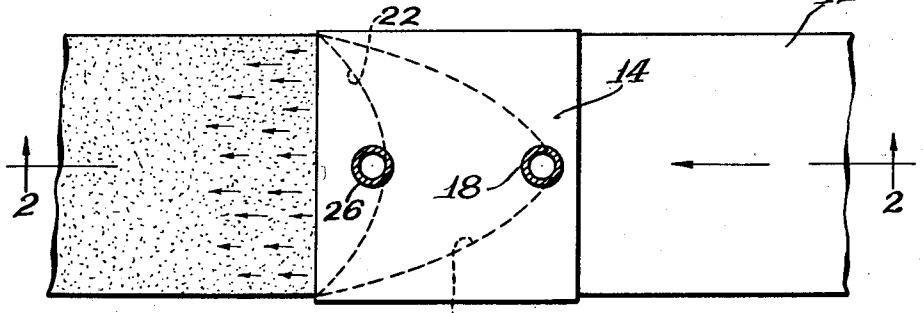
April 23, 1957 A. C. ALLEN 2,789,922

METHOD AND APPARATUS FOR APPLYING A THIN FILM OF LIQUID

Filed May 24, 1952

FIG. 1.



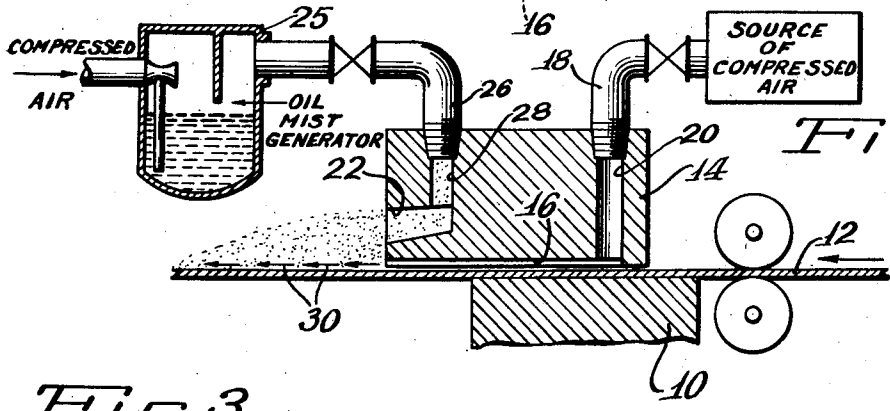


FIG. 2.

FIG. 3.

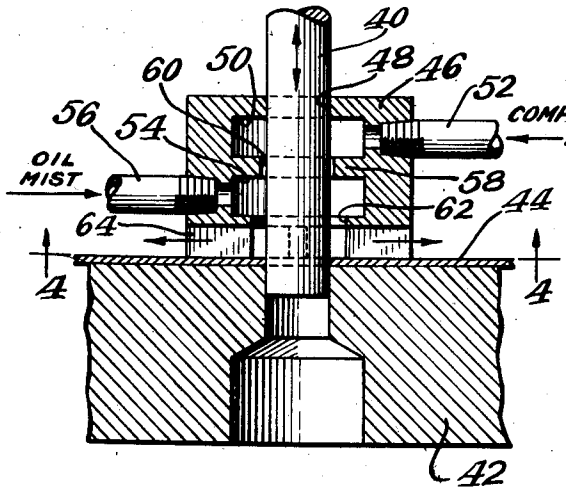
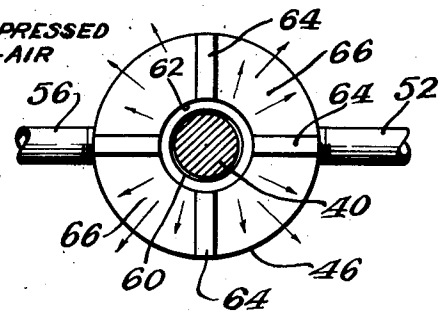


FIG. 4.



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Attys.

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METHOD AND APPARATUS FOR APPLYING A THIN FILM OF LIQUID

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Application May 24, 1952, Serial No. 289,920

9 Claims. (Cl. 117—106)

My invention relates generally to a method and apparatus for applying a thin film of liquid to a part, and more particularly to applying a thin film of lubricant to sheets, rods, wire, punches, ways, etc.

In many processes and in many machines, it is desirable to apply a thin film of liquid, for example, a lubricating oil, to a strip or sheet, or to a rod or wire, in the course of its manufacture, or to apply a thin film of lubricant to a machine tool part, such as a punch, rod, piston, ways, etc.

It is the primary object of my invention to provide a method and apparatus for applying such film uniformly and economically.

A further object is to provide apparatus and a method for applying an extremely thin film of lubricant to a moving strip, rod, wire, or machine tool part.

Other objects will become apparent from the following description, reference being had to the accompanying drawings, in which

Fig. 1 is a plan view of the apparatus used in applying a thin film of oil, or other liquid, to a strip of metal or the like;

Fig. 2 is a vertical cross sectional view thereof, taken on the line 2—2 of Fig. 1;

Fig. 3 is a central vertical cross sectional view of a modified form of the invention; and

Fig. 4 is a bottom plan view of the film applying head shown in Fig. 3.

It is sometimes difficult to apply a uniformly very thin film of a liquid to a moving strip, rod, or wire. Various methods of spraying the liquid have been employed, sometimes including means for imparting opposite electrostatic charges to the liquid, and the surface to which the film is to be applied, but such apparatus is usually expensive and often applies a film thicker than necessary, and is thus uneconomical. Other methods, such as applying the liquid by a brush or by a roller, likewise result in application of a much greater quantity than is required.

Contrary to what one might expect, I have discovered that a liquid (hereinafter assumed to be a lubricating oil) may be formed into a mist by a suitable mist generator, the oil mist conducted to the space adjacent a surface to be lubricated, and caused to be deposited upon the surface by producing a thin layer high velocity jet of air flowing immediately adjacent the surface to which the film is to be applied.

As illustrated in Fig. 1, the apparatus for accomplishing this comprises a base 10 over which a strip 12, which is to have an oil film applied to the upper surface thereof, passes in the direction indicated by the arrows. Above this support 10 is a head 14, the lower surface of which has a generally parabolic recess 16 which has a thin opening at the left edge of the head to form a flaring nozzle having a width substantially equal to the width of the swath of the surface to be coated. Partially formed by the surface to be coated, the nozzle points along the surface in substantially parallel relation thereto. Air under pressure is supplied through a conduit 18 and a passageway 20 to this space between the sheet 12 and the recessed portion 16 of the head. This compressed air flows outwardly from the outlet at the left-hand edge of the head 14 in a thin high velocity stream closely adjacent the upper surface of the sheet 12. The head 14 is also provided with a wide parabolic distributing port 22 to which an oil mist under relatively low pressure is supplied from a suitable source 25 through a conduit 26 and a passageway 28 leading to the port 22. Emerging from the port 22 the mist forms a "cloud" of relatively low velocity which settles on the high velocity sheet of air sweeping from the nozzle 16 in generally parallel relation to the surface to be coated. The means for generating the mist may be of any well known construction, for example of the type shown in the copending application of Karl E. A. Gothberg, Serial No. 18,590, filed April 2, 1948, which has matured into Patent No. 2,610,700.

One might expect that the rapidly moving thin sheet of air along the surface of the top of the strip 12, indicated by the small arrows 30, would prevent the particles in the oil mist from contacting the surface of the sheet 12, but actually the contrary is true. The particles of oil in the oil mist are extremely minute, averaging approximately five microns in diameter, and they do not settle readily. However, due to the venturi effect, the air stream at 30 produces a reduced pressure area directly above it, and the air carrying the oil mist particles is drawn into this air stream. The oil mist particles, having a mass greater than the surrounding air, acquire a sufficiently high velocity motion in a direction having a substantial downward component that their momentum carries them through the thin air stream at 30 and they strike the surface of the sheet 12 and coalesce thereon.

The oil mist particles may be thought of as spheres having an external skin which is relatively strong, because of their minute size and they thus have an extremely high ratio of surface area to volume. This "skin," due to surface tension, cannot be broken to permit the oil to coalesce on the surface of the sheet unless the particles strike the surface at a sufficiently high velocity that the forces, due to the momentum of the particle, are sufficient to overcome the surface tension forces which form the virtual skin on the surface of the particles. If the oil mist particles do not strike the surface with sufficient velocity, they will rebound and return to the air stream, and thus will not be deposited upon the surface of the sheet 12.

The fundamental principle of the invention is therefore to supply an aerosol or mist (of the liquid to be deposited) adjacent the surface to be coated, and then causing the particles of the liquid in the mist to move with a sufficiently high velocity component toward the surface to coalesce thereon, accomplishing this by causing a thin high velocity stream of air to flow along said surface.

The principles of the invention may be utilized in various other types of apparatus. For example, in the embodiment shown in Figs. 3 and 4, the principle is used for the lubrication of a punch. In these figures a punch 40 is cooperable with a die 42 to perforate a sheet 44. A suitably held block 46 surrounds the punch 40 and has an opening 48 at its top, which has a snug fit with the punch 40. An upper compartment 50 within the body 46 is supplied with compressed air through a conduit 52. A similar lower compartment 54 is supplied with oil mist under relatively low pressure through a conduit 56. The compartments 50 and 54 are separated by a wall 58 which has an opening 60 of slightly greater diameter than that of the punch 40. The bottom of the block 46 is provided with a relatively large opening 62 and the

block 46 is spaced from the sheet 44 by a plurality of radial ridges 64 to provide passageways 66 for the relatively free escape of air.

When in operation, the compressed air from chamber 50 flows at high velocity in a thin cylindrical sheet along the surface of the punch 40. The cloud of oil mist in the chamber 54 is thus drawn into this high velocity stream, due to a venturi effect, and the oil particles acquire motion, having a sufficiently high velocity component toward the punch 40 so as to penetrate the high velocity sheath around the punch 40 and still retain enough velocity so as to break up and coalesce upon the punch to provide an extremely thin film of lubricant thereon. The compressed air, together with such minor proportion of the mist particles as do not acquire sufficient velocity toward the punch to coalesce thereon, escape to the atmosphere through the relatively large opening 62, and the passageways 66 between the ridges 64. An oil film is thus formed on the punch 44, reducing the friction as it passes through the sheet 44 into the die 42.

By properly adjusting the relative pressures at which the oil mist and compressed air are supplied, a very large proportion of the oil carried in the mist will be coalesced upon the punch 40. It is preferable that the high velocity stream of air flow in the direction of movement of the sheet 12 in the embodiment shown in Figs. 1 and 2.

An arrangement similar to that shown in Figs. 3 and 4 may be employed to lubricate rods or wires being pulled through a drawing die, or it may be used to lubricate any reciprocating rod, such as a piston rod, to reduce friction and wear.

Similarly, the form of the invention shown in Figs. 1 and 2 may be utilized to lubricate the ways of a machine tool, in which instance the body 14 of the apparatus will be shaped to conform with the shape of the ways.

Apparatus incorporating the principle of this invention may also be used to apply thin coatings of liquids other than oil, provided they are not highly volatile and are capable of being broken up into extremely fine particles, in the order of a few microns in diameter.

As indicated above, a suitable apparatus for producing a mist or aerosol of the type desirable for use with the apparatus shown herein, is disclosed in the said copending application of Karl E. A. Gothberg. In some uses of the invention, the head 14 may be moved while the sheet or other part to which the film is to be applied, is stationary.

While I have shown and described preferred embodiments of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. The method of applying to a surface a thin coating of a liquid which is capable of being subdivided to form an aerosol, which comprises, supplying an aerosol cloud of the liquid to a space near the surface to be coated, and simultaneously therewith passing a thin high velocity stream of air along the surface to be coated between the latter and the aerosol cloud so that the high velocity stream of air draws the aerosol toward the surface to coalesce liquid from the aerosol onto the surface, the point of first contact of the high velocity air stream being at an appreciable distance from the aerosol cloud.

2. The method of applying to a surface a film of liquid which is capable of being subdivided to form an aerosol which comprises, supplying an aerosol cloud of the liquid to a space adjacent the surface to be coated at relatively low velocity, and at the same time passing a thin stream of high velocity air immediately adjacent and generally parallel to the surface to which the film is to be applied from a point an appreciable distance from the aerosol cloud and between the surface and the aerosol cloud so that liquid particles are coalesced from the cloud onto the surface to be coated.

3. The method of coating a surface with a thin film of liquid, which comprises, generating an aerosol of the liquid in which the liquid particles are extremely small, passing a thin stream of high velocity gas over a swath of the surface to be coated in substantially parallel contact therewith, and maintaining a cloud of the aerosol in contact with the stream of air sweeping over the surface to be coated at a point appreciably downstream of the start of its passage over the surface to be coated, whereby the fluid particles in the cloud are drawn through the moving air stream onto the underlying surface.

4. The method of coating a surface with a thin film of liquid, which comprises, generating an aerosol of the liquid in which the fluid particles average approximately five microns in diameter, forming a generally stagnant cloud of the aerosol in close proximity to the surface to be coated, and passing a thin high velocity stream of gas directly along and generally parallel with the surface to be coated between the latter and the aerosol cloud, whereby liquid particles are coalesced from the cloud onto the surface, the point of first contact of the high velocity air stream being at an appreciable distance from the aerosol cloud.

5. The method of covering a surface with a thin film of liquid which comprises generating a mist of the liquid in which fluid particles are very small, providing a cloud of the mist in proximity to the surface to be coated and having a negligible velocity, and accelerating particles of the mist to impinge on and be deposited upon the surface by passing a thin stream of high velocity gas parallel to the surface and between the surface and the cloud, the point of first contact of the high velocity air stream being at an appreciable distance from the aerosol cloud.

6. Apparatus for applying a thin film of liquid to a surface, comprising, in combination, a gas discharge member having an outlet passageway and adapted to be disposed immediately adjacent the surface to be coated, said discharge member having means in communication with said outlet passageway forming with the surface to be coated a thin outlet opening having a width substantially equal to the swath of the surface to be coated and adapted to point along the surface in substantially parallel relation adjacent thereto, means for supplying gas under pressure to said discharge member to produce a thin high velocity stream of gas flowing along and in contact with the surface, means for generating a mist of extremely fine particles of the coating liquid, and means connected to said mist generating means and having an outlet for maintaining a relatively low velocity cloud of the mist at the outlet side of said thin outlet opening, whereby the high velocity stream of gas will draw particles of the mist through the gas stream to be coalesced on the surface in the form of a thin film of liquid, and said mist outlet being at an appreciable distance from the point where the high velocity air first contacts the surface to be coated.

7. Means for coating a surface with a thin film of liquid, comprising, in combination, means for generating a mist of extremely fine particles of the coating liquid, means connected to the generating means and having an outlet for maintaining a cloud of the mist adjacent the surface to be coated, a source of gas under pressure, and gas discharge means connected to said source and having a surface adapted to be disposed adjacent the surface to be coated and to cooperate therewith to form a thin, relatively wide gas outlet to project a thin stream of high velocity gas between the mist cloud and the surface in parallel relation to the latter, and said mist outlet being at an appreciable distance from the point where the high velocity air first contacts the surface to be coated.

8. Apparatus for applying a liquid to a surface in a very thin film, comprising, in combination, means for

generating a fine mist of the liquid, means having an outlet for conducting the liquid in mist form to a space closely adjacent the surface to be coated, a source of air under pressure, air discharge means connected to the source of air under pressure and having an extended surface which is adapted to cooperate with the surface to be coated to define a thin relatively wide air outlet to direct a thin stream of high velocity air generally parallel to and immediately adjacent the surface to be coated between the latter and the space for the mist, and said mist outlet being at an appreciable distance from the point where the high velocity air first contacts the surface to be coated.

9. Apparatus for applying a liquid to a surface in a very thin film, comprising, in combination, means for generating a mist of the liquid, means having an outlet for conducting the liquid in mist form to a space closely adjacent the surface to be coated at a relatively low velocity, a source of air under pressure, air discharge means connected to the source of air under pressure and having an extended surface conforming generally in shape to the surface to be coated and which is adapted to cooperate therewith to define an air outlet to direct a thin

high velocity stream of air therealong in immediate parallel relation to the surface to be coated between the surface and the space for the mist, and means for moving the surface in the direction of flow of the thin high velocity stream of air emitted from said air outlet, whereby the high velocity stream of air draws the liquid mist toward the surface from which mist the liquid is coalesced onto the surface, and said mist outlet being at an appreciable distance from the point where the high velocity air first contacts the surface to be coated.

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