United States Patent [19]

Kozak et al.

[11] **3,734,384**

[45] **May 22, 1973**

[54] **APPARATUS FOR ROLL PRESSURE BONDING**

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[22] Filed: **June 11, 1971**

[21] Appl. No.: **152,318**

Related U.S. Application Data

[62] Division of Ser. No. 824,205, May 13, 1969, Pat. No. 3,632,034.

[52] **U.S. Cl.** **228/4**, 29/471.1, 29/497.5, 156/178, 156/302, 228/5, 228/44

[51] **Int. Cl.** **B23k 1/00**

[58] **Field of Search**.....228/4, 5, 6, 44; 219/470; 72/236; 29/471.1, 471.3, 497.5, 498; 156/178, 302, 543, 553, 554, 580

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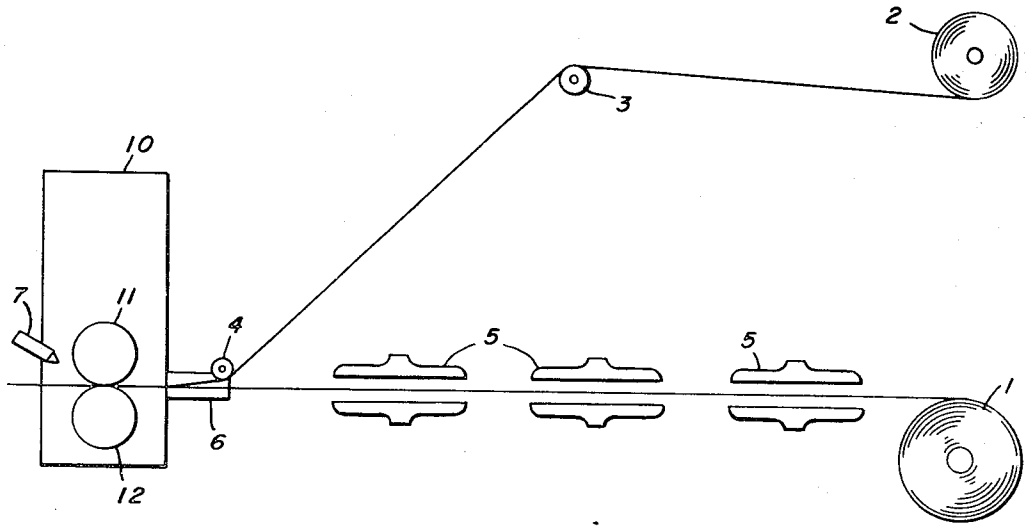
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[57] **ABSTRACT**

The application describes a method and apparatus for roll pressure bonding a plurality of stripes to a substrate. Through unique roll arrangements and designs, stripes of controllable thickness are produced, as conditions which cause non-uniform roll pressures are eliminated. Furthermore, these unique roll arrangements and designs protect the substrate in the areas between the stripes from surface damage such as roll scratching. Additionally, novel means are provided which both guide and heat the materials.

10 Claims, 8 Drawing Figures



Patented May 22, 1973 3,734,384

4 Sheets-Sheet 1

FIG. 1.

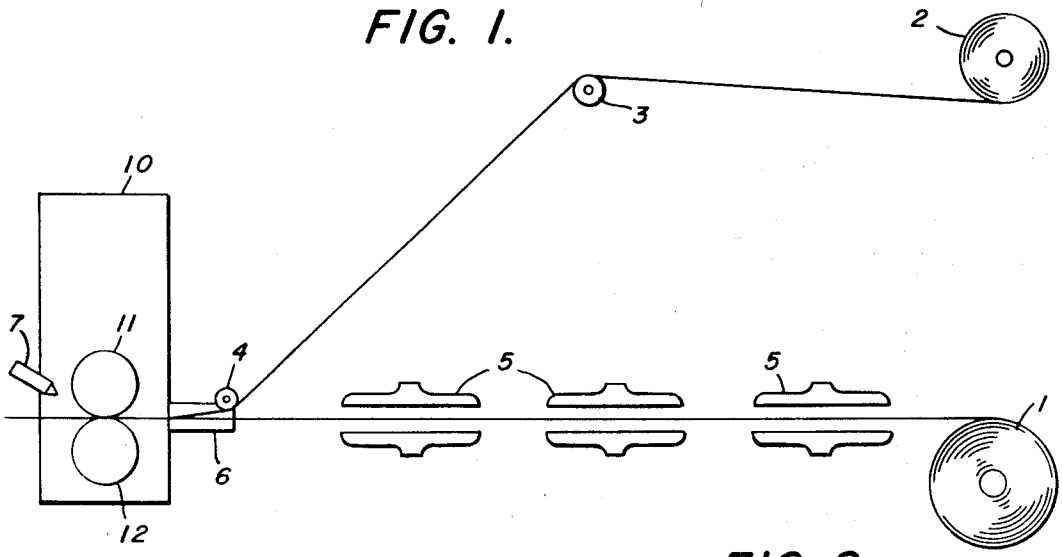
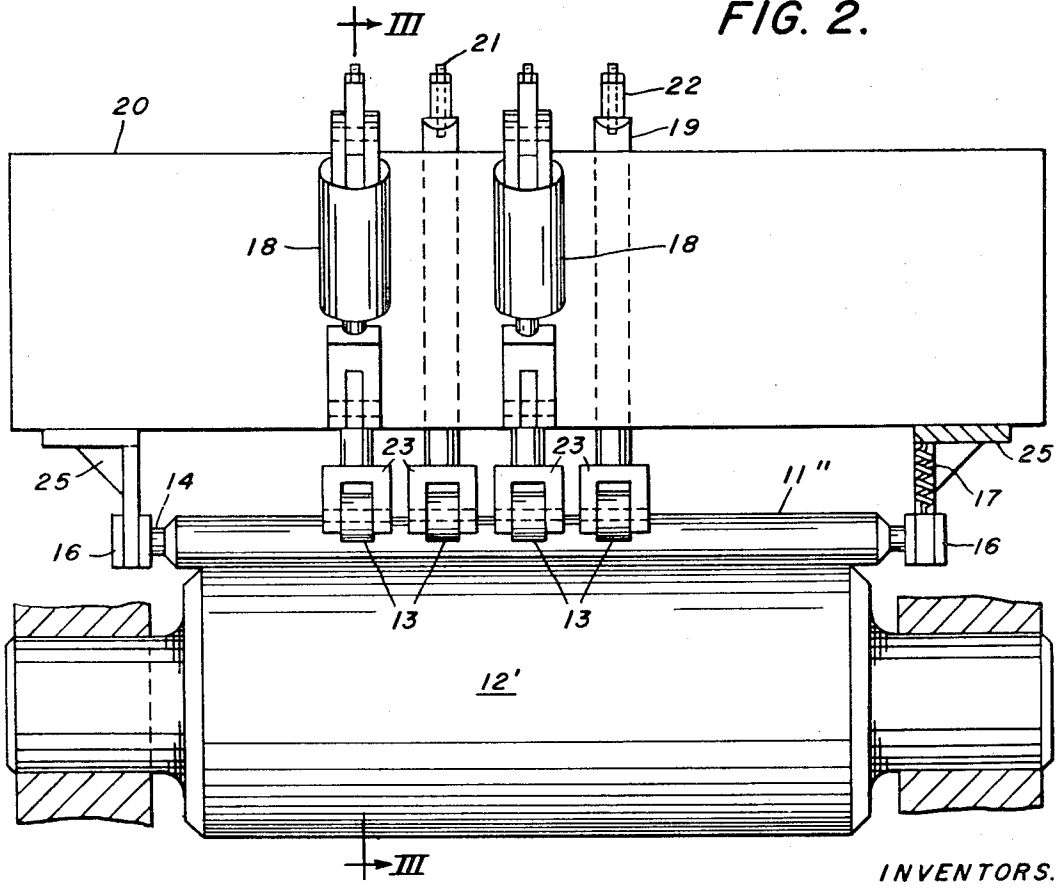


FIG. 2.



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FIG. 3.

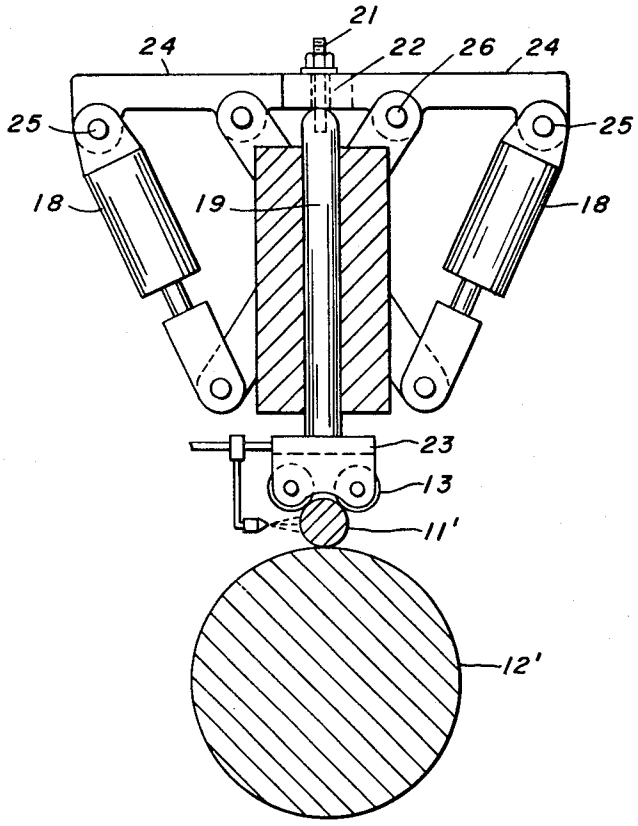


FIG. 5.

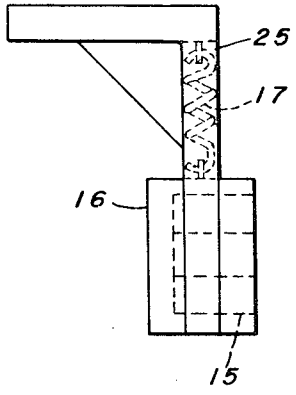
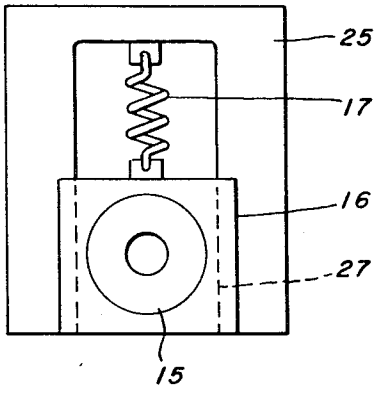


FIG. 4.



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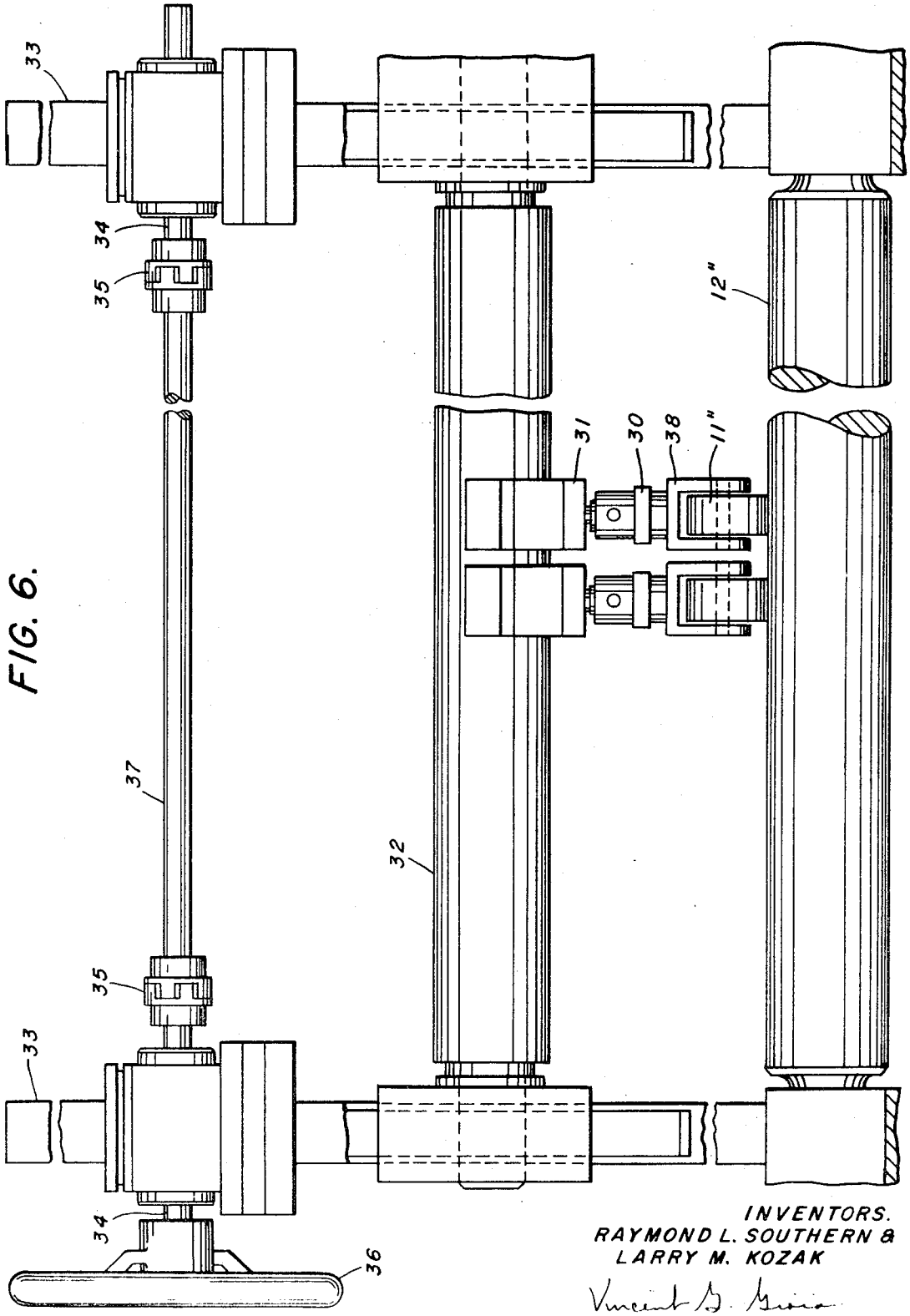


FIG. 6.

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FIG. 7.

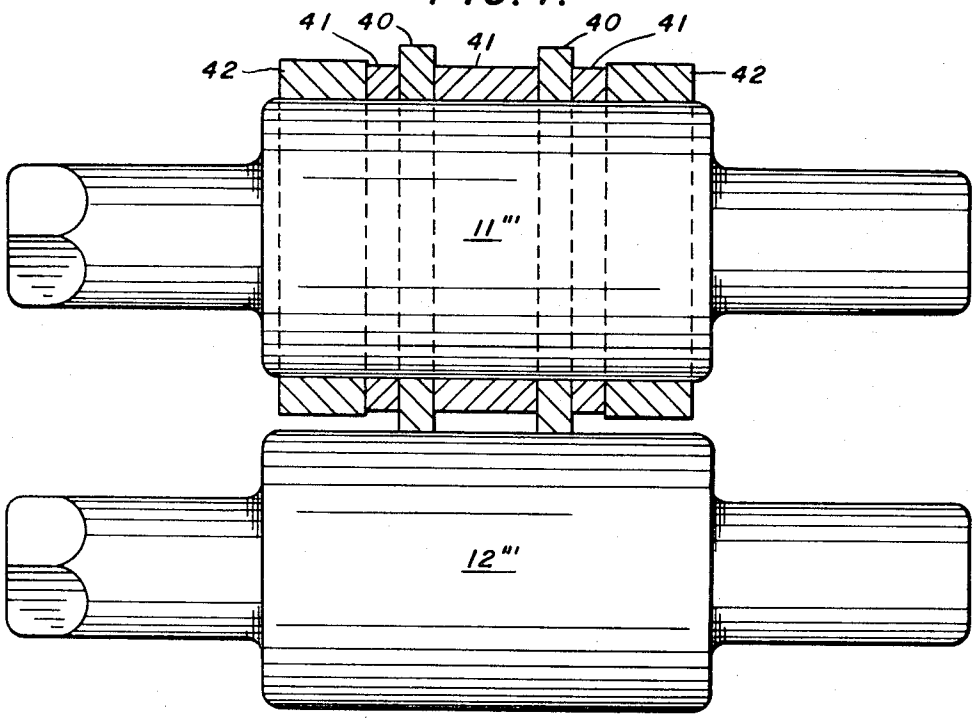
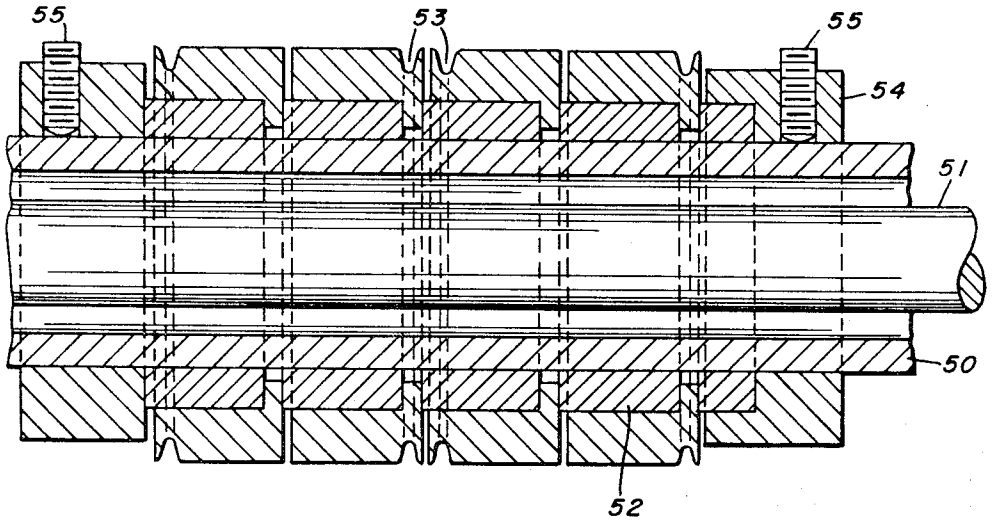


FIG. 8.



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APPARATUS FOR ROLL PRESSURE BONDING

This application is a division of U.S. application Ser. No. 824,205 filed May 13, 1969, now U.S. Pat. No. 3,632,034 issued Jan. 4, 1972.

This application relates to a method and apparatus for pressure bonding a first material to a second material and more particularly to a method and apparatus for pressure bonding a plurality of spaced apart stripes to a substrate.

Roll bonding of composite members is widely accepted today. Cookware is often made from composite aluminum-stainless steel stock. Aluminum offers excellent heat transfer characteristics but is susceptible to staining and difficult to clean. On the other hand stainless steel does not have the heat transfer characteristics of aluminum but can easily be cleaned and is resistant to stain. Titanium-aluminum composites are also made since they provide a stock material which has an outer surface of titanium with its inherent strength and corrosion resistance and a core of less expensive aluminum. More recently, stainless steel substrates have been pressure bonded to metal more anodic than carbon steel so as to produce composite stock suitable for fabrication into automotive and other decorative trim members.

Stainless steel is ideally suited for automotive trim as it has a bright lustrous surface and is stain resistant to a variety of contaminants. However, since most automotive bodies are constructed of carbon steel, the use of stainless steel can result in galvanic corrosion. Carbon steel is anodic to stainless steel and galvanically corrodes in the vicinity of the stainless steel trim in the presence of an electrolyte, such as moisture.

To protect the carbon steel it has been the practice to coat stainless steel with a non-ferrous sacrificial metal which is electrochemically anodic to mild carbon steel prior to forming the stainless into trim members. The sacrificial metal is applied to those sections which will eventually contact the automotive body, i.e. the return flange of the fabricated trim members. This generally encompasses the bonding of sacrificial metal to the upper planar surfaces of stainless substrates along their edges and at regular intervals thereacross, thereby producing stripes of sacrificial metal at each edge and across the surface. The stripes across the surfaces are twice the width of the edge stripes and are slit along their longitudinal axis so as to produce strips of stainless steel of a desired width with sacrificial stripes at each edge, suitable for fabrication into automotive trim members.

The presently preferred method for coating the stainless substrate is roll pressure bonding. Although roll bonding equipment has been used in the past for producing composite members, e.g. cookware: a roll bonder which could satisfactorily bond a plurality of uniformly thick spaced apart stripes to a substrate had not existed until the present invention. Conventional roll bonders comprise an upper work roll and a lower work roll. They are subject to "barrelling", a condition caused by heat concentration gradients within the roll and/or "deflection concavity", a condition caused by pressure differentials.

Heated sheets passing through a roll transfer heat to the roll. Unfortunately the heat is not uniformly distributed throughout the roll and concentrates in the center. As a result the center of the roll expands to a greater degree than does the ends, thereby assuming the shape

of a barrel; a shape adverse to quality bonding as it causes the central material, e.g. center stripes of sacrificial metal, to be over rolled and compressed to a greater extent than the end material, e.g. edge stripes of sacrificial metal. Like "barreling" the phenomenon of "deflection concavity" is also disadvantageous. It is caused by uneven pressure loads which cause the roll surface to be concave in the bonding zone. Over rolling of the end material is characteristic of it.

Our invention teaches a method and apparatus for producing roll bonded stripes of controllable thickness by providing controllable pressure to the widths of material which form the stripes after bonding. We have three preferred embodiments for carrying out the invention, all of which substantially eliminate the adverse effects of "barreling". They comprise: (1) a flexible work roll with a plurality of spaced apart backup rolls: (2) a relieved ring work roll; and (3) a plurality of work rolls. In addition to the substantial elimination of "barreling" the first and third embodiments substantially eliminate the adverse effects of "deflection concavity". All the embodiments have the advantage of substantially eliminating the problem of scratching substrate metal in the area between bonded stripes. This is very important as this area becomes the exposure surface of stainless steel automotive trim members. A further feature of this invention is a novel means which performs the dual functions of guiding and heating the materials which form the composite stock.

It is accordingly an object of this invention to provide novel apparatus for roll pressure bonding.

It is another object of this invention to provide a novel method for roll pressure bonding.

It is another object of this invention to provide a novel apparatus for uniformly roll pressure bonding a plurality of spaced apart stripes to a substrate.

It is another object of this invention to provide a novel method for uniformly roll pressure bonding a plurality of spaced apart stripes to a substrate.

It is another object of this invention to provide novel means for both heating and guiding material to be hot rolled pressed.

It is a further object of this invention to provide a novel method for both heating and guiding material to be hot rolled pressed.

The foregoing and other objects of the invention will be best understood from the following description, reference being had to the accompanying drawings wherein:

FIG. 1 is a schematic side view of one possible arrangement for the apparatus of this invention;

FIG. 2 is a partial end elevational view looking at the rolls where the bonded material exits therefrom, a portion of which is sectional, showing one of the roll pressure bonding embodiments of this invention;

FIG. 3 is a partial side elevational view taken substantially along line III—III of FIG. 2, a portion of which is sectional, showing the roll arrangement embodiment of FIG. 2;

FIG. 4 is a side view of the lifter spring mechanism for the work roll of the roll arrangement embodiment of FIGS. 2 and 3;

FIG. 5 is an end view of the bracket which holds the lifter spring mechanism of FIG. 4;

FIG. 6 is a partial end elevational view looking at the rolls where the bonded material exits therefrom, show-

ing a second roll pressure bonding embodiment of this invention;

FIG. 7 is a partial end elevational view looking at the rolls where the bonded material exits therefrom, showing a third roll pressure bonding embodiment of this invention;

FIG. 8 is a sectional view of a means for both heating and guiding material.

We refer now to the drawings for a description of the apparatus and method of this invention. Since a primary use for the invention is the manufacture of sacrificial coated stainless steel automotive trim, the following discussions and examples are directed to this embodiment. As pointed out earlier, the sacrificial metal is one which is anodic to mild carbon steel. Typical sacrificial metals are aluminum, zinc, cadmium, magnesium and base alloys and mixtures thereof. They can be supplied in a variety of widths in the form of wire, sheet, foil or powder. At the present time aluminum wire is preferred.

FIG. 1 is a schematic side view of one possible arrangement for the apparatus of this invention. It comprises a coil 1 of stainless steel, adapted to be supplied from any conventional uncoiler, a plurality of spools 2 of aluminum wire (only one of which is shown), also adapted to be supplied by suitable uncoiling means, a first guide means 3 and a second guide means 4 for the wire, radiant heaters 5 for bringing the stainless to desired temperature, a strip guide 6 for the stainless steel, a spray head 7 and a rolling stand 10. Rolling stand 10 comprises a top work roll 11 and a bottom work roll 12 which are designed and arranged in a manner so as to bond a plurality of controllably thick aluminum stripes to the stainless. The details of the arrangements and designs are discussed below. Guide rolls and means 3, 4 and 6 are arranged in a purely exemplary manner which should in no way be construed as limiting. For example, they can be replaced by suitable supplying means which serve the dual functions of supplying and guiding. The radiant heaters 5 are also exemplary and can be replaced by other well-known conventional heating means, e.g. induction furnaces and resistance heating means. Furthermore, there are instances when a cold pressure bond is desired and hence no need for heating means. Heating of the sacrificial aluminum wire does not require heating means even when hot roll bonds are formed, as it can be heated by conduction, i.e., by bringing it into contact with the heated stainless steel, since the aluminum is of a relatively small mass in comparison to the stainless. An alternative heating method for the aluminum is a heated guide roll, shown in FIG. 8 and described below. Spray head 7 issues a release agent, e.g. a fine mist of water mixed with lubricants or minerals, through air atomizing nozzles. The purpose of spraying is to prevent the wire from being seized by the upper work roll and not for lubricity or cooling. The impurities in the water, e.g. oil or silicone, deposit a very thin film on the surface of the roll as the water evaporates. This surface film fills in the surface pits of the roll and prevents the aluminum from getting caught in them. Of course, spraying can be replaced by other means for applying release agents, e.g. brushes and rolls. It is also possible to apply the release agent by hand, e.g. rubbing.

A preferred roll arrangement and design for producing uniform stripes of sacrificial metal is shown in FIGS 2 through 5. FIG. 2 is a partial end elevational view of an embodiment of roll stand 10, a portion of which is in section. It comprises roll stand frame 20, upper work roll 11', lower work roll 12', a plurality of backup rolls 13 seated in housings 23, an upper work roll shaft 14 seated in thrust bearings 15 (FIG. 5), chocks 16 enclosing thrust bearings 15, brackets 25 connecting chocks 16 to the roll stand frame 20 through work roll lifter springs 17, and pressure cylinders 18 for raising and lowering backup rollers 13 through plungers 19, backup roll movers 21, rocker arms 22 and additional parts shown in FIG. 3 and described below. Upper work roll 11' is flexible and is straddled by a plurality of backup rolls 13 (see FIG. 3 which shows the straddling) spaced apart so as to distribute uniform pressure to the metal which forms the sacrificial stripes. It is small enough so that it will bend rather than over-roll any section. For the production of aluminum coated stainless steel automotive trim, the flexible upper work roll is generally no greater than 3" providing it is solid. Hollow flexible rolls can be larger. Their sectional moment of inertia, however, should be no greater than that for the largest useable solid roll. Rolls larger than 3 inches could be employed to bond metal wires harder than aluminum.

FIG. 3 is a partial side elevational view, a portion of which is in section, of the roll stand embodiment of FIG. 2, showing one particular means for raising and lowering the backup rolls 13. It comprises hydraulic pressures cylinders 18 connected to rocker arms 24 through pivots 25 about which rocker arms 24 turn, pivots 26 also about which rocker arms 24 turn, a backup roller mover 21 which raises and lowers plunger 19 through rocker arm 22, and a housing 23 which holds backup rollers 13 and moves with connected plunger 19. When pressure cylinders 18 push upward, rocker arms 24 revolve, thereby lowering plungers 19 and backup rolls 13. Conversely, when pressure cylinders 18 push down, rocker arms 24 revolve in the opposite directions, thereby raising plungers 19 and backup rolls 13. Although the exemplary means described in this paragraph for raising and lowering the backup rolls 13 show a set of straddle rolls in the same horizontal plane, it is within the scope of this invention to use sets of offset straddled backup rolls, e.g. every other backup roll could be removed alternately side to side, to use a plurality of sets of straddled rolls having in excess of two rolls each and to replace the plurality of sets of straddled backup rolls with a plurality of non-straddling backup rolls.

When backup rolls 13 are raised work roll 11' is also raised. This is accomplished by work roll lifter springs 17 and brackets 25 which are attached to roll stand frame 20. The operation of lifter springs 17 is best described in conjunction with FIGS. 4 and 5. FIG. 4 shows a side view of the lifter spring mechanism and FIG. 5 shows an end view of the bracket which holds the lifter spring mechanism. Comprising FIG. 4 are lifter spring 17 connected to bracket 25 at one end and to chock 16 at the other end and track 27 cut from bracket 25 upon which chock 16 slides up and down. FIG. 5 comprises bracket 25, chock 16, thrust bearing 15 within chock 16 and upper work roll shaft 14 within thrust bearing 15. When the backup rolls 13 relieve the pressure upon the upper work roll 11', it is pulled up by chocks 16 which are in turn pulled up by work roll lifter springs 17 while chocks 16 slide on tracks 27. Like the apparatus for raising and lowering the backup

rolls the apparatus for raising the upper work roll as described in this paragraph and as shown in FIGS. 4 and 5 is only exemplary and should in no way be construed as limiting.

Placing the apparatus as shown in FIGS. 1 through 5 into operation is as follows. Spools of aluminum wire are placed in position as is a coil of stainless steel. The aluminum wires are then threaded over the first guide 3, under the second guide 4, and between upper work roll 11' and lower work roll 12'. Upper work roll 11' is in its raised position held by chocks 16 which are in turn held by lifter springs 17. At the same time the stainless steel is passed through unenergized radiant heaters 5, strip guide 6 and between upper work roll 11' and lower work roll 12'. The aluminum wires and stainless steel are then placed on a coiler (not shown). Subsequently, backup rolls 13 are lowered as described earlier, thereby also lowering upper work roll 11' so as to arrange it and lower work roll 12' in their bonding position. Radiant heaters 5 are next energized to heat the stainless steel to a preferred bonding temperature, i.e., a temperature of at least 375°F. The aluminum is raised to a preferred bonding temperature, i.e., a temperature of at least 140°F, by heat transferred from the stainless steel as it is brought into contact with the heated stainless steel prior to entry into the nip of the rolls. Power is then supplied to drive the coiler which acts as the driving force withdrawing stainless steel sheets through the roll with spaced apart uniform stripes of aluminum bonded thereto. As an alternative, one or more work rolls may be driven instead of the coiler.

A second embodiment of this invention eliminates "barreling" through a plurality of upper work rolls and both "barreling" and "deflection concavity" through a plurality of upper work rolls, each having their own pressure supplying means. FIG. 6 shows an example of this embodiment. It comprises a plurality of upper work rolls 11'', a plurality of hydraulic pressure cylinders 30 connected to the upper work rolls 11'' through a plurality of housings 38, a plurality of saddles 31 connected to the hydraulic cylinders 30, an arbor 32 seated within saddles 31 holding the upper work rolls 11'' in place against a lower work roll 12'' through the saddles 31, hydraulic pressure cylinders 30 and housings 38, inverted worm gear screw jacks 33 for raising and lowering the arbor 32 and a hand wheel 36 connected to the jacks through shafts 34 couplings 35 and shaft 37. As was the case for the first embodiment, modifications and changes of the structure shown in FIG. 6 are well within the scope of this invention. For example, the plurality of hydraulic cylinders could be replaced by a plurality of springs or weights or eliminated entirely.

FIG. 7 shows a third embodiment of this invention. It comprises a relieved ring upper work roll 11''' and a lower work roll 12'''. Relieved ring roll 11''' comprises rings 40 arranged so as to conform to the wires being bonded, spacers 41 and locking collars 42 to hold the rings in wires. through set screws (not shown). This embodiment works satisfactorily with the bottom roll as is shown in FIG. 7 but it has been found preferable to use two relieved ring rolls. When two relieved ring rolls are used the rings on the bottom roll are generally wider than those on the top as they do not have to conform to the wires. This third embodiment can be made operable by removing the plurality of upper work rolls, the hydraulic pressure cylinders and the saddles shown in FIG. 6 and by replacing the arbor with the ring relieved roll shown in FIG. 7. It is an additionally advantageous embodiment as is the second embodiment since it is adaptable to a bonding process wherein the aluminum is embedded into the stainless. This advantage is made possible by the high concentration of pressure obtainable at the bonding surface of the ring.

Earlier it was disclosed that one of the objects of this invention was to provide a novel method and apparatus for heating the material to be bonded. This is accomplished by a guide means which performs the dual functions of guiding and heating. FIG. 8 shows such a guide means in the form of a roll suitable for guiding wires This concept is, however, adaptable to sliding guide means and guide means suitable for other forms of material, e.g. foil. The guide means as shown in FIG. 8 comprises a stationary journal tube 50 surrounding a heating element 51, self-lubricating bearings 52 and wire guide groove blocks 53 surrounding journal tube 50 and locking collars 54 for holding self-lubricating bearings 52 and guide groove blocks 53 in place by means of set screws 55.

From the above paragraphs it will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific examples thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they should not be limited to the specific examples described herein.

We claim:

1. Apparatus for roll pressure bonding a plurality of spaced apart stripes to a substrate including in combination means for supplying a plurality of spaced apart widths of striping material; means for supplying a substrate; roll pressure bonding means for applying substantially uniform pressure to each width of striping during bonding, said bonding means comprising a lower work roll which contacts said substrate, a plurality of individually adjustable upper work rolls aligned to contact said plurality of spaced apart widths of striping material, said plurality of upper work rolls being spaced apart at distances corresponding at most to the respective distances between the spaced apart widths of striping material to which they are aligned; means for guiding said plurality of spaced apart widths of striping material to said roll pressure bonding means; and means for receiving said substrate from said roll pressure bonding means with said plurality of spaced apart stripes bonded thereto.

2. Apparatus according to claim 1 including means for heating said substrate.

3. Apparatus according to claim 1 including means for heating said plurality of spaced apart widths of striping material.

4. Apparatus according to claim 1 including heating guide means for heating and guiding said plurality of spaced apart widths of striping material.

5. Apparatus according to claim 4 wherein said heating guide means comprises a heated guide roll.

6. Apparatus according to claim 1 including means for applying a release agent to said roll pressure bonding means.

7. Apparatus according to claim 1 including means for withdrawing said plurality of spaced apart widths of striping material and said substrate from their respec-

tive supplying means through said roll pressure bonding means.

8. Apparatus according to claim **7** wherein said receiving means and said withdrawing means comprises a power driven coiler.

9. Apparatus according to claim **7** wherein said withdrawing means comprises a power driven work roll.

10. Apparatus according to claim **1** including a plurality of pressure applying means, each of which is connected to one of said upper work rolls to adjust the pressure of each of said upper work rolls against said lower work roll.

* * * * *