Sept. 20, 1971 A. R. COPITHORNE 3,605,686

COATING MACHINE

Filed May 26, 1969 2 Sheets-Sheet 1

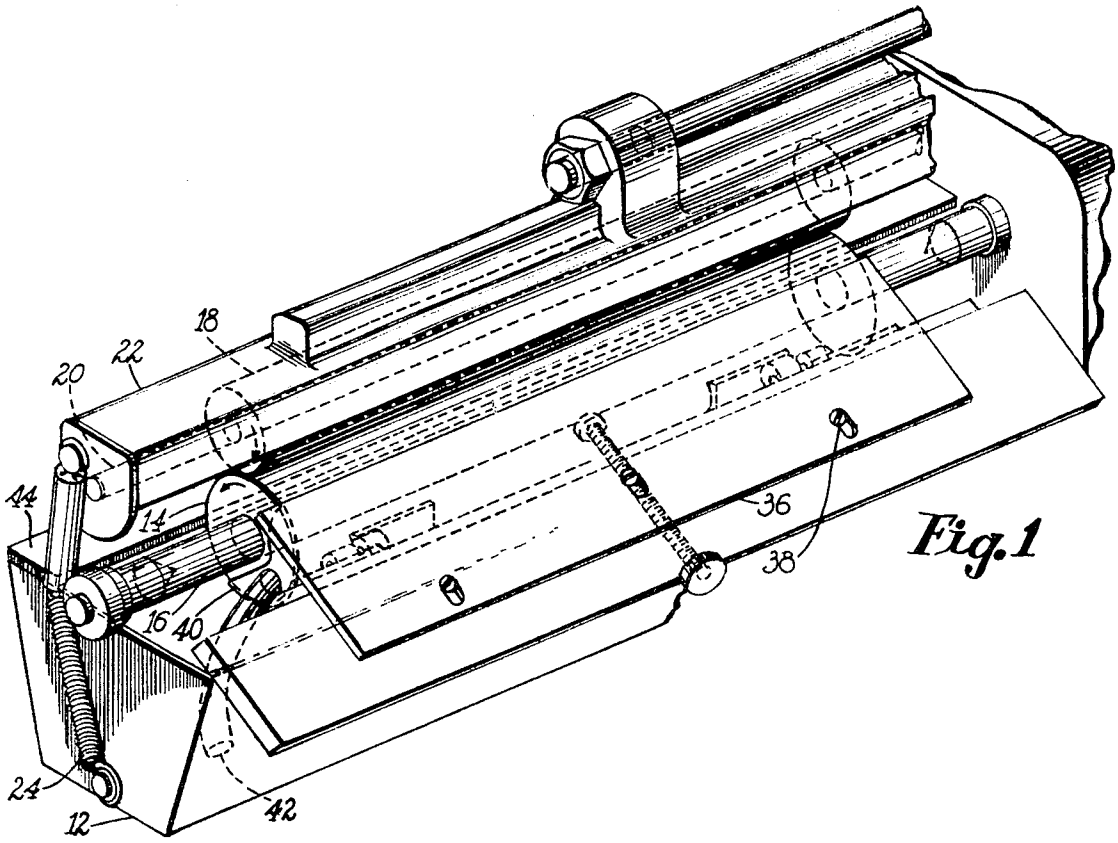
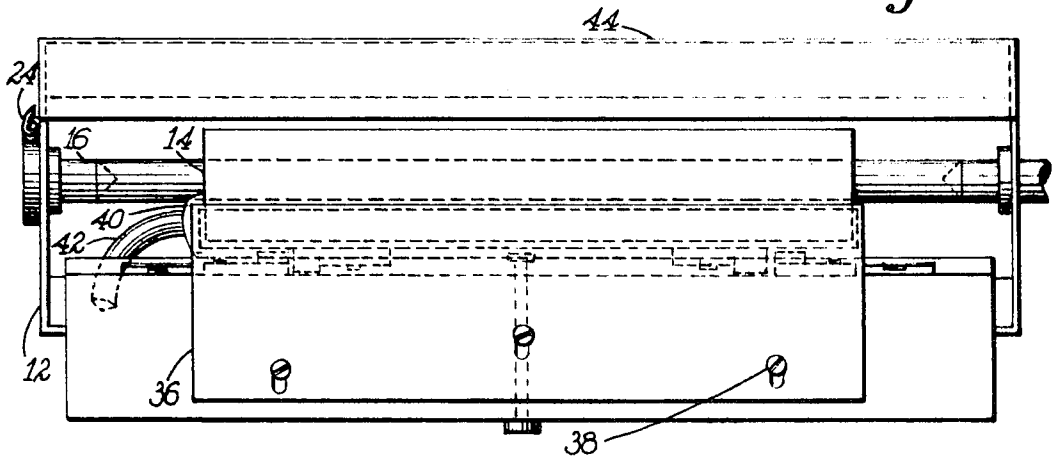


Fig. 1

Fig. 2



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Fig. 3

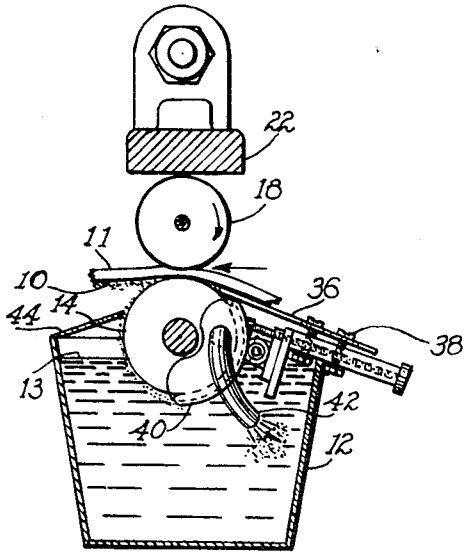


Fig. 4

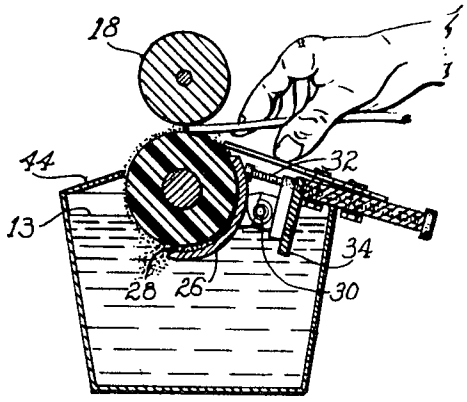


Fig. 5

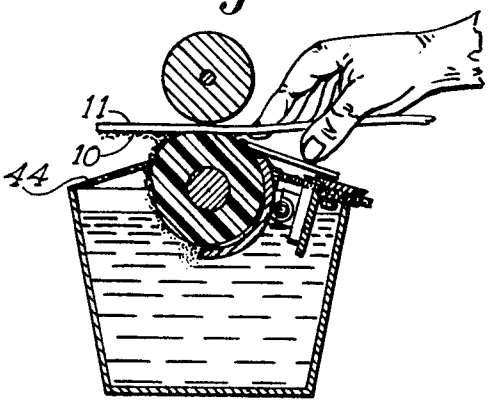
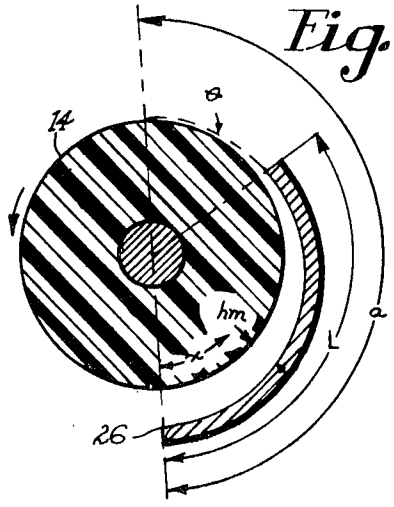


Fig. 6



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3,605,686

COATING MACHINE

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Int. Cl. B05c 1/02
U.S. Cl. 118—249 9 Claims

ABSTRACT OF THE DISCLOSURE

A machine is provided for applying an even coating of liquid to a workpiece fed through the machine. The machine is particularly suitable for applying liquid bonding cement to shoe soles and is comprised of a resilient roll drivingly mounted in a trough containing a quantity of the cement. An arcuate pressure plate of slightly larger curvature than the roll is mounted in close proximity to the roll surface and defines an arcuate wedge-shaped gap in which the liquid develops a pressure upon rotation of the roll to thereby control the thickness of the film on the roll and prevent distortion of the roll when a workpiece bears against the roll.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates generally to coating machines and more particularly is directed towards a machine for applying an even layer of a liquid such as cement to a workpiece such as a shoe sole of irregular contour.

(2) History of the prior art

In the manufacture of certain types of shoes, the soles are cemented to the shoe bottom by applying a liquid bonding cement, sometimes preceded by a primer, to the back surface of the sole. One way by which this is done is to rotate the sole manually against an applicator, so that sole margin receives a coating. This is a rather time consuming operation since each sole must be manipulated manually to insure proper coating. Other types of coating machines embody a feed-through operation in which the sole is fed directly between a pair of rolls, one of which is a solid metal roll, partially submerged in the cement so that a film is carried to the top of the roll. Film thickness is controlled by a stationary doctor blade which serves to remove excess cement from the roll as it revolves. The applicator roll is opposed by a feed roll revolving at the same speed and in the opposite direction as the applicator roll but spaced from it by the thickness of the workpiece. Machines of this type are satisfactory for workpieces of uniform thickness but where the workpiece varies in thickness as with a reduced sole, there will be no contact between the reduced portions of the sole and the roll surface so that the desired transfer will not take place over all of the sole.

While a resilient applicator roll will follow closely the contours of the workpiece, it has been found that a direct substitution of a resilient roll for a hard applicator roll will not function as intended. The workpiece will cause sufficient distortion of the resilient roll so that the roll surface will bulge out into contact with the doctor blade, wiping the surface of the resilient roll clean of the cement and preventing any substantial transfer of the cement to the workpiece. While this problem may be avoided by adding a rigid metal auxiliary roll to transfer a doctored film of fluid to the resilient roll at a point opposite the workpiece, this approach makes the machine more complex and adds a further element which must be cleaned from time to time of the cement or other liquid.

Accordingly, it is an object of the present invention to provide improvements in coating machines. A more

particular object of this invention is to provide improvements in machines for applying a uniform coating of cement, or the like, to a workpiece particularly of irregular thickness such as a reduced shoe sole. A still further object of this invention is to provide a simple and efficient machine of the character described in which the film thickness may be readily adjusted.

SUMMARY OF THE INVENTION

This invention features apparatus for applying a coating of uniform thickness to a workpiece, such as a reduced shoe sole, comprising a housing adapted to contain a quantity of coating liquid such as cement, a resilient roll mounted in the housing for partial submersion in the liquid, a feed roll mounted parallel to the resilient roll in a closely spaced relation thereto, and an arcuate pressure plate of slightly greater curvature than the resilient roll to and mounted in close proximity to the resilient roll to form an arcuate wedge-shaped volume between the resilient roll and the arcuate pressure plate. When the resilient roll is rotated partially submerged in the liquid cement, for example, an even film of liquid will be applied to the roll and will be transferred uniformly over the entire surface of a workpiece, even one of irregular thickness.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective, partly in phantom, of a coating machine made according to the invention,

FIG. 2 is a top plan view of the FIG. 1 apparatus but without the feed roll assembly,

FIG. 3 is a sectional view in side elevation of the FIG. 1 apparatus,

FIGS. 4 and 5 are sectional views in side elevation showing the apparatus in operation, and

FIG. 6 is a somewhat diagrammatic side elevation of the roll and pressure plate for illustrating operating principles.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown a machine for applying a coating **10** and a liquid primer or cement to a workpiece such as a reduced shoe sole **11** fed through the machine. The apparatus is generally organized about a tank or trough **12** adapted to contain a quantity of whatever liquid **13** is to be applied to the workpiece **11**. The apparatus of the illustrated embodiment has been found to be particularly useful in applying an even coating of liquid cement primer and liquid cement, such as urethane, neoprene or the like, to a surface of a reduced shoe sole which may vary in thickness by a factor of 5 to 1, for example.

Mounted to the tank and partially submerged in the liquid **13**, is a resilient roll **14** carried by a shaft **16** and driven by any suitable power means such as a motor (not shown). In practice, the resilient roll and its supporting shaft are mounted in such a manner as to be readily disassembled from the tank to facilitate periodic cleaning of the resilient roll and the trough. Mounted parallel to the resilient roll **14** is a feed roll **18** carried by a shaft **20**, also driven but in a direction opposite to the resilient roll and spaced from the resilient roll at the minimum thickness of the workpiece to be coated. The drive of the two rolls is such that the workpiece **11**, when fed from the right-hand side of the machine as viewed in FIGS. 3, 4 and 5, will be caught between the two rolls and pulled through, the resilient roll applying a coating of cement or the like to the under side of the workpiece. Preferably, the roll **18** is of a rigid material, typically a metal such as steel or aluminum, and the assembly is carried by a supporting frame **22** which is movable to and away from the

resilient roll to permit access to the trough and disassembly for periodic cleaning. The frame **22** typically is connected as by means of a spring **24** to the trough **12** so as to provide a yielding connection between the two rolls.

Mounted in close proximity to the resilient roll **14** is an arcuate pressure plate **26** having a concave curvature slightly greater than that of the resilient roll **14** and tilted in spaced relation to the resilient roll so as to define an arcuate wedge-shaped volume or gap **28** between the resilient roll and the concave surface of the pressure plate. The pressure plate preferably is co-extensive lengthwise with the resilient roll and covers perhaps a third or more of the circumference of the resilient roll. The pressure plate is pivotally mounted as by means of a hinge **30** and its upper sector engages an adjustment screw **32** by which the tilt of the pressure plate may be changed. By manipulating the adjustment screw **32** the pressure plate may be tilted to or away from the roll surface so as to control the film thickness as desired. The pressure plate is mounted so that the gap between the pressure plate and the resilient roll is greatest at the inlet end of the wedge-shaped volume **28** which is located below the surface of the liquid and the gap is least at the discharge or the upper end of the wedge-shaped volume. The pressure plate is supported by means of a bracket assembly **34** mounted to the trough wall. The bracket assembly also carries an optional doctor blade **36** which is provided with screws **38** to permit adjustment thereof so as to provide an alternate control over film thickness. In practice, the arcuate pressure plate is co-extensive with the length of the resilient roll and is provided with end walls **40** which serve to maintain the liquid within the wedge-shaped volume. Each wall is provided with a conduct **42** which provides a path for excess liquid to return to the trough.

Insofar as liquid cements such as used in the manufacture of shoes are rather volatile and the fumes are somewhat noxious, a cover plate **44** is provided and extends between the trough wall on the discharge side of the machine into close proximity with the resilient roll **14** thereby preventing evaporation of the liquid in the trough and reducing the release of fumes. Thus the doctor blade and the pressure plate assembly together with the cover plate **44** substantially enclose the trough leaving only the upper arcuate portion of the resilient roller **14** exposed to the atmosphere.

It is desirable that the roll **14** be of a highly resilient material so that it may readily conform to irregularities in the surface or in the thickness of the workpiece **11**. In selecting the roll material consideration must be given to its compatibility with the type of liquid cement or other coating substance employed. The material of the roll obviously should not be attacked by the liquid cement and should be of such a nature that it will transfer readily from the surface of the roll to the workpiece. In practice, it has been found that a resilient glue-glycerin material, such as used in printing press rolls or the like, is particularly satisfactory since it is highly resilient, smooth, readily formed, durable and is compatible with shoe cement. While apparently not critical it has been found in practice that a resilient roll having a durometer hardness in the range of 15 to 25 has provided very satisfactory results.

When the resilient roll is rotated towards the curved pressure plate **26**, a quantity of liquid cement will be drawn into the wedge-shaped volume **28** between the roll and the pressure plate and, depending upon the velocity, the wedge angle, the thickness, the length and the viscosity, a pressure will be developed in the wedge volume. The purpose of producing a pressure between the resilient roll and the pressure plate is to maintain a film of cement, or other liquid, between the plate and the roll which film may be transferred to the workpiece. The thickness of the film can be changed by adjusting the tilt of the pressure plate through manipulation of the adjustment screws **32** or by adjusting the gap between the doctor blade **36** and the resilient roll surface.

The apparatus provides an improvement over existing coating machines which do not deposit a uniform film of a liquid on a workpiece of varying thickness such as an outsole for a woman's novelty shoe where the thickness may vary by a factor of 5 to 1. Existing machines consist generally of a solid metal roll rotating in a bath of liquid cement so that a film of the cement is carried to the uppermost side. The thickness is controlled customarily by a stationary doctor blade which removes excess cement from the roll as it revolves. This transfer roll is opposed by a feed roll revolving at the same speed and spaced away from it by the thickness of the workpiece. While this arrangement works satisfactorily for workpieces of uniform thickness a variation in the cross section of the workpiece will result in raised portions of the workpiece surface being coated while recessed surfaces will not contact the transfer roll and no transfer will take place. While a resilient roll, such as made of elastomeric material, can follow the contours of the workpiece more closely than a rigid roll, it has been found that if a direct substitution of such a resilient roll is made the roll is displaced or distorted to such an extent by the workpiece as it passes through the machine that substantially no coating will take place. It has been found that when the workpiece is fed between the feed roll and the transfer roll, the resilient transfer roll will bulge out under the action of the workpiece and the bulging portion of the resilient roll will bear against the doctor blade and be wiped clean of cement. Thus no cement will be transferred to the workpiece even though the rolls may be in intimate contact with the workpiece. While attempts have been made to resolve this problem by adding a rigid metal auxiliary roll which transfers a doctored film to the resilient roll at a point opposite the workpiece this third roll constitutes an additional complexity and involves an additional component which must be cleaned.

The present invention eliminates the necessity for an auxiliary transfer roll since the pressure maintained in the arcuate wedge volume by the liquid prevents the resilient roll from deforming and thereby reducing film thickness. To produce the desired film thickness for transfer to the work, the wedge angle may be changed by pivoting the pressure plate as described above. Optionally, the doctor blade **36** may be advanced into the film to control the film thickness above the pressure plate while the pressure plate is left free to pivot and find its best position.

It will be noted that the construction of the device, with the pivot approximately ⅔ of the distance from the leading edge, resembles a thrust block such as used in thrust bearings for supporting heavy loads on an oil cushion. Much test and theoretical work has been done on such thrust bearings. The present invention advances this work to a partially enclosed horizontal shaft made of resilient material where the dimensions are so chosen that any movement of the shaft towards the pressure plate is resisted by the force of the liquid pressure generated by the wedge-shape of the liquid. It has been found that in operation such a liquid wedge has the property of increasing the pressure, and therefore the force, exponentially as the film thickness decreases according to the equation: (see FIG. 6)

$$P_m = \frac{\mu v L^2}{h_m^2(2a-L)} \tag{1}$$

where μ is the viscosity, v is the velocity, P_m is the mean pressure and since θ is small

$$h = \theta(a-x) \tag{2}$$

It can be seen therefore that the apparatus can be made in any size found convenient for application to a particular machine provided that the relationship expressed in Equation 1 is maintained.

It can further be seen that the nearly incompressible liquid which is drawn into the wedge at the bottom of the roll will exit at the top with the excess passing out the sides. In coating machines of the type described it is de-

sirable to keep the liquids well mixed since the volatile solvent part of the liquid may evaporate more quickly where it is exposed to the air and create differences in viscosity. It is usual to provide a separate pump within the body of the machine to mix and circulate the liquid. The described apparatus is therefore provided with the cup-shaped walls described at the ends of the pressure plate and roll and which are connected by the conduit to the bottom of the trough. Thus the liquid is automatically circulated by the action of the machine and a separate pump is not necessary.

The machine can be employed for coating work pieces with a variety of substances such as cement primers and urethane or neoprene cement such as used in bonding shoe soles. Liquids of different viscosities can be employed and accommodated by various techniques such as using pressure plates with different curvatures or by tilting the plate to control the thickness of the film. Another alternative is to use a roll of selected resiliency since the harder the resilient roll the thinner will be the film produced by its action with the pressure plate.

The curved pressure plate develops a fluid bearing pressure which prevents deformation of the resilient roll and when the workpiece passes between the feed roll and the resilient roll, the resilient roll will not deform or bulge against the doctored blade or against the pressure plate. Therefore the liquid on the roll will not be wiped off either by the pressure plate or by the doctor blade, but rather will be transferred to the workpiece surface. Since the resilient roll conforms to the contours of the workpiece, the workpiece will receive an even coating of the liquid regardless of changes in thickness or other irregularities in its surface.

Having thus described the invention what I claim and desire to obtain by Letters Patents of the United States is:

1. A machine for applying a coating of liquid to the surface of a workpiece comprising:
   (a) a container adapted to contain a quantity of said liquid;
   (b) a resilient roll rotatably mounted in said container and partially submerged in said liquid;
   (c) power means drivingly connected to said resilient roll for rotation thereof;
   (d) means mounted in spaced relationship to said resilient roll for urging said workpiece against said resilient roll; and
   (e) a pressure plate having inlet and outlet edges in spaced longitudinally parallel relationship to the axis of said resilient roll, said inlet edge being submerged in said liquid and said outlet edge being above the surface of said liquid, said pressure plate having a curved inner surface facing oppositely the cylindrical surface of said resilient roll, the curved inner surface having a radius of curvature greater than the radius of curvature of the cylindrical surface of said resilient roll, the cylindrical surface of said resilient roll and the curved inner surface of said pressure plate forming an arcuate wedge-shaped gap.

2. A machine according to claim 1 wherein said means for urging is a roll.

3. A machine according to claim 1 including a doctor blade mounted in spaced parallel relation to said resilient roll and above the surface of said liquid.

4. A machine according to claim 1 wherein said resilient roll is fabricated at least in part of an elastomeric material.

5. A machine according to claim 4 wherein said material is a glue-glycerin composition.

6. A machine according to claim 1 including positioning means engaging said pressure plate for selectively tilting said pressure plate with respect to said resilient roll and operating to vary said wedge-shaped gap.

7. A machine according to claim 1 wherein said pressure plate is coextensive in length with said resilient roll and spans a substantial arcuate portion thereof.

8. A machine according to claim 7 wherein said plate is formed with end walls closing the ends of said gap.

9. A machine for applying a coating of liquid to the surface of a workpiece, comprising
   (a) a container adapted to contain a quantity of said liquid,
   (b) a resilient roll mounted in said container for rotation partially submerged in said liquid,
   (c) power means drivingly connected to said resilient roll for rotation thereof,
   (d) a pressure plate mounted in closely spaced parallel relation to the surface of said roll in position to be partially submerged in said liquid,
   (e) said pressure plate being formed with a curved inner surface facing oppositely the cylindrical surface of said roll and of greater curvature than said roll,
   (f) said pressure plate being coextensive in length with said resilient roll and spans a substantial arcuate portion thereof,
   (g) said plate being formed with end walls closing the ends of said gap,
   (h) a conduit connected to at least one of said end walls and extending below the surface of said liquid,
   (i) means for tilting said plate with respect to said roll to form an arcuate wedge-shaped gap therebetween.

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JOHN P. McINTOSH, Primary Examiner

U.S. Cl. X.R.

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