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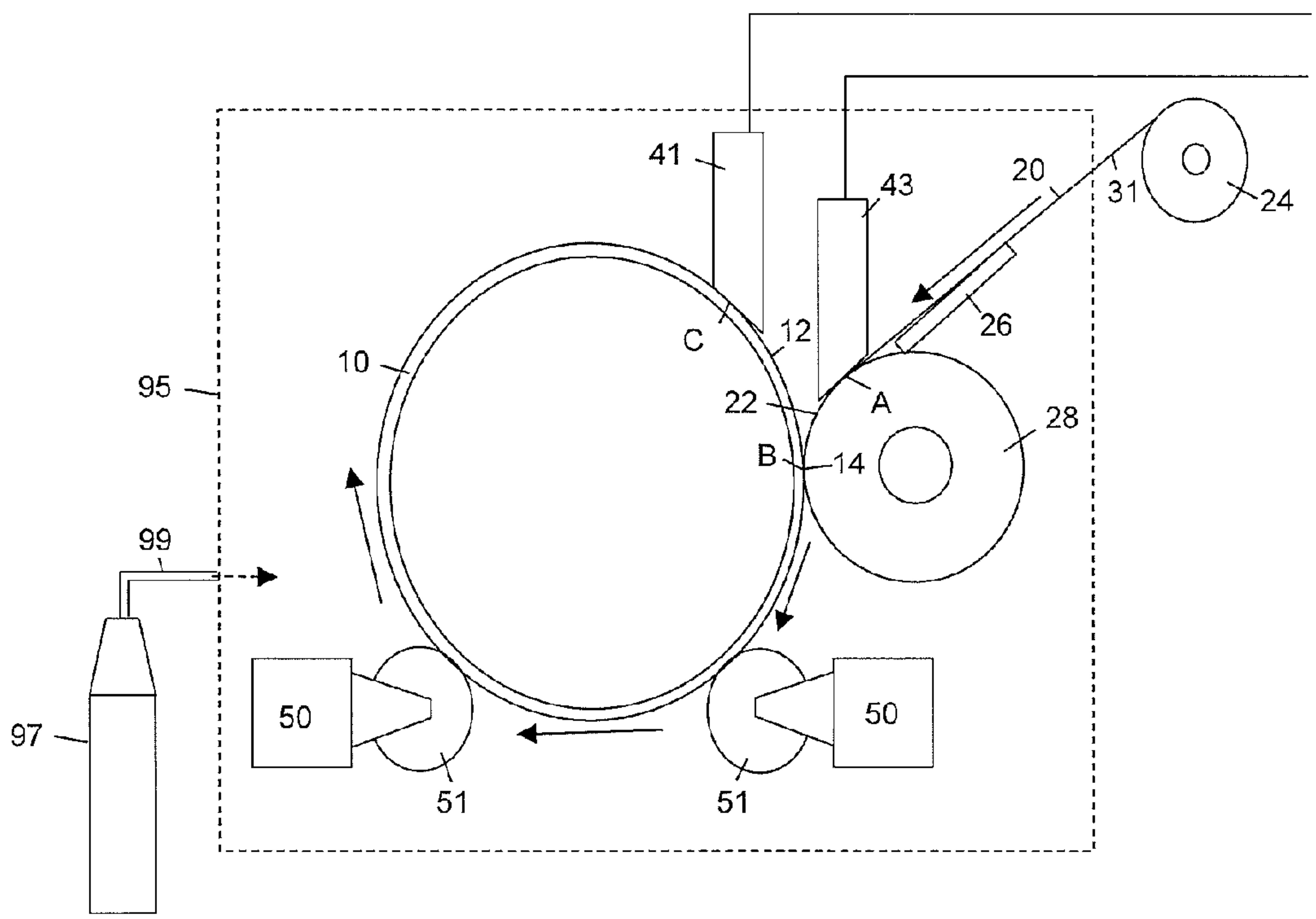
(54) Titre : PROCEDE POUR APPLIQUER UN REVETEMENT PROTECTEUR A DES TUYAUX ET DES TUBES
(54) Title: METHOD FOR APPLYING PROTECTIVE COVERING TO PIPES AND TUBES



(57) Abrégé/Abstract:
The manufacture of clad tubes (30) is described. Tube (10) intended to line the walls of a combustion chamber is made of a high strength material to contain the high-pressure steam created. However, these tubes (10) are typically not corrosion/erosion resistant. Manufacture of tubes (10) with both high strength and high resistance to corrosion/erosion would be prohibitively expensive. Therefore, tubes (10) are covered with a non-corrosive material to protect them. This is done by surface welding a strip (20) of high alloy material to the outer surface (12) of the tubes (10). It is preferable to use electric high frequency resistance welding to surface weld the strip (20) onto tube (10). The strips (20) are preferably attached with little melting and metal dilution allowing the strip 20 to keep its corrosion/erosion resistance properties.

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(54) Title: METHOD FOR APPLYING PROTECTIVE COVERING TO PIPES AND TUBES

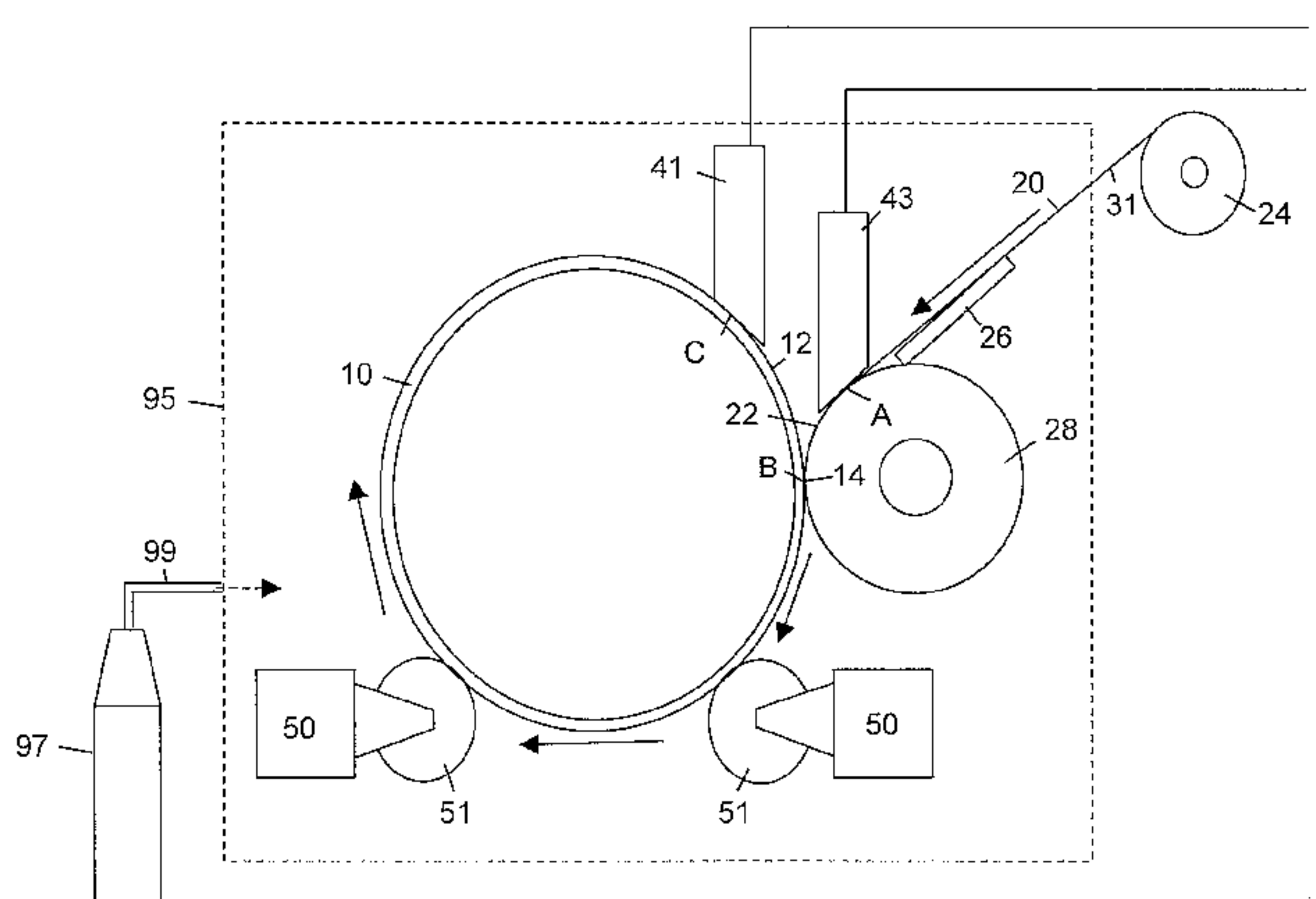

Figure 3

(57) Abstract: The manufacture of clad tubes (30) is described. Tube (10) intended to line the walls of a combustion chamber is made of a high strength material to contain the high-pressure steam created. However, these tubes (10) are typically not corrosion/erosion resistant. Manufacture of tubes (10) with both high strength and high resistance to corrosion/erosion would be prohibitively expensive. Therefore, tubes (10) are covered with a non-corrosive material to protect them. This is done by surface welding a strip (20) of high alloy material to the outer surface (12) of the tubes (10). It is preferable to use electric high frequency resistance welding to surface weld the strip (20) onto tube (10). The strips (20) are preferably attached with little melting and metal dilution allowing the strip 20 to keep its corrosion/erosion resistance properties.

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METHOD FOR APPLYING PROTECTIVE COVERING TO PIPES AND TUBES

TECHNICAL FIELD

[0001] The present disclosure relates generally to a method for cladding tubes, and more particularly, to a method of wrapping strips of material to outer surface of tubes to clad them.

BACKGROUND OF THE INVENTION

[0002] Steam generation pipes within a boiler are exposed to corrosive and erosive environments that cause the premature failure of pipes and tubes due to wall thinning leading to rupture.

[0003] The steam generated typically used in running a turbine for production of electricity and in chemical processes for providing energy to initiate a chemical reaction. Some boilers include one or more walls, each formed of a plurality of tubes, the walls being secured to one another thereby surrounding a combustion chamber within the boiler. Additional groups of tubes can be disposed within the combustion chamber.

[0004] Each of the tubes also has an inside surface defining a passage extending therethrough. One end of each of the plurality of tubes can be in fluid communication with a water supply header while an opposing end of each of the plurality of tubes can be in fluid communication with a steam header. During operation of the boiler, combustion generally occurs in the combustion chamber and heats water flowing through the passages, creating steam that is fed to the steam header. The outer surfaces of the tubes in the combustion chamber and throughout the boiler are exposed to fuel, combustion, heat and combustion byproducts that corrode the tubes. As a result, the useful life of the tubes is reduced.

[0005] There have been a number of methods employed to add protective coverings to standard pipes and tubes to improve their resistance to increase strength, or to prevent corrosion and erosion. Virtually all of the methods that weld the protective coverings require the covering to be completely melted to adequately attach the covering to the tube.

[0006] In conventional welding, a welding rod is melted at its tip. The structure being welded has a trough of material that is also melted. The molten welding rod and the molten surface mix together to create a 'bead'. The 'bead' has a composition that is a mixture of both the molten welding rod and the molten surface. Since a significant amount of welding rod and a significant amount of surface are mixed, there is significant mixing of the metals. Therefore, if the welding rod is made of a high concentration of a high-grade metal and the surface being welded has a lower concentration of the high-grade metal, the resulting mixture ('bead') has a lower concentration of the high-grade metal as compared with the original welding rod. This results in the dilution of the concentration of the high-grade metal in the mixed metal bead.

[0007] Therefore, as more of the welding rod and more of the surface are melted, more dilution occurs. The diluted metal has less corrosion resistance, erosion resistance and/or less strength.

[0008] Therefore, by welding the entire surface of an object, such as tubing, requires a large amount of heat. The large amount of heat may distort the tubing and it is often difficult to control the amount of covering material deposited to optimum thicknesses. This method of cover tubing is difficult to implement.

[0009] Typically tubes operating in corrosive or erosive environments are coated, using techniques such as thermal spray or vapor deposition to provide a more protective surface layer. In the most aggressive environments clad tubing produced by co-extrusion has been used. However limitations in the integrity of the bond formed in this way can lead to debonding particularly during long exposures in thermal cycling conditions as a result of the stresses associated with the mismatch in thermal expansion coefficients between the austenitic and ferritic steels.

[0010] Currently, there is a need for a method of protecting boiler tubes from erosion and corrosion that may be easily applied without the need for large amounts of energy.

SUMMARY OF THE INVENTION

[0011] According to an aspect of the present invention, there is provided a method for producing a clad tube comprising: providing a tube having an outer surface; providing an elongated strip for cladding said tube, said elongated strip having a planar inner surface disposed between a pair of edges; surface welding the planar inner surface of the strip and the outer surface of the tube while helically wrapping the strip around the outer surface of tube such that the edges of the strip abut each other; pressing together the strip and the tube as it is being surface welded; wherein the surface welding includes passing an electrical surface current between a first contact positioned to contact the strip and a second contact positioned to contact the tube to thereby pass the electrical surface current along the planar inner surface of the strip, through an interface where the planar inner surface of the strip and the outer surface of the tube meet, and along the outer surface of the tube to provide heat to melt the planar inner surface of the strip and the outer surface of the tube at the interface therebetween.

[0012] According to another aspect of the present invention, there is provided a clad tubing manufactured by the steps of: providing a tube having an outer surface; providing an elongated strip for cladding said tube, said elongated strip having a planar inner surface disposed between a pair of edges; surface welding the planar inner surface of the strip and the outer surface of the tube while helically wrapping the strip around the outer surface of tube such that the edges of the strip abut each other, wherein the surface welding includes passing an electrical surface current between a first contact positioned to contact the strip, and a second contact positioned to contact the tube to thereby pass the electrical surface current along the planar inner surface of the strip, through an interface where the planar inner surface of the strip and the outer surface of the tube meet, and along the outer surface of the tube to provide heat to melt the planar inner surface of the strip and the outer surface of the tube at the interface therebetween; and pressing together the strip and the tube as it is being surface welded.

[0013] In some embodiments, a strip of non-corrosive material is applied to the outer surface of the tube to protect tube from corrosion.

[0014] Some embodiments provide a method for producing clad tubes by providing a first tube; providing an elongated strip; surface welding an inner surface of the strip and the outer surface of the tube while helically wrapping the strip around the outer surface of tube; and pressing the strip to the tube as it is being surface welded.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Referring now to the Figures, which are exemplary embodiments, and wherein the like elements are numbered alike:

[0017] Figure 1 is a perspective view of a strip of material being applied to the outer surface of a tube according to one embodiment of the present invention.

[0018] Figure 2 is a top plan view of the strip of material being applied to the outer surface of a tube of Figure 1.

[0019] Figure 3 is an elevational view of the strip of material being applied to the outer surface of a tube of Figures 1 and 2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0020] Figure 1 illustrates a tube 10 of less expensive material, such as a low-alloy steel, that lacks properties such as corrosion resistance, erosion resistance or high strength and that is intended to be used in a boiler. Without protection, corrosion and erosion of the tube 10 reduce the tube wall thickness to a thickness that does not have the strength to retain the pressure of steam within the tubes. When this occurs, they burst. This low-alloy steel tube 10 should be protected to reduce corrosion and erosion, and the thinning of the tube walls.

[0021] A strip 20 that is made of a material that exhibits corrosion resistance, erosion resistance, or additional strength is shown here partially wrapped around the outside surface 12 of tube 10. It is preferably wrapped or wound around the tube in a helical fashion while being welded using surface welding techniques creating clad tubing 30.

[0022] The strip 20 is manufactured from a suitable corrosion/erosion resistant material that can withstand high temperatures and corrosive environments, such as austenitic steel. While the strip 20 is described as being manufactured from austenitic steel, it is contemplated that the cladding tube can be manufactured from other corrosive-resistant, erosion-resistant, high strength or other cladding materials, depending upon its intended use.

[0023] As shown in Figure 1, it is preferable that the strip 20 be surface welded on its inner surface 22 to the outer surface 12 of tube 10 where they meet an interface 14.

[0024] One type of electrical resistance weld is a high frequency weld. In this type of weld, a high-frequency alternating current is passed through the strip 20 and the tube 10 setting up a current path. The current flows through the surface of the strip 20 and tube 10 and creates resistive heating in the metal, similar to a toaster heating wire.

[0025] Figure 2 is a top plan view of the strip 20 of material being applied to the outer surface 12 of a tube 10 of Figure 1. Figure 3 is an elevational view of the strip of material being applied to the outer surface of a tube of Figures 1 and 2.

[0026] With reference to Figures 2 and 3, a frame 50 is shown having rollers 51 are used to support the tube 10 as it is being processed. Rollers 51 allow the tube to be rotated. A motor 61 causes rotation of the tube 10. A second motor 71 causes longitudinal motion of the tube 10. Preferably, the motors as well as other aspects of the system activated, coordinated and controlled by the controller 100.

[0027] Strip 20 is stored on and provided from a roll 24. A guide 26 is angled with respect to a longitudinal axis of the tube 10. As the tube is rotated by the controller 100 and motors 61, 71, the strip 20 is provided from a supply roll 24 guided by guide 26, pressed against the tube 10 by pressing roller 28 and spirally wound around tube 10.

[0028] A contact 41 is coupled to a lead of a welding unit 90 and is positioned to make contact with the strip 20 at a location marked “A” near the location “B” where the strip 20 contacts the pipe 10.

[0029] A second contact 43, coupled to a second lead of the high frequency welder unit 90 is positioned to contact the tube 10 at a location marked “C”.

[0030] The welding unit 90 is activated and controlled by controller 100. When activated, it causes a surface current to flow between the first contact 41 and the second contact 43. Since there is a large current, even a small inductance in the strip 20 and/or the tube 10 causes significant heat to be created.

[0031] The current passes between the surface of strip 20 at location “A”, through the meeting to the tube 10 and strip 20 at location “B” and to the second contact 43 at location “C”.

[0032] The current route between A-B-C creates a “V” shape. Due to the nature of surface currents, they converge and concentrate their energy at location “B” where the welding occurs.

[0033] Since the heat is provided by a surface current, it is applied evenly at over the inside surface of the strip 20 and the outside surface 12 of the tube 10. The amount of metal melted at both the strip 20 and the tube 10 is very small compared to conventional welding. There is significantly less mixing of the metals and significantly less dilution.

[0034] During the surface welding of the present embodiment, there is substantially less mixing, dilution and the weld is not just in a bead, but also along the inner surface 12 of the strip 10. Therefore, if a high nickel steel is used as strip 10, it will be diluted less by using high frequency welding as compared with conventional welding, and therefore keep more of its corrosion resistant properties. This results in significant cost savings.

[0035] This type of weld applies heat only to the region being welded and does not melt the tube and strip material overall. Therefore, there is less warping and distortion of the tube 10 and strip 20 as compared with prior art methods that require melting of the outer protective material, and the corrosion-resistance of the strip alloy is not diluted by mixing with the lower grade alloy of the tube material.

[0036] Once the strip 20 and tube 10 are heated, they melt slightly at the surfaces 12, 22. Using high-frequency resistance welding, the surface currents melt only 5-15% of the thickness of the strip 20. It may be about 0.040 inches thick. This is considerably less than the 0.1 – 0.3 inches that are common to conventional welding of similar geometry and use. A pressing roller 28 presses the strip to the tube 10 thereby causing the molten inner surface 22 of strip 22 to forge to the molten outer surface 12 of pipe 10.

[0037] The rotation and longitudinal movement of tube 10 are chosen by controller 100 so that the strip 20 is spirally wrapped onto tube 10. Since the current flows also through the edges 31, 33 of strip 20, the edges also heat up. If the rotation and longitudinal motion of the tube 10 are correctly chosen, the tape will fit flush against the tube 10 and the previous wrapping of the strip 20. Since there is also a concentration of current flow as a first edge 31 of strip 20 meets the second edge 33 near interface 14. This concentration of current also causes the adjacent edges 31, 33 of the spiraled strip 20 to melt and fuse together. Therefore, the strip edges may also be forged together causing one wrap of the strip 20 to bond to the previous wrap of the strip 20.

[0038] Preferably, the welding is done an inert atmosphere. Therefore, a source of an inert or non-reactive gas 97, such as neon, argon or xenon passes through an input line 99 into an inert enclosure 95. The inert enclosure encompasses the welding area and seals it to the degree that it can maintain a generally inert atmosphere. This reduces or eliminates the oxidation and other reactions that occur during the welding.

[0039] In this embodiment of the present invention, the tube 10 is rotated as the strip 20 is would around its outer surface. It may also be that a device would rotate around the tube 10.

[0040] The resulting clad tubing 30 exhibits strength due to the tube 10 being made of a high strength material. The clad tubing 30 also exhibits corrosion resistance due to strip 20 covering tube 10. Tube 30 is significantly lower cost than a tube made entirely of a high-strength, corrosion resistive material.

[0041] In an alternative embodiment, the tube 10 may be preheated prior to wrapping the strip 20 onto pipe 10. Many different preheaters may be used, however, an inductively coupled coil 80 is provided in Figure 2. The coil 80 induces a rapidly changing current in tube 10 that results in resistive heating. The use of the preheating coil 80 increases the effectiveness of the device.

[0042] To implement the present invention, it was found that existing tube fin applying machinery might be reconfigured to attach the metal strip 20 to the surface of a tube 10. This results in low start up costs and dual use of existing machinery.

[0043] While the invention has been described with reference to various exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention. Therefore, the scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

CLAIMS:

1. A method for producing a clad tube comprising:

providing a tube having an outer surface;

providing an elongated strip for cladding said tube, said elongated strip having a planar inner surface disposed between a pair of edges;

surface welding the planar inner surface of the strip and the outer surface of the tube while helically wrapping the strip around the outer surface of tube such that the edges of the strip abut each other;

pressing together the strip and the tube as it is being surface welded; wherein the surface welding includes passing an electrical surface current between a first contact positioned to contact the strip and a second contact positioned to contact the tube to thereby pass the electrical surface current along the planar inner surface of the strip, through an interface where the planar inner surface of the strip and the outer surface of the tube meet, and along the outer surface of the tube to provide heat to melt the planar inner surface of the strip and the outer surface of the tube at the interface therebetween.

2. The method of claim 1, wherein the tube is made of a first metal and the strip is made of a second metal and the surface welding minimizes dilution of the strip with the first metal.

3. The method of claim 1 or 2, wherein the strip is formed of corrosion resistive material, erosion resistive material, or a corrosion and erosion resistive material.

4. The method of any one of claims 1 through 3, wherein the tube is formed of a low-alloy steel that lack properties of corrosion resistance and/or erosion resistance.

5. The method of any one of claims 1 through 4, wherein electrical surface current is a high frequency current.

6. The method of any one of claims 1 through 5, wherein the electrical surface current melts only 5-15% of the thickness of the inner surface of the strip which forges to the outer surface of the tube when pressed against the tube.

7. The method of any one of claims 1 through 6, further comprising:

bonding an edge of the strip to an edge of a previous wrapped strip to create a more continuous covering.

8. The method of any one of claims 1 through 7, wherein the pressing comprises:

pressing the strip against the tube with a pressing roller.

9. The method of any one of claims 1 through 8 further comprising

preheating the tube prior to helically wrapping the strip around the outer surface of tube.

10. The method of any one of claims 1 through 8 further comprising

preheating the tube prior to helically wrapping the strip around the outer surface of tube with an inductively coupled coil.

11. The method of any one of claims 1 through 10, wherein the surface welding takes place in an inert atmosphere.

12. The method of any one of claims 1 through 11, wherein the tube comprises a first material and the elongated strip comprises a second material having a higher strength than said first material.

13. A clad tubing manufactured by the steps of:

providing a tube having an outer surface;

providing an elongated strip for cladding said tube, said elongated strip having a planar inner surface disposed between a pair of edges;

surface welding the planar inner surface of the strip and the outer surface of the tube while helically wrapping the strip around the outer surface of tube such that the edges of the strip abut each other, wherein the surface welding includes passing an electrical surface current between a first contact positioned to contact the strip, and a second contact positioned to contact the tube to thereby pass the electrical surface current along the planar inner surface of the strip, through an interface where the planar inner surface of the strip and the outer surface of the tube meet, and along the outer surface of the tube to provide heat to melt the planar inner surface of the strip and the outer surface of the tube at the interface therebetween; and

pressing together the strip and the tube as it is being surface welded.

14. The clad tubing of claim 13, wherein the tube is made of a first metal and the strip is made of a second metal and the surface welding minimizes dilution of the strip with the first metal.

15. The clad tubing of claim 13 or 14, wherein the strip is formed of corrosion resistive material, erosion resistive material, or a corrosion and erosion resistive material.

16. The clad tubing of any one of claims 13 through 15, wherein the tube is formed of a low-alloy steel that lack properties of corrosion resistance and/or erosion resistance.

17. The clad tubing of any one of claims 13 through 16, wherein electrical surface current is a high frequency current.

18. The clad tubing of any one of claims 13 through 17, wherein the electrical surface current melts only 5-15% of the thickness of the inner surface of the strip which forges to the outer surface of the tube when pressed against the tube.

19. The clad tubing of any one of claims 13 through 18, further comprising:

bonding an edge of the strip to an edge of a previous wrapped strip to create a more continuous covering.

20. The clad tubing of any one of claims 13 through 19, wherein the pressing comprises:

pressing the strip against the tube with a pressing roller.

21. The clad tubing of any one of claims 13 through 20 further comprising

preheating the tube prior to helically wrapping the strip around the outer surface of tube.

22. The clad tubing of any one of claims 13 through 21 further comprising

preheating the tube prior to helically wrapping the strip around the outer surface of tube with an inductively coupled coil.

23. The clad tubing of any one of claims 13 through 22, wherein the surface welding takes place in an inert atmosphere.

24. The clad tubing of any one of claims 13 through 23, wherein the tube comprises a first material and the elongated strip comprises a second material having a higher strength than the first material.

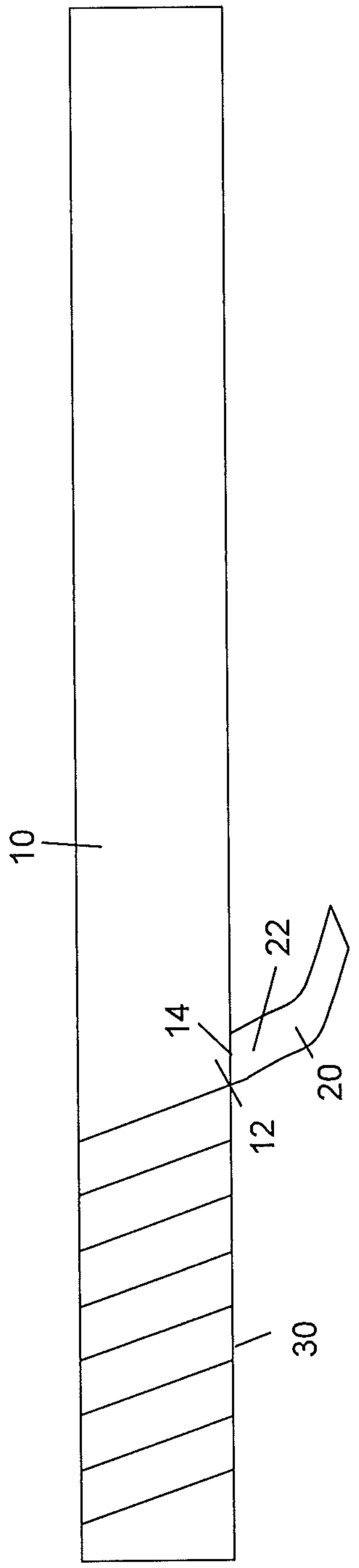

Figure 1

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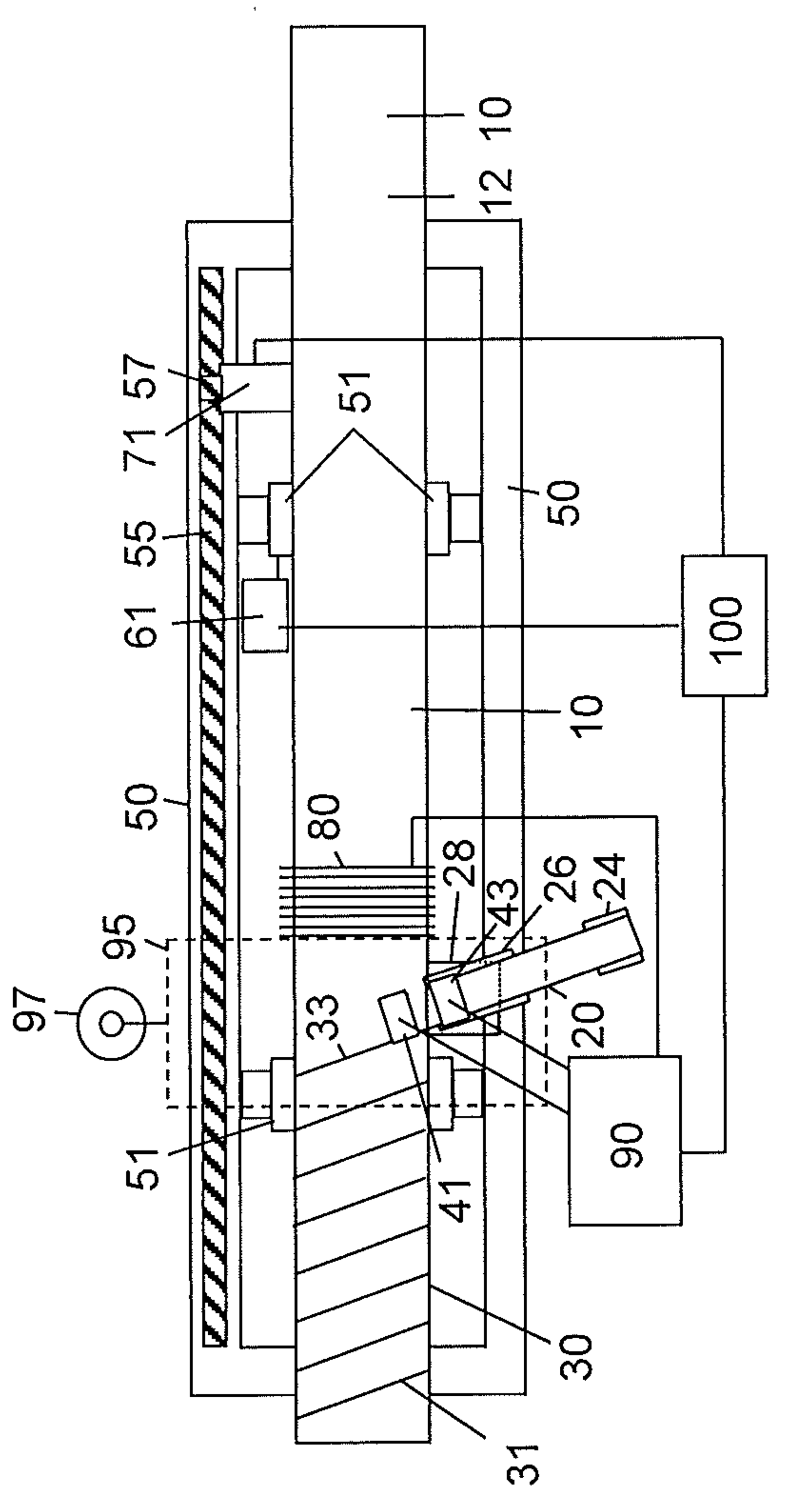
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Figure 2

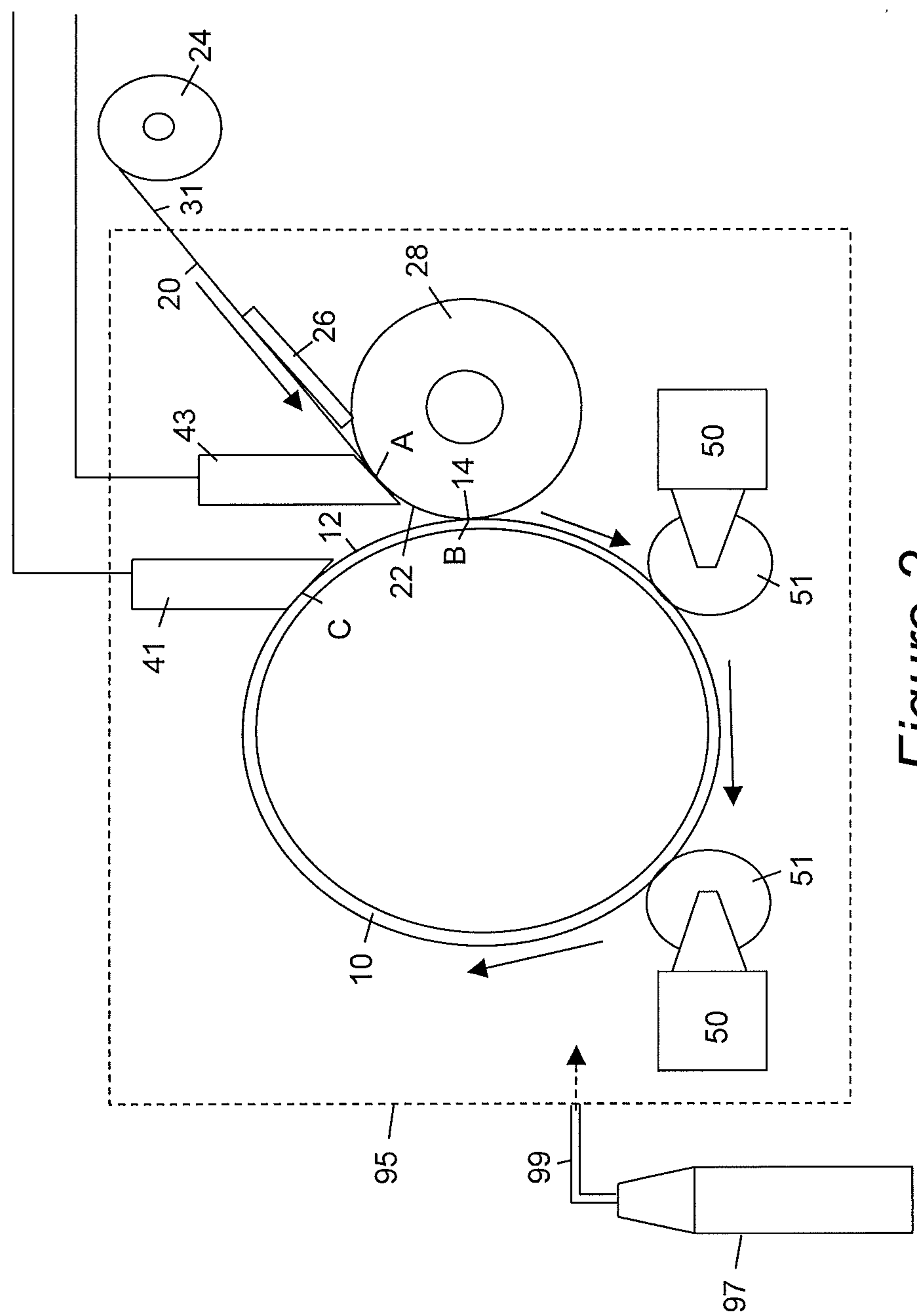
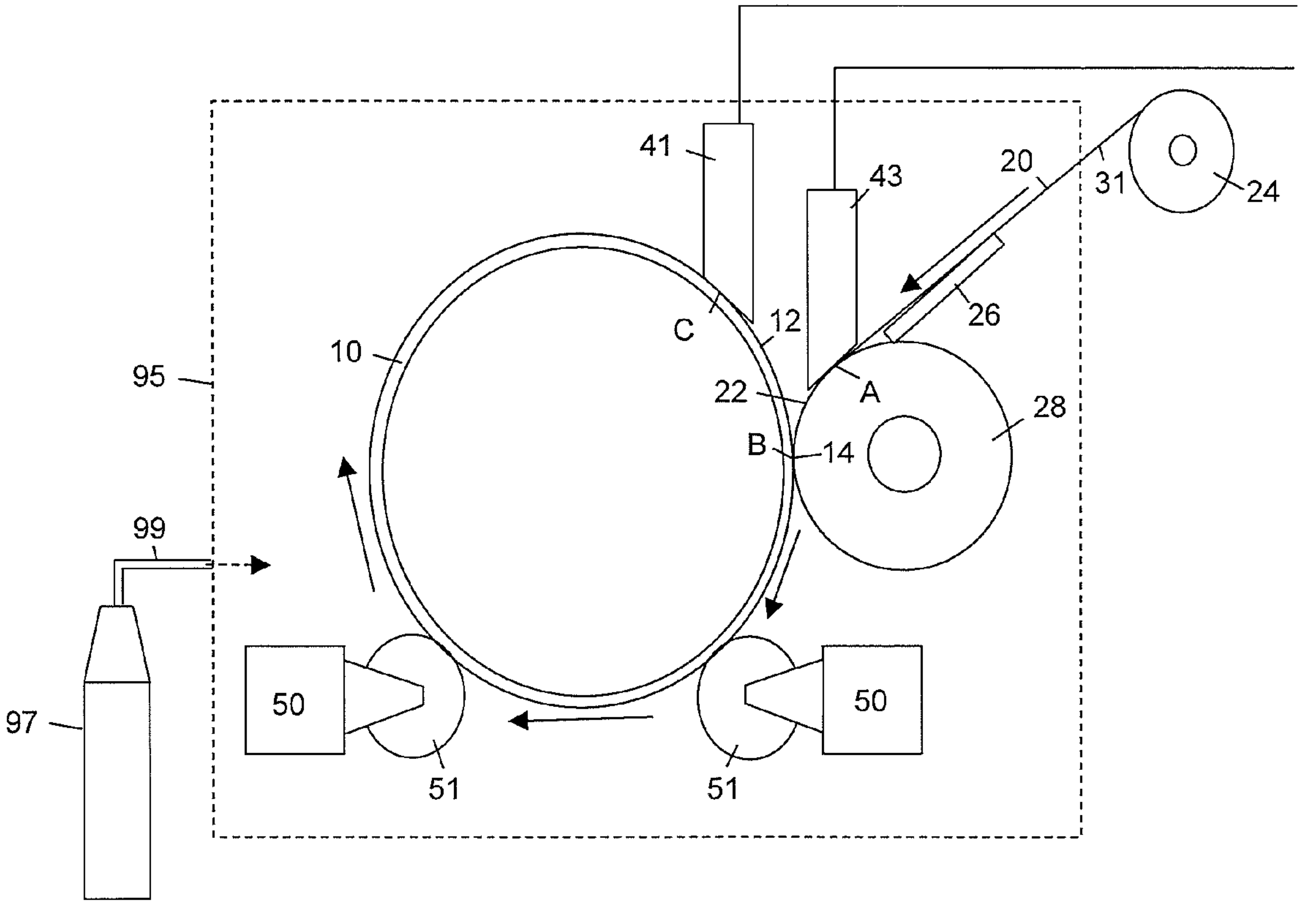


Figure 3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