# United States Patent [19]

**Kudo et al.**

[11] **3,722,463**

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[54] **TUBE COATING APPARATUS**


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[51] **Int. Cl.** ....................**B05c 11/122**

[58] **Field of Search** ....................118/4, 6, 7, 8, 2, 65, 67, 118/405, DIG. 11, DIG. 12, DIG. 13; 214/1 P; 226/1; 117/113–115; 29/433


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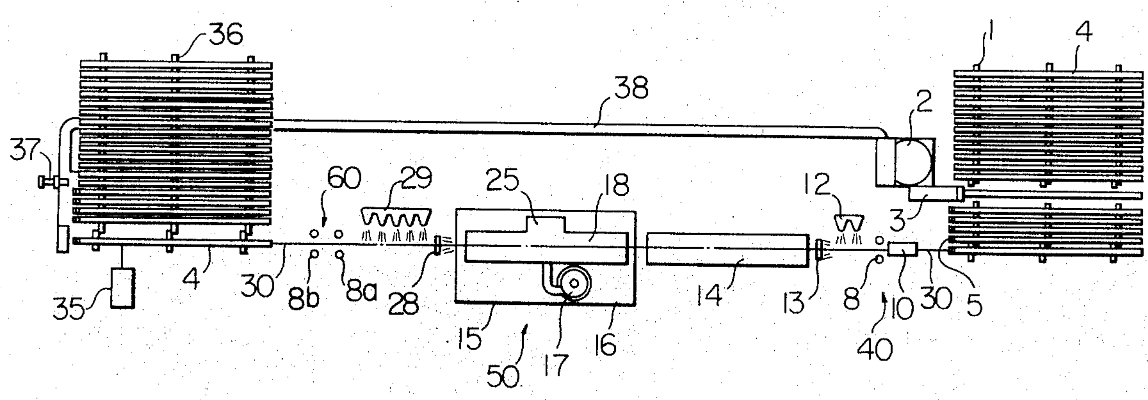
[57] **ABSTRACT**


A galvanizing apparatus includes means connecting individual lengths of tube sections by assembly of a connector element therewith, means to convey the assembled sections through a plurality of treating stations, means to thereafter disconnect the tube sections and to return the connector element to the connecting means.


**7 Claims, 10 Drawing Figures**



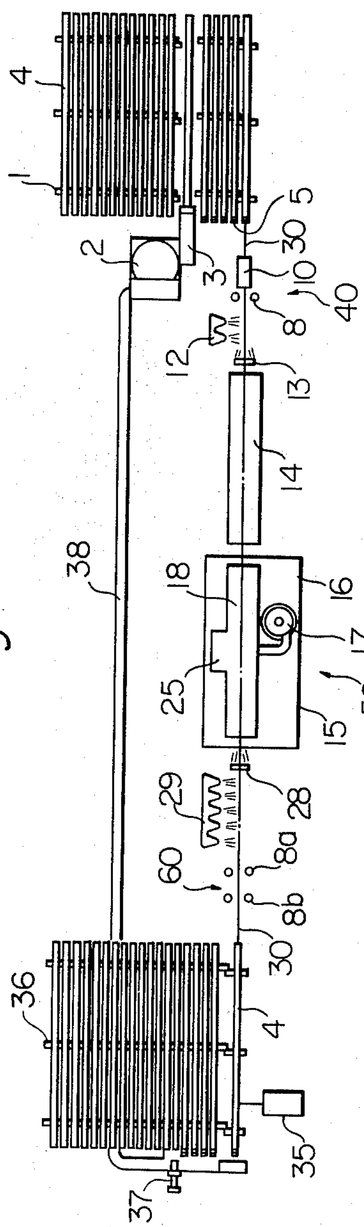


Fig. 1

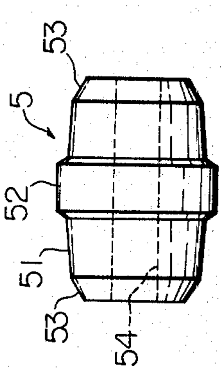


Fig. 6

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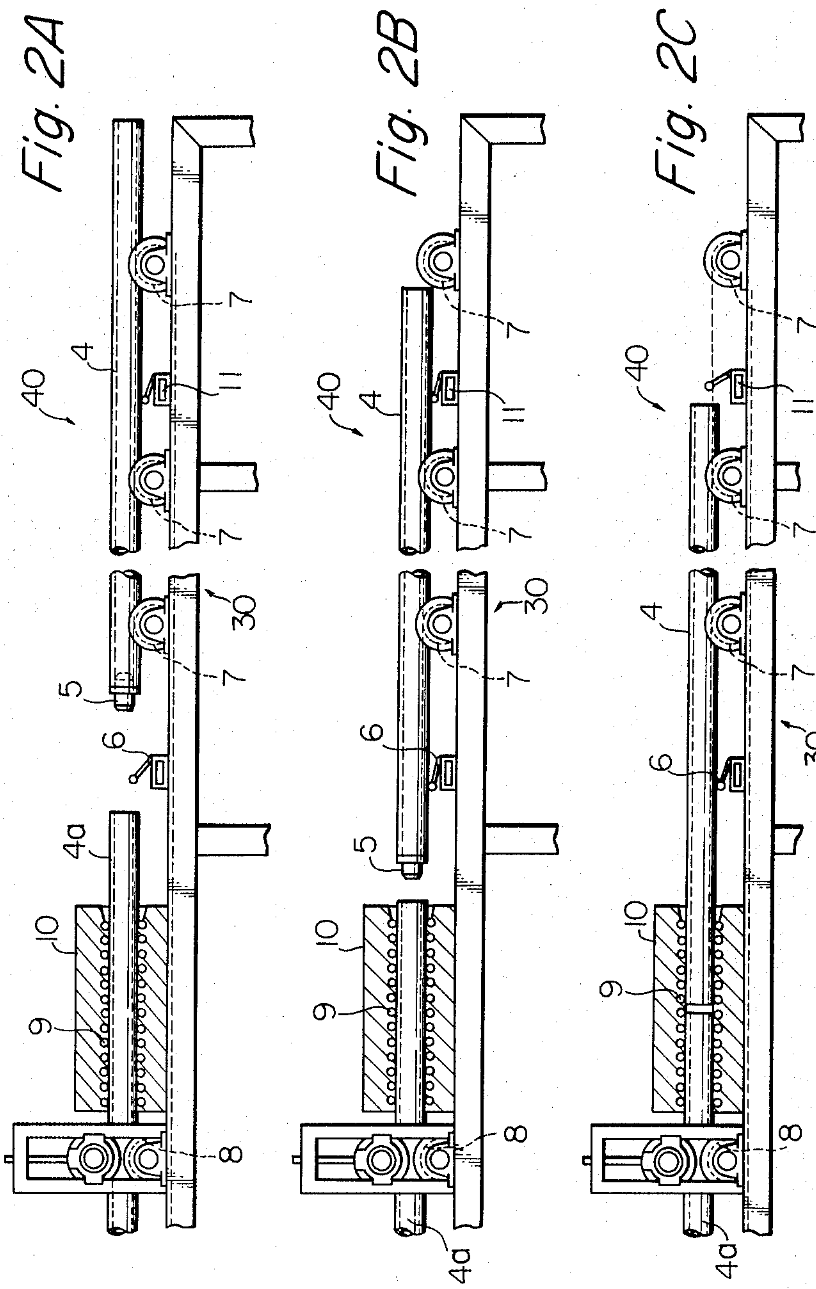


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*Fig. 3*

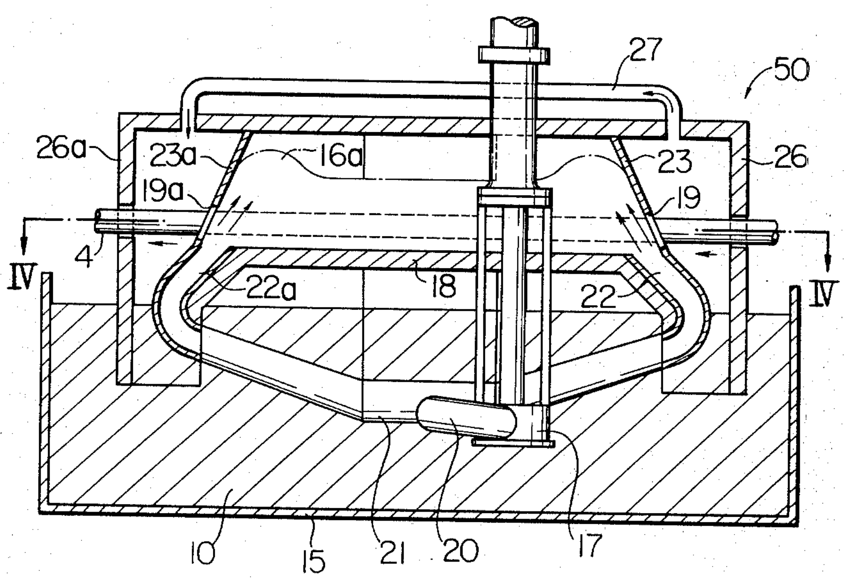
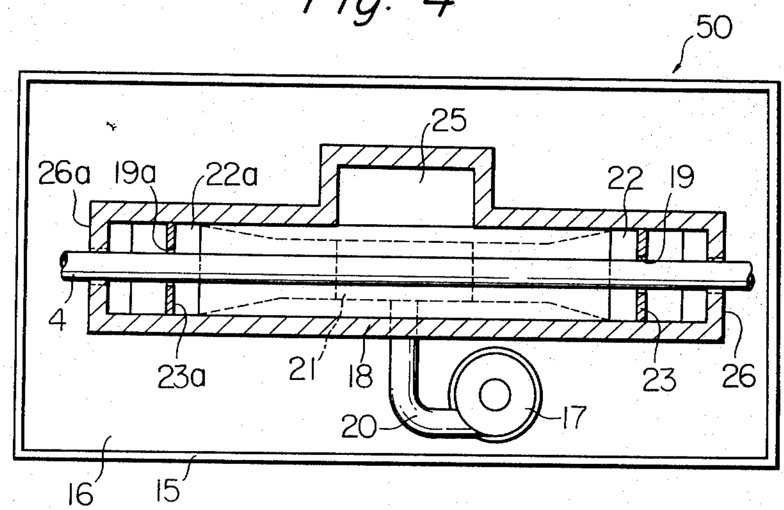



*Fig. 4*

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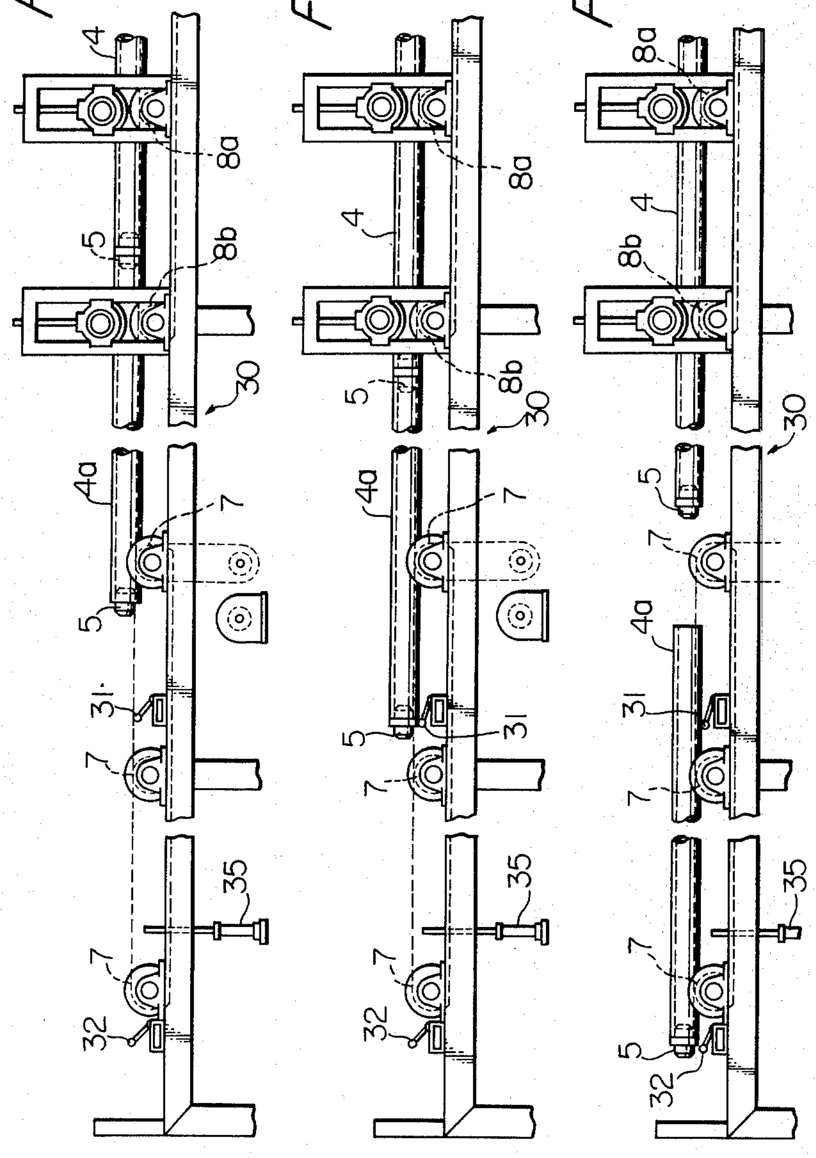


Fig. 5A

Fig. 5B

Fig. 5C

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## TUBE COATING APPARATUS

The present invention relates to an apparatus for forming galvanized coating with molten metal on only outer surfaces of steel tubes.

Steel tubes galvanized in outer surfaces with molten metal have the wide range of use as, for example, structural pipe, conduit tube, refrigerator tube, and so forth. In order to galvanize outer surfaces of such tubes with molten metal for such uses, several processes have been already introduced, for example,

a. in the pretreatment before galvanizing, inner surface of the tube is given ungalvanizing treatment such as chemical conversion treatment;
b. after the tube is galvanized in inner and outer surfaces by common galvanizing, the galvanized coating on the inner surface only is dissolved away by, for example, acid while the coating on the outer surface is protected from the acid; and
c. the tubes are assembled beforehand into a structure ready for use and then only outer surfaces thereof are coated by galvanizing.

However, these processes, in comparison to the common processes for galvanizing both surfaces of the tubes, have such problems as increase in steps requiring manual operation, mechanization of which is difficult, increase in material required, and increase in cost due to heavy reduction in production efficiency.

Because there is a limit in length of galvanizing bath, length of the pipe to be galvanized is limited by the length of the bath. And a patented invention was proposed under the title "Continuous tube forming and galvanizing" U.S. Pat. No. 3,122,114) for providing an exterior surface galvanizing machine with molten zinc in the production line for forming thin electric-welded steel tubes. However, since this galvanizing machine is incorporated in the tube forming line, it cannot apply to galvanizing of individual tubes cut out or tubes of arbitrary diameters. Since the galvanizing rate is dependent upon the tube forming rate, it is impossible to control the galvanizing rate independently. Accordingly, this galvanizing machine according to the U.S. Pat. No. 3,122,114 is difficult to apply to galvanizing of thick steel tubes, to increase thickness of the galvanized coating, and to apply to other tube forming method than the electric-welded tubing method. Therefore, this galvanizing machine is not suitable for multi-purpose use.

Moreover, in this exterior surface galvanizing machine, because of the method adopted therein for introducing the molten zinc into the reservoir housing and for storing it, unless non-oxidizing atmosphere is maintained in the heating furnace and the inside and outside of the housing by, for example, introduction of inert gas thereto, the desirable galvanized coating will not be obtained and the production loss will be increased by occurrence of oxidization of the zinc. Thus, since it is essential to maintain non-oxidizing atmosphere in this machine, it is inevitably complicated in structure and difficult in operation.

The present invention provides an apparatus for drastically obviating these disadvantages of the conventional processes for galvanizing of exterior surfaces of tubes with molten metal. More particularly, the present invention provides an apparatus for practicing the process for forming uniform coating with molten metal on only outer surfaces of tubes by performing all such steps continuously and automatically on a series of conveyors without necessity to use inert gas, as connecting individual tubes of any length lengthwise with connecting members having communicating holes or with connecting members of adhesive material, sealing hermetically the leading end of the connected tubes, rendering such pretreatments continuously as cleansing the outer surfaces of the tubes and flux treatments and so forth, galvanizing the outer surfaces of the connected tubes by passing them through the case to which molten metal is continuously fed from the molten metal kettle, and then disconnecting the connected tubes into individual tubes by removing the connecting members from the tubes.

FIG. 1 is a schematic flow diagram of the continuous galvanizing system;

FIGS. 2A, B and C are side views of tube connecting means showing the step of connecting the tubes continuously on the roller conveyor;

FIG. 3 is a side sectional view of the molten metal kettle for continuously contacting the molten metal to the outer surface of the tube;

FIG. 4 is a cross sectional view taken along the line Iv—IV of FIG. 3;

FIGS. 5A, B and C are side views of the connected tube disconnecting means showing the step of disconnecting the connected tube continuously; and

FIG. 6 is a plan view of a tube sealing joint.

An embodiment of the present invention is described in detail below with reference to the drawings. In FIG. 1, individual tubes **4** of arbitrary length given pretreatments such as degreasing and pickling are placed on inclined transfer table **1**, ends of the tubes **4** are aligned in a line by an ordinary stopper (not illustrated), and a sealing joint **5** which is to be described below with reference to FIG. **6** is pushed into the end of the tube **4** by inserting means **3**. The individual tubes **4** thus prepared are placed in order on roller conveyor **30**.

The individual tubes **4** are advanced to tube connecting means **40** which is to be described below with reference to FIGS. 2A, B and C where ends of the tubes are connected to each other by means of the sealing joints **5**.

The connected tube **4** passes through spray distributor **12** of flux solution (for example, a solution of mixture of zinc chloride and ammonium chloride) and excess solution remover **13** for blowing off compressed air and advanced into ordinary tunnel-type heating furnace **14**. The excess solution sticking to the outer surface of the tube is removed by, for example, compressed air blown off by the excess solution remover **13** to facilitate the preheating of the tube of the succeeding step. Such pretreatments as degreasing and pickling may be rendered by, for example, showering before flux treatment. Here, the connected tube **4** is heated to the predetermined temperature (in galvanization of zinc, for example, surface of the tube is heated to higher than 200°C).

Then, the heated connected tube **4** is advanced to the molten metal kettle **50** where the outer surface of the tube is coated with the desired metal, for example, zinc, aluminum, lead, tin, etc.

The galvanized connected tube **4** is removed of excess coating by the excess coating remover **28** blowing off compressed air and is cooled by shower-type cooler **29**.

The cooled connected tube **4** is disconnected into the former individual tubes **4** by connected tube disconnecting means **60** which is to be described below with reference to FIGS. 5A, B, and C, and advanced to product transfer table **36**. After the ends of the disconnected tubes are aligned in line, said sealing joints **5** are removed from the ends of the tubes by clamping remover **37** and returned to the vibration feeder **2** by belt conveyor **38**. Thus, a series of continuous galvanizing process is completed.

Each steps and means referred to above are described in detail below.

As shown in FIG. **6**, the sealing joint **5** is provided with a larger diameter portion **52** at the central part, slightly tapered smaller diameter portions **51** at both sides of the larger diameter portion **52**, and substantially tapered end portions **53**. And a hole **54** is provided along the central axis of the sealing joint **5**. Ends of an individual tube surround the both smaller diameter portions **51** and are stopped by the larger diameter portion **52**. The hole **54** of the sealing joint **5** acts, when the tube is heated, as a vent to let the air expanded within the tube escape to the atmosphere through the succeeding tubes. But, at the foremost and outermost ends of the connected tube, sealing joints having no hole are used. The sealing joint **5** is made of such material as may be capable of preventing the cooling water from flowing into the tube, free from damage by repeated use, and having a proper degree of fittable and removable property, for example, wood, soft metal, synthetic resin, and so forth.

The tube connecting means **40** is described below with reference to FIGS. 2A, B, and C. As shown in FIG. 2A, tubes **4** each having a sealing joint **5** fitted thereto are advanced in order automatically to magnet roller **7** of the roller conveyor **30**, and switching the limit switch **11** "on" to start the roller **7**, the pipes **4** are advanced further. Peripheral speed of the magnet roller **7** is determined to be **2 — 3** times that of the forward roller **8** of the roller conveyor when the limit switch **6** is switched "on". When the tube **4** switches the limit switch **6** "on" as shown in FIG. 2B, the magnet roller **7** is accelerated to make the front end of the tube **4** on itself collide with the rear end of another tube **4***a* advancing in front of the tube **4** from behind (see FIG. 2B), and the tubes **4** and **4***a* are completely connected together automatically by the sealing joint **5** while passing through connecting guide **10** provided with freely rotating balls **9** therewithin (see FIG. 2C). After the tubes are perfectly connected, the limit switch **11** is immediately made "off" to reduce the driving speed of the magnet roller **7** to the same peripheral speed of the forward roller **8** whereby to prevent the roller from slipping.

The connecting of the tubes may be performed in the method wherein the roller **7** is freely rotated and the tube **4** on the roller **7** is pushed into the another tube by a pusher operated, for example, by an air cylinder.

It is not necessary to maintain the non-oxidizing atmosphere within the heating furnace **14** under the ordinary heating condition wherein the composition of the flux chrystallized film of the outer surface of the tube does not change in the heating furnace, oxidizing of the outer surface is prevented, and forming of the coating of the molten metal can be accelerated in the next step. When the heating condition is extremely strong, inside of the heating furnace **14** may be maintained under non-oxidizing atmosphere by introducing, for example, an inert gas thereinto. Heat source of the heating furnace **14** may be the heat of exhaust gas from the metal melting furnace and combustion in the auxiliary combustion means (heavy oil, gas, etc.) for temperature control.

Feeding and storing method of the molten metal is described in detail below with reference to the FIGS. **3** and **4**. Molten metal **16** (the temperature of, for example, zinc, is between 460° and 470°C) within the kettle **15** is pumped up by pump **17**, passes through passages **20** and **21**, and is transferred into storing case **18** from feed openings **22** and **22***a*. The feed openings **22** and **22a** are disposed with the angle of projection of 35 – 40° with respect to the horizontal plane. The molten metal forms fluxes of stream along damper guides **23** and **23***a* in the direction of the extension of the feed openings **22** and **22***a* within the storing case **18**, and the fluxes of stream themselves act like embankments to minimize overflow of the molten metal through the clearance between the openings **19** and **19***a* of the damper guides **23** and **23***a* and the outer periphery of the tube **4**. The molten metal **16***a* is stored inside the both streams. The molten metal of the amount substantially equivalent to the amount to be fed overflows through the overflow opening **25** provided at the side of the storing case **18** and continuously flows back to the molten metal kettle **15**.

Although there is a narrow clearance between the openings **19** and **19***a* of the damper guides **23** and **23***a* and the outer periphery of the tube **4**, the inside of the store case **18** is isolated from the external atmosphere by the fluxes of stream along the damper guides. Thus, since the inside of the case **18** and the overflow opening **25** are maintained under non-oxidizing atmosphere, there is no oxidizing of the molten metal and, accordingly, there is no necessity to introduce an inert gas within the store case **18**. Although there is an overflow of a very small amount of the molten metal from the clearance between the openings **19** and **19***a* of the damper guides **23** and **23***a* and the tube **4** as mentioned above, oxidization of the overflowing molten metal is mitigated by flux sublimating gas produced by contact of the molten metal at the openings **19** and **19***a* of the damper guide **23** with the flux on the outer surface of the tube and filling the space within the outer wall **26**. And, by introducing of the sublimating gas into the space within the outer wall **26***a* through the communicating pipe **27**, oxidizing of the molten metal overflowing into the space is also mitigated. Therefore, there is no necessity to introduce an inert gas thereinto.

It is desirable that all the faces contacting with the flowing molten metal of, for example, the pump, feed passages, and the store case are lined with an inert material such for example as ceramics to prevent the production of dross.

Taking the case of galvanizing with zinc as an example, the galvanizing amount of about 150 – 400 $g/m^2$ can form the coating of about 20 – 60$\mu$ of thickness.

The connected tube disconnecting means is described below in detail with reference to FIGS. 5A, B and C. As shown in FIG. 5A, the connected tubes **4**, **4***a* are carried on the roller conveyor **30** and advanced onto the rollers **8***a* and **8***b*. When the connected tubes **4**, **4***a* pass the rollers **8***a* and **8***b* to make the limit switch **31** "on" as shown in FIG. 5B, the peripheral speed of the magnet roller **7** is accelerated to 2 – 3 times of that of the rollers **8***a* and **8***b* to disengage the connection between the preceding tube **4***a* and the succeeding tube **4**. Then, when the limit switch **32** is made "on" by the preceding tube **4***a*, the peripheral speed of the magnet roller **7** is decelerated to the same to that of the rollers **8***a* and **8***b*, and the tube **4***a* is transferred from the roller conveyor **30** to the product transfer table **36** shown in FIG. **1** by the operation of the air cylinder **35**.

The advancement of the tube on the roller conveyor may be carried out inclining the roller to give rotation to the pipe so as to equalize the flux coating, heating, and metal coating on the outer surface of the tube.

As described above, the present invention, capable of forming a uniform coating of a molten metal on the outer surface only of steel tube, has such great advantages that all the steps are carried out continuously and automatically on the conveyor, the process and system of this invention can apply to any length of tubes if only sufficient spaces are provided at both ends of the conveyor line, without necessity of human labor and of introducing an inert gas to maintain non-oxidizing atmosphere within the system. And, therefore, the present invention can reduce manual operation and improved production efficiency greatly.

We claim:

**1**. A system for continuously coating outer surfaces of elongated steel tubes with a molten galvanizing metal, said system comprising:

a. conveying means for longitudinally and sequentially conveying a plurality of said tubes in a path;

b. automatic connecting means, including a sealing joint, for connecting each tube while being conveyed to a longitudinally adjacent tube;

c. a container adapted to hold said metal, said path extending from said connecting means through said container for coating of the connected tubes;

d. feeding means for feeding said metal to said container;

e. disengaging means for disengaging the coated tubes after passage through said container;

f. means for returning the sealing joint to the connecting means.

**2**. A system as set forth in claim **1**, wherein said connecting means include inserting means for pushing a sealing joint into an end of one of two tubes adjacent the other tube to be connected to said one tube, and means for varying the speed of said two tubes relative to each other until said joint is also inserted into an end of the other one of said two tubes.

**3**. A system as set forth in claim **2**, wherein said disengaging means include means for varying the speed of two adjacent coated tubes until said two tubes are moved apart and said joint is released from one of said two coated tubes, and pulling means for pulling said joint from the other coated tube.

**4**. A system as set forth in claim **3**, further comprising means for distributing flux on the surfaces of the connected tubes, and furnace means for heating the distributed flux on the connected tubes prior to said passage.

**5**. A system as set forth in claim **4**, further comprising means for removing an excess of said metal from the coated tubes after said passage, and cooling means for showering the coated tubes after removal of said excess with a fluid coolant.

**6**. A system as set forth in claim **3**, wherein said conveying means include a plurality of magnetic rollers, and drive means for rotating said rollers, at least one of said speed varying means including means for rotating respective rollers at different speeds.

**7**. A system as set forth in claim **1**, wherein said feeding means include a kettle adapted to hold said molten metal, said container being disposed within said kettle and formed with a circulating passage and an overflow, and pump means for feeding said metal from said kettle to said passage at a rate sufficient for circulating said metal through said passage and said overflow.

* * * * *