April 9, 1957 O. S. TUTTLE 2,788,051

APPARATUS FOR APPLYING A COATING TO SHEET MATERIAL

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Fig. 1

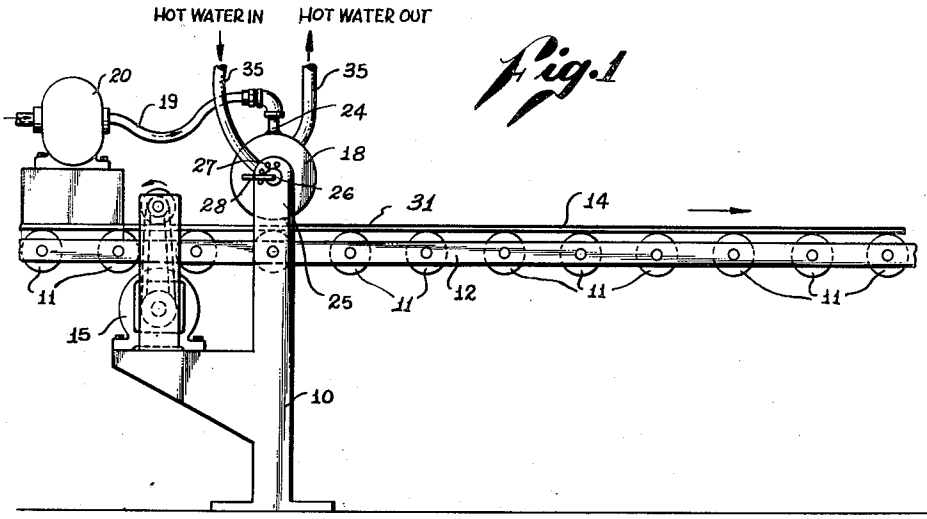


Fig. 2

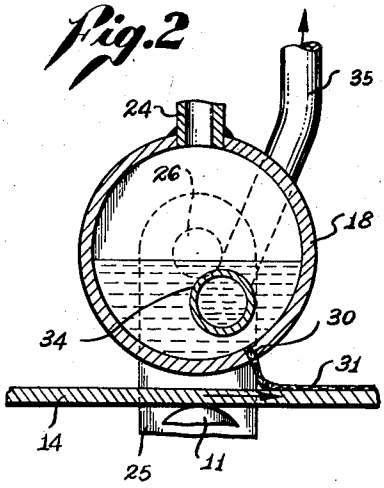


Fig. 3

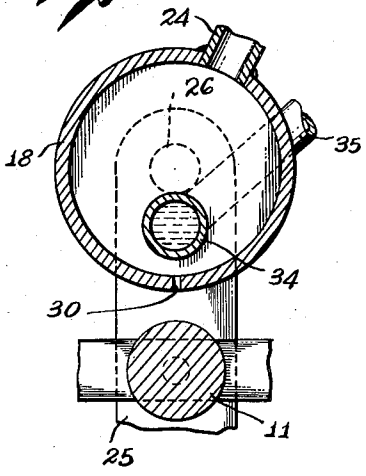
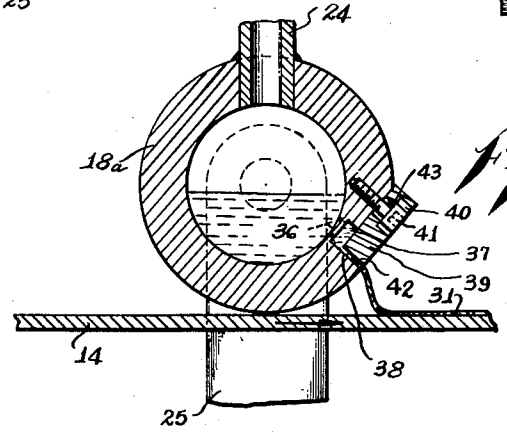


Fig. 4



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APPARATUS FOR APPLYING A COATING TO SHEET MATERIAL

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2 Claims. (Cl. 154—1)

My invention relates generally to protective or adhesive coatings and more particularly to a method and apparatus for applying such coatings.

The conventional way to apply protective and adhesive coatings to sheet material is by means of brushes, rollers, or sprayers. All of these methods result in a coating which is somewhat uneven, and which cannot be accurately controlled to achieve a predetermined layer thickness. In the case of adhesive coatings, this may cause an imperfect bond between attached members, while in the case of protective coatings, it permits deterioration of the coated surface in the area of any imperfections. Furthermore, former methods of applying a coating substance are highly wasteful of the substance applied, because of a natural tendency to err upon the side of overabundance.

My invention is particularly advantageous in connection with the construction of laminates wherein adhesives are employed to bond sheets or panels to an inner core. Large surface areas must be coated with a suitable adhesive and the integrity of the resulting assembly is highly dependent upon achieving a uniform bond between the layers. Likewise, the invention is advantageous in the application of protective stripper coatings to aircraft skin sheets or in similar large surface coating operations. It is to be understood that the invention is not directed to a coating operation of any particular character, but rather to the application of the coating substance in a rapid and efficient manner.

It is therefore a major object of my invention to provide a method of applying a flowable coating substance directly upon the surface of sheet material in a continuous process.

Another object of the invention is to provide a method of applying a coating substance to obtain a uniform coating of controllable and predetermined thickness.

It is also an object of my invention to provide apparatus for carrying out the invention including an applicator having an elongated orifice therein for discharging a film of coating material onto a sheet passing thereby.

A further object of the invention is to provide apparatus of the class described having means for controlling the width of the orifice slot.

It is an additional object of the invention to provide adjustable means for determining the relative angular position of the applicator relative to the plane of movement of the sheet material.

Still another object of the invention is to provide an applicator having heating means therein for controlling the discharge temperature of the coating material.

A still further object of the invention is to provide apparatus of the class described which is simply and durably constructed for dependable service.

These and other objects and advantages of the invention will become apparent from the following detailed description of a preferred embodiment of the apparatus and from an inspection of the accompanying drawing in which:

Figure 1 is a side elevation of the complete apparatus;

Figure 2 is an enlarged sectional detail through the applicator shown in operating position;

Figure 3 is a sectional detail similar to Figure 2, showing the applicator in non-operating position; and

Figure 4 is a sectional detail through a modified form of applicator.

My method of applying a coating differs from previous methods in that the coating is applied directly upon the surface of sheet material without being transferred first to the surface of brushes or rollers and then wiped upon the surface of the sheet. The first step in the method is to form a continuous film or layer of coating substance in a flowable state. I prefer to do this by extruding or discharging the coating through a suitable orifice into the air. The orifice is of elongated slotted shape and is extended transversely of conveyor means for moving the sheet material along a linear path at a uniform rate. As the coating is extruded into the air in the form of a continuous film, it is impinged against the surface of the sheet material before it has undergone any change of shape. By this, I means that the air space between the mouth of the extrusion orifice and the surface of the sheet material is of sufficient length to permit the definition of a film, but is short enough to prevent the film so formed from becoming discontinuous or of irregular thickness. As can be understood, no definite spacing can be stated since it will depend upon the characteristics of the coating substance.

As the coating film is impinged against the surface of the sheet material, it adheres to and covers the moving surface of the latter. By adjusting the extrusion rate of the coating to equal the rate of travel of the sheet material, I, in effect, merely lay the already formed coating film upon the surface of the sheet material. For this reason, I am able to obtain a coating which is of uniform thickness throughout the length of the sheet. Control of the extrusion process permits the coating layer to be of any desired thickness. Considering the method in more detail, it will be discussed in connection with a preferred form of apparatus.

Referring now to the drawings and particularly to Figure 1 thereof, the numeral **10** indicates the base or standard of a horizontally extending conveyor means. A plurality of rollers **11** are mounted along a conveyor table **12** for supporting a flat sheet of material **14** which is moved along a linear path defined by the top plane of the rollers. Suitable driving means **15** are adapted to drive sheet **14** at a uniform rate of travel in the direction indicated by the arrows.

Above conveyor **12** is an applicator body **18** which is extended transversely of the path of travel of sheet **14** and is spaced slightly above the top surface thereof. Conduit means **19** preferably connect body **18** with a pump unit **20** which is adapted to be connected to a source of coating substance or material in a flowable state. In the case of an adhesive coating, the adhesive may be a resin of thermosetting type, many of which are commercially available. These adhesives vary considerably in viscosity and chemical compositions depending upon the sheet materials which are to be coated. Similarly, it may be desired to apply a protective coating which is also subject to wide variation. I have found that the method and apparatus described herein are suitable for applying all such coatings which are capable of being prepared in a flowable state and extruded into a thin film.

The coating material is supplied to applicator body **18** under pressure from pump **20**. The pressure head required is dependent upon the character of the coating substance and the rate of extrusion which is desired. Under some conditions, a slight head might be sufficient to extrude the coating substance, but normally, a relatively

high pressure will be desirable. As is best seen in Figure 2, applicator body **18** is formed as an elongated tubular member having an upper coupling **24** adapted for connection to conduit means **19**. The ends of body **18** are closed and are mounted upon arms **25** extended upwardly from base **10**. In order that body **18** may pivot about its own axis, it is connected to arms **25** by means of end pivot pins **26** seen in Figure 1. Adjustment holes **27** and locking bolts **28** are also provided on arms **25** for holding body **18** in a fixed position relative to conveyor table **12**.

In the lower portion of body **18** is an elongated slotted orifice **30** which extends transversely across sheet **14** and is adapted for discharging or extruding a thin film of coating substance **31** downwardly against the surface of the sheet. The width of orifice **30** is predetermined to give the desired thickness of coating **31** upon sheet **14** and is normally quite small. As can be seen in Figure 2, the extruded film strikes the surface of sheet **14** and adheres thereto. Since sheet **14** is moving forwardly a continuous coating is formed on the surface thereof. By variations in the pressure within body **18**, and the width of orifice **30**, the rate of discharge of the coating film **31** is adjusted so that it equals the rate of travel of sheet **14**. In this manner, a coating **31** of uniform thickness is obtained along the entire length of sheet **14**.

To obtain free and constant flow of film **31**, it is desirable that orifice **30** be rotated from the verticle in the direction of movement of sheet **14**. The amount of angular rotation desired is dependent upon the rate of travel of sheets **14** and may be adjusted by means of adjustment holes **27** and locking bolts **28**. When the applicator is not in use, it is desirable to have orifice **30** extend directly downward so that a hardened film crust of minimum size will be formed at the mouth of orifice **30**. For this reason, applicator body **18** is pivotally moved to the position shown in Figure 3. In the event that a very thin coating substance is used, body **18** may be rotated so that orifice **30** points upwardly and no further flow can take place.

When working with many coating substances, particularly those of a thermosetting type, it is desirable to accurately control the extrusion temperature of the coating film. To this end, I provide heating means within body **18**. Typically, the heating means take the form of a longitudinally extending pipe **34** which extends through the body adjacent orifice **30**. A heating medium such as hot water is supplied to pipe **34** through external end conduits **35**.

In Figure 4, I have shown a modified form of applicator having an orifice of adjustable width. This feature is particularly desirable where the same coating apparatus is to be used for applying different kinds of coatings. An applicator body **18***a* is of tubular thick walled construction and has an upper coupling **24** adapted to be connected to a source of coating material. Near the bottom of body **18***a* are a plurality of spaced openings **36** which open into a slotted elongated opening **37** extending the length of the body. One side of opening **37** has a radially directed wall **38** forming the back side of the orifice, while the opposite side of the opening is cut back to mount a slidable gate block **39**. Block **39** has outer slots **40** and inner slots **43** cooperating with lock screws **41** engageable in body **18** to secure the block relative to rear wall **38**, and thus define a narrow mouthed orifice **42** of adjustable width.

While I have thus shown a very simple form of apparatus for carrying out the invention, it can be understood that modifications and refinements will be apparent to those skilled in the art. Therefore, I do not wish to be restricted except as defined in the appended claims.

I claim:

1. Apparatus for applying a coating of a thermosetting coating substance to sheet material which includes: a pair of fixed spaced-apart supporting members; a pair of coaligned rotatable bearings, each mounted in one of said members; an elongated tubular body having closed ends integrally formed therewith, the ends thereof being each permanently affixed to the adjacent ends of said rotatable bearings to be externally and rotatably mounted therebetween; means attached to said rotatable bearings for adjusting said rotatably mounted tubular body to a plurality of fixed positions; conduit means having one end communicating with said body; a pump connected to the free end of said conduit means and adapted to be connected to a source of coating substance in a flowable state whereby to pump said coating substance through said conduit means to said tubular body; heating means within said tubular body for controlling the temperature of said coating substance; and a continuous slotted elongated orifice formed in said tubular body for extruding said coating substance onto a sheet material moving at a uniform rate along a substantially horizontal linear path below, and in a transverse direction to, said tubular body, the continuous slotted orifice being rotatable to a fixed position by means of said adjusting means to extrude said coating substance onto said sheet material at a fixed angle of incidence therewith and at a rate equal to the rate of travel of the sheet material, said tubular body being rotatable and adjustable to a non-operative position whereby said orifice is in an upward position to prevent gravitational flow of said coating substance.

2. Apparatus for applying a coating substance which comprises a thermosetting substance to a sheet material which includes: a pair of fixed spaced-apart supporting members; a pair of coaligned rotatable bearings, each mounted in one of said members; an elongated tubular body having closed ends integrally formed therewith, the closed ends of said body being permanently affixed to adjacent ends respectively of said rotatable bearings to be thereby externally and rotatably mounted between said supporting members; means attached to said rotatable bearings for adjusting said rotatably mounted tubular body to a plurality of fixed positions; conduit means having one end communicating with said body; a pump connected to a source of coating substance in a flowable state and to the free end of said conduit means whereby to pump said coating substance through said conduit means to said tubular body; heating means within said tubular body for controlling the extrusion temperature of said coating substance; an elongated opening formed in said tubular body; and an adjustable elongated gate member movably attached to the exterior surface of the wall of said tubular body positioned so as to adjust the width of said opening to form a continuous slotted orifice thereby controlling the thickness of said coating substance as it emerges therefrom onto a sheet material moving at a uniform rate along a substantially horizontal linear path below and in a transverse direction to said tubular body, the slotted orifice being rotatable to a fixed desired position by means of said adjusting means to extrude said coating substance onto said sheet material at a fixed desired angle of incidence thereto and at a rate equal to the rate of travel of the sheet material, said tubular body being rotatable and adjustable to a non-operative position whereby said orifice faces upwardly to prevent gravitational flow of said coating substance.

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