow against the atomized column of enamel mixture giving it a shape simulating a fan.

In order to interrupt the spraying operation, the air valve 31 is actuated to shut off the supply of air. The spring 72 thus functions to project the diaphragm to the right, drawing the valve head 70 tightly into its seat. The enamel will continue to circulate through the enamel chamber, returning through the circuit traced hereinbefore, thus preventing the solid particles held in suspension in the enamel mixture from settling and plugging up the passageways.

Assuming now that it is desired to shut down the spraying apparatus, then the valve 42 is opened connecting the passageway 24 to the passageway 25, by-passing the spray guns. The valves 29 and 30 are closed. The enamel now circulates through the by-pass so as to prevent any clogging of the passageways or pipes between the storage reservoir and the valves 29 and 30.

In order to flush the portion of the spraying apparatus by-passed, the drain 46 and valve 32 are opened, as shown in Fig. 9, permitting water to flow from the pipe 21, through passageways 27 and 37, valve 32, duct 45, passageway 50, manifold 55, passageway 58, port 87, passageway 83, the enamel chamber, passageway 84, port 88, passageway 59, manifold 56, passageway 51, and out through the drain 46. In this manner the portions of the spraying apparatus forward of the control valves may be flushed to remove the enamel mixture.

After the enamel mixture has been completely washed out of the spraying apparatus, the valve 32 and drain 46 are closed, and the valve 44 and drain 47 are opened, as shown in Fig. 10. This permits a current of air to flow in the water circuit just traced, only in the opposite direction, forcing all the water that may have remained in the apparatus out through the drain 47.

The pump 92 may then be shut down and all the enamel drained back into the reservoir. It will readily be appreciated that the pipes leading from the enamel tank may be so disposed that the enamel mixture will drain back into the reservoir. However, means for pumping the enamel from the pipes and passageways may be provided and since the required apparatus is well known, it is not shown in this drawing.

In some instances, an automatic control for the air valve may be provided. In large pipe plants, where the spraying operations are carried out continuously, it is preferable that an automatic control be provided.

Referring to Fig. 8, the automatic control illustrated comprises a solenoid 93 which is connected to the gate valve 94 disposed to control the delivery of compressed air through the pipe 20. The energization of the solenoid may be effected from any suitable power source such as the battery 95. A switch, such as shown at 96, is disposed to be actuated by the pipe 97. The switch arm which is provided with a roller 98 is disposed to be engaged by the pipe 97 to effect the closure of the switch as the pipe is moved to the left as shown in Fig. 1.

The pipe should effect the closure of the switch 96 before it reaches the nozzles 49 of the spraying apparatus. This permits the starting of the spraying operation before the atomized enamel is directed against the pipe, thus establishing the

desired whirling stream of atomized enamel mixture.

In the operation of the control apparatus the switch is closed, establishing an electric circuit which may be traced from the battery 95 through conductor 99, switch 96, conductor 100, solenoid 93, and conductor 101, back to the battery. The solenoid is energized, actuating the gate valve and permitting air to flow forward through the valve 31, which is set in an open position when such a control is provided. The remainder of the operation is as described hereinbefore.

Since certain changes may be made in the above construction and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matters contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. In an enamel spraying apparatus for spraying the internal surfaces of long tubular articles, in combination, a plurality of spray guns for discharging the enamel in an atomized condition in the proper direction to coat the surface to be enameled, a head carrying the spray guns, means in the head disposed to distribute enamel to the spray guns and controlling the spraying operations, a long arm having a plurality of channels therein connected to the spray head, means for supporting one end of the arm having channels therein communicating with the channels in the arm, and a carriage disposed on the arm near the head to ride in the tubular article and support the outer end of the arm.

2. An enamel spraying apparatus for coating the inside of tubular articles, a spray head, a plurality of spray guns disposed on the spray head to be set at different angles to the axis of the head, a mandrel having a plurality of channels therein connected to the spray head, and an annular plate disposed at right angles to the axis of the spray head constituting a baffle to close the opening through the article during spraying operations to prevent circulation of air currents through the tubular article.

3. In apparatus for coating the interior of tubular articles with an enamel mixture, in combination, a plurality of spray nozzles disposed at an angle to the longitudinal axis of the article to be coated to give the enamel a motion spirally of the tubular article, means for delivering the enamel mixture under pressure to the nozzles, and means for circulating the enamel in the delivery means independently of the nozzles to maintain the solids of the enamel mixture in suspension.

4. In apparatus for coating the interior of tubular articles with an enamel mixture, in combination, a plurality of spray nozzles disposed at an angle to the longitudinal axis of the article to be coated to give the enamel a motion spirally of the tubular article, means for delivering the enamel mixture under pressure to the nozzles, and means for by-passing and isolating the spray nozzles to circulate the enamel mixture when the spraying operation has been discontinued to maintain the solid particles of the enamel mixture in suspension.

5. In apparatus for coating the interior surface of a pipe with an enamel mixture, in combination, a plurality of spray guns for discharging the enamel mixture against the interior surface of the pipe, means for delivering the enamel mixture to the spray guns under pressure, means associated with the means for delivering enamel to the spray guns for by-passing the spray guns, means for isolating the spray guns from the means for delivering the enamel, and means for flushing the spray guns with a cleaning liquid to prevent the clogging of the channels by the settling of the solids in the enamel mixture after the spray guns have been isolated.

6. In apparatus for coating the interior surface of a pipe with an enamel mixture, in combination, a plurality of spray guns for discharging the enamel mixture against the interior surface of the pipe, the spray guns being disposed to discharge the enamel mixture spirally of the pipe, means for delivering the enamel mixture to the spray guns under pressure, means associated with the means for delivering enamel to the spray guns for by-passing the spray guns, means for isolating the spray guns from the means for delivering the enamel, and means for flushing the spray guns with a cleaning liquid to prevent the clogging of the channels by the settling of the solids in the enamel mixture after the spray guns have been isolated.

7. In apparatus for coating the interior surface of a pipe with an enamel mixture, in combination, a plurality of spray guns for discharging the enamel mixture against the interior surface of the pipe, means for delivering the enamel mixture to the spray guns under pressure, means associated with the means for delivering enamel to the spray guns for by-passing the spray guns, means for isolating the spray guns from the means for delivering the enamel, means for flushing the clogging of the channels by the settling of the solids in the enamel mixture after the spray guns have been isolated, and means for discharging a current of air through the nozzle after the flushing operation has been completed.

8. A spraying apparatus for coating the interior surfaces of tubular articles with an enamel mixture comprising, in combination, a plurality of nozzles for discharging a spray of enamel mixture spirally of the interior surface of the tubular member, means for supplying the enamel mixture under pressure to the nozzles, means for circulating the enamel mixture independently of the nozzles, means for by-passing the nozzles and establishing a local circuit for circulating the enamel mixture, means independent of the supply means for flushing the nozzles, and a baffle associated with the nozzles and supply means for preventing circulating of air through the tubular article and cooperative to effect an even distribution of the enamel mixture discharged through the nozzles.

9. In a machine for coating articles with vitreous enameling material and the like, a spray head, passages in said head for conducting enameling material therethrough for spraying operations, a valve in said head connecting said passages to additional passages for by-passing said enameling material, means for directing a cleaning fluid through said enameling passages after a spraying operation, and means for directing air through said passages to remove all cleaning fluid prior to another spraying operation.

10. In a machine for coating articles with vitreous enameling material and the like, a source of enameling material, a spray head, means connecting said head with said source of enameling material, means for returning excess enameling material from said head to said source, means for cutting off the supply of enameling material

from said head, means for directing water through both of said first named means to cleanse the same of enameling material, and means for directing air through said means for removing the water therefrom prior to another spraying operation.

11. In a machine for coating articles with vitreous enameling material and the like, a source of enameling material, a spray head, means connecting said head with said source of enameling material, means for returning excess enameling material from said head to said source, means for cutting off the supply of enameling material from said head, means for directing water through both of said first named means to cleanse the same of enameling material, and means for directing air through said means in a direction opposite to the flow of water therethrough for removing the water therefrom prior to another spraying operation.

12. In a machine for coating articles with vitreous enameling material and the like, a spray nozzle comprising a body chamber, a flexible diaphragm dividing said body chamber into two parts, means connecting one part of said chamber to a source of enameling material under pressure, means connecting the other part of said chamber to a source of compressed air at a higher pressure than that of said enameling material, a discharge port for said enameling material, a valve controlling said port, and means connecting said valve with said diaphragm to effect opening of the valve when compressed air is admitted to said chamber on one side of the diaphragm.

13. In a machine for coating articles with vitreous enameling material and the like, a spray nozzle comprising a body chamber, a flexible diaphragm dividing said body chamber into two parts, means connecting one part of said chamber to a source of enameling material under pressure, means connecting the other part of said chamber to a source of compressed air at a higher pressure than that of said enameling material, a discharge port for said enameling material, a valve controlling said port, means normally biasing said valve to closed position, and means connecting said valve with said diaphragm to effect opening of the valve when compressed air is admitted to said chamber on one side of the diaphragm.

14. In a machine for coating articles with vitreous enameling material and the like, a spray nozzle comprising a body chamber, a flexible diaphragm dividing said body chamber into two parts, means connecting one part of said chamber to a source of enameling material under pressure, means connecting the other part of said chamber to a source of compressed air at a higher pressure than that of said enameling material, a discharge port for said enameling material, a valve controlling said port, means normally biasing said valve to closed position, means connecting said valve with said diaphragm to effect opening of the valve when compressed air is admitted to said chamber on one side of the diaphragm, and adjustable means limiting the extent of opening of said valve.

15. In an apparatus for coating the interior of cylindrical tubular articles with enameling material and the like, a plurality of spray guns for emitting a flattened stream of atomized enameling material, means for supporting the guns within the article and for relative longitudinal movement therewith, said guns being disposed diagonally on lines offset from and at an angle to the longitudinal axis of the article to impart to the enameling material ejected from said guns a swirling motion as it is directed against the curved surface of the article.

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