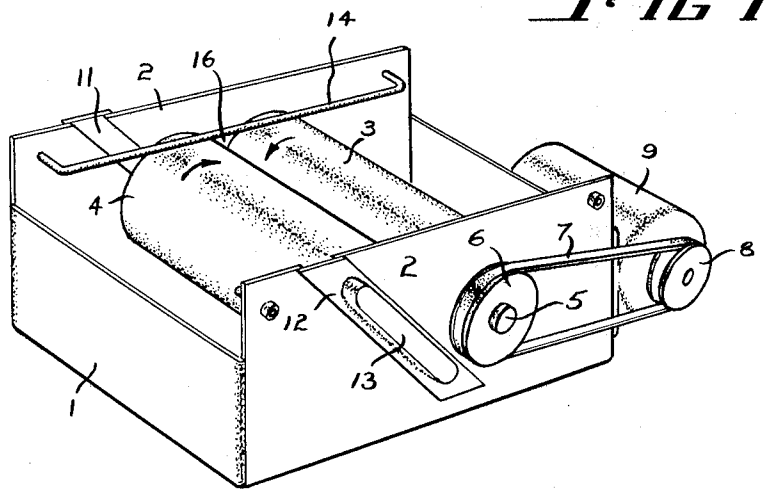
June 21, 1966 K. M. OLIPHANT 3,256,855

MACHINE FOR APPLYING LIQUIDS

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FIG 1



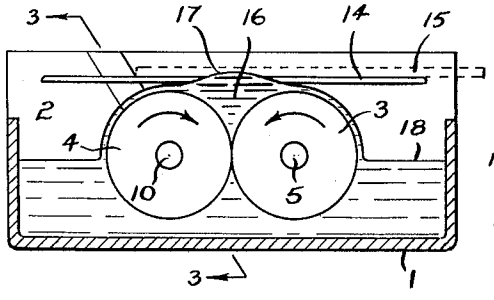


FIG 2

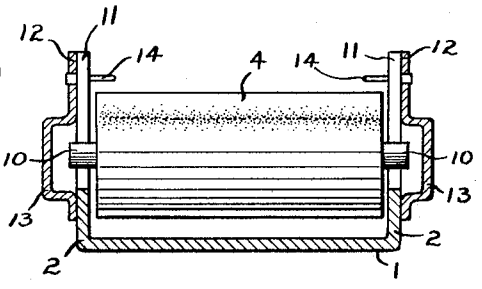


FIG 3

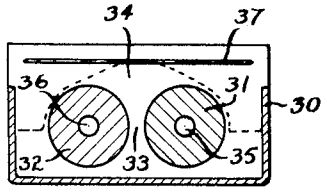


FIG 4

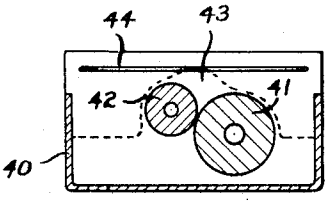


FIG 5

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MACHINE FOR APPLYING LIQUIDS

Filed April 1, 1963 2 Sheets-Sheet 2

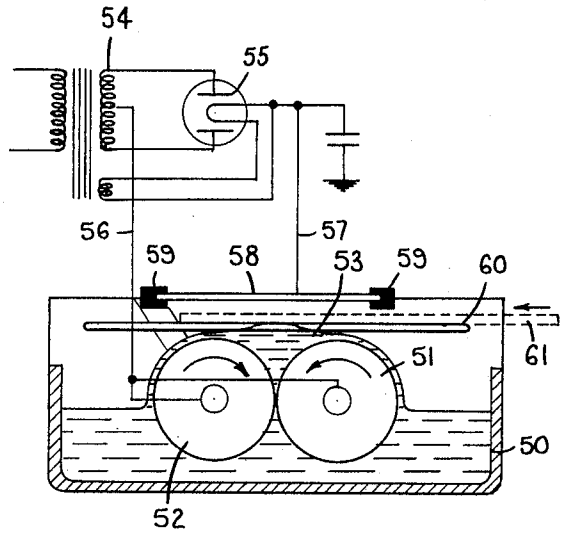


FIG 6

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3,256,855

MACHINE FOR APPLYING LIQUIDS

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Claims priority, application Australia, Apr. 2, 1962, 16,037
4 Claims. (Cl. 118—637)

This invention relates to an improved machine for applying liquids and in particular it relates to a machine which can be used for applying developers to papers or the like.

At the present time it is customary to apply developers to papers by using an applicator roller or the like to convey the liquid to the base or by submerging the base in the liquid or by using a single driven roller to apply liquid to the base.

A very effective method of applying developer liquids to a base such as a web of paper or the like is one which forms the subject of an earlier application of ours in which a single roller is used to lift liquid from a developer containing tank and to form a liquid wedge between the upper part of the roller and the base.

While such a device is extremely useful in applying xerographic developers to paper, in that the wedge consists of a constantly replenished film of developer, it is the object of this invention to provide certain improvements to this type of apparatus.

It has been known to use two rollers to supply a viscous liquid on to a tray over which a web of material passes, but the earlier device was unsuitable for liquids of low viscosity such as xerographic liquid developers.

An object of the present invention is to provide a larger film or body of developer than is possible by the methods known heretofore, with the required degree of turbulence for good development, and also to give a more rigid control of the face of the developer presented by the device.

According to our invention this is achieved by utilising a pair of rollers at least one of which dips into the developer held in a tank, which rollers are not completely submerged in the developer, and which are driven so that their upper or outer surfaces move toward each other and are spaced sufficiently closely together to form a trough between them, the rotation of the rollers carrying liquid on their peripheries into this trough from which the developer can flow back into the tank over the rollers or through a gap between the rollers or over one roller if that is required, a feature of the invention being the placing of the rollers between end plates which prevent unrestricted flow from the end of the trough and thus allow low viscosity liquids to be handled by the device.

By utilising a pair of rollers which turn towards each other it will be realised that what could be termed a standing wave of developer is formed which can have its upper or outer surface curved to project above the tops of the rollers, and the shape or curvature of which wave can be controlled by the speed of rotation of the rollers or by their positioning, the invention thus allowing a standing wave of developer to be formed in a trough between the rollers which wave projects out from the rollers and thus presents a highly effective pool of developer which is constantly replenished and which can be contacted by a web of paper or other base on which development is to be effected. The tops of the rollers should project substantially above the liquid level in the tank to raise the main part of the trough itself above the liquid level.

It is possible to use with the device means for producing an electrostatic field between the rollers and an electrode which causes the developer to be urged either into the direction of the paper or the like being coated or away from it.

It will be realised that the construction of the invention can be substantially varied, but to enable it to be fully understood embodiments thereof will now be described with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of a simple form of the invention,

FIG. 2 is a sectional through the tank showing the rollers in end elevation and indicating the liquid being carried over to form the standing wave,

FIG. 3 is a section on line 3—3 of FIG. 2, the roller being left unsectioned,

FIG. 4 is a sectional view somewhat as FIG. 2 but showing how the rollers may be spaced apart to further control the standing wave,

FIG. 5 is a view corresponding to FIG. 4 but showing how one large and small roller may be used, and

FIG. 6 is a view corresponding to FIG. 2 but showing how an electrostatic field may aid development.

Referring first to FIGS. 1, 2 and 3, a tank **1** is provided with a pair of side plates **2**, the tank carrying in it the rollers **3** and **4** forming the pair.

The shaft of the roller **3** projects through bearings in the end plate **2** of the tank and has on it a drive pulley **6** which is coupled by means of a belt **7** to the pulley **8** of an electric motor **9** mounted on the end of the tank **1**, the motor **9** serving to drive the roller **3** in the direction of the arrow on the roller.

The roller **4** is driven by contact with the roller **3** and to achieve this the shaft **10** is accommodated in a pair of inclined slots **11** in the end plates **2** of the tank **1**, the slots being closed by means of plates **12** which are provided with an outward deformation **13** to accommodate the ends of the shaft **10**.

Because of the inclination of the slots **11** the roller **4** will be urged against the roller **3** due to its weight and drive will therefore be transmitted to the roller **4** by contact with the roller **3**.

A pair of guide members **14** secured to the end plate **2** of the tank **1** serve to engage the edges of sheets which are passed over the rollers when it is desired to contact the surface of the sheets with the developer liquid, such a sheet being indicated by **15** in FIG. 2.

It will of course be obvious that the sheet can be hand fed through the developer zone or it could form part of a continuous web.

It will be realised when two rollers **3** and **4** are positioned in the manner outlined, a trough **16** will be formed between them, this trough being kept full of developer during operation by the fact that the rollers will carry developer on their outer surface and will deposit it in the trough, the liquid being held in this trough because the rollers are in contact with each other in this embodiment and the end plates **2** close the ends of the trough **16** to prevent the escape of liquid at this locality.

When the rollers are revolved at the correct rate of revolution say 250 to 350 revolutions for a roller diameter of three quarters of an inch, the trough will be filled with liquid, and the upper surface of the liquid, due to the constant supply of liquid to the trough, will curve upwardly as indicated by the line **17** in FIG. 2, this upward curve extending into the path of the paper or other member **15** which is moved over the guides **14** and thus ensuring that an electrostatic image on such a paper or other base will be in effective contact with the developer liquid and yet will not contact the rollers so that while adequate development takes place due to the turbulence of the liquid and the constantly renewed supply of the liquid de-

veloper there will be no smudging because the rollers do not contact the surface being developed.

It is interesting to note that with lower or higher revolutions per minute generally less liquid is pumped. As larger rollers must effect a greater lift, they also are usually not of any advantage.

The level of the developer within the tank **1** is normally kept at just below the centres of the rollers 3 and 4 as indicated by the line **18** on FIGURE 2, this ensuring that the standing wave **17** in the trough **16** is elevated well above the level **18** of the liquid and therefore there is a much better pumping action of liquid to and a flow from the trough than is the case if the rollers are simply submerged in the liquid itself.

In FIG. 4 a tank **30** has in it a pair of rollers **31** and **32** which are spaced apart to leave a gap **33** between them through which some of the liquid from the trough **34** can return, this arrangement being used where it is desirable to have a much greater rate of circulation of the liquid in the trough **34**.

Because the rollers **31** and **32** are spaced apart it will be realised that there will be a uniform bleed of liquid along the length of the trough **34**, this ensuring a level surface along the rollers at the top of the standing wave.

It will be realised that when the two rollers **31** and **32** do not touch, that both will have to be independently driven to rotate in the correct direction, but this can be readily achieved by simply mounting a pulley on the shaft **35** of the roller **31** and another pulley on the shaft **36** of the roller **32** and connecting these by means of a crossed belt, or by gears, so that they rotate in opposite direction.

The guide **37** for the paper or the like is again provided.

In this embodiment it will be realised that the standing wave in the trough **34** will drain away through the opening **33** at a rate determined by the gap between the rollers **31** and **32**, and this form of the invention is therefore used, as stated earlier, where it is desired to provide greater circulation of liquid into and from the trough **34**.

In the embodiment shown in FIG. 5 the tank **40** again carries within it a roller **41** and a roller **42**, but the roller **42** is of smaller diameter and does not of itself dip into the developer liquid in the tank, the roller **41** carrying the liquid into the trough **43** as in the previous embodiments, the roller **42** ensuring that there is the required build up of the standing wave of developer in the trough **43**.

The guide **44** again serves to ensure that the material which is being developed will not contact either of the rollers **41** or **42** but will maintain a constant distance therefrom so that there will be uniform subjecting of the image to the developer as the member which carries the image on it is moved through the standing wave zone of the machine.

In the embodiment shown in FIGURE 6 the tank **50** is provided with a pair of rollers **51** and **52**, this view corresponding to FIG. 2 in that it utilizes a pair of rollers of equal diameter again revolving so that their upper surfaces approach each other to form between them a trough **53** into which the developer is carried by the peripheries of the rollers **51** and **52** to form the standing wave.

In this figure however is demonstrated how the action of the developer can be further controlled by utilizing an electrostatic field generated by a high voltage transformer **54** and rectifier **55**, one lead **56** of the unit being coupled to the two rollers **51** and **52**, which must be of conductive material, so that they form an electrode within the developer liquid, the other lead **57** from the unit connecting to an electrode **58** supported from the tank **50** by means of insulator blocks **59**.

The guide for the paper or the like is designated **60** while the paper is designated **61**.

In use the object of this form of the invention is to apply a potential through the developer and the air space above same so that the particles of pigment in the developer, which comprises an insulating liquid in which the particles are suspended, can be moved towards or away from the top of the standing wave in the trough **53**, so that either the pigment particles in the developer can be concentrated at the interface of the standing wave with the paper or the like **61** being developed or according to the theory which utilizes opposite biasing can be given an opposite potential to the electrostatic image on the paper **61** to reduce deposition of developer particles on those areas of the electrostatic image where normally deposition might take place by adsorption. By having the opposite polarity on the electrode **58** these areas are rendered of opposite polarity to the image with the result that the developed image has a much cleaner background than otherwise.

From the foregoing description it will be apparent that by making the rollers a close fit together and limiting the outflow at the ends of the rollers from the trough formed between them, it is possible to operate with a relatively small movement of liquid, but if for the purpose of stirring or the maintenance of homogenity in the liquid a large flow is required it is only necessary to allow a more rapid get away of the liquid from the trough between the rollers such as by positioning the rollers slightly apart to allow liquid to be carried through the gap between them at the base of the trough as illustrated in FIG. 4.

The constant movement of the liquid when the rollers are revolving ensures that the liquid in the tank is being adequately stirred to prevent settlement of solid particles carried in the liquid of the xerographic developers, and similarly the standing wave of developer is constantly replenished and is kept in a substantial rate of movement so that at all times sufficient developer is available to ensure the best possible development taking place.

By regulating the speed of revolution of the rollers within limits, it is possible to vary the shape of the upper surface of the standing wave of liquid, and in this way it can be assured that the image which is to be developed, will be in contact only with the liquid, there being a gap between such image supporting means and the rollers themselves.

The advantage of this of course is that there is no smudging or similar effects which can take place when direct contact exists.

The device can form part of a larger machine, such as a machine handling continuous webs of material, or can be associated with single sheet coating or printing mechanisms.

The rollers can be formed of metal or of insulating material and may serve as electrodes as demonstrated in FIG. 6.

A substantial advantage of the device is that the standing wave of developer can be produced quickly by simply rotating the rollers, and therefore a paper web or the like passing through a machine can be taken through the machine completely clear of the coating liquid but the liquid can be brought into place to contact the base by merely switching on the driving means for the roller.

From the foregoing it will be realised that a simple and effective machine is provided which simply uses a multiplicity of rollers which rollers may be of varying sizes if that is required.

What I claim is:

1. Apparatus for wet development of xerographic images, comprising:

a tank to contain a liquid developer;

a first roller and a second roller positioned in said tank in close proximity to each other to form a trough between them and to have the lower surface of at least one dipping into the developer in said tank, but both rollers projecting substantially above the liquid level in said tank,

plates adjacent the ends of the rollers and projecting above the ends of the rollers to close the two ends of the trough formed between said rollers and thereby limit the escape of developer liquid over the ends of the rollers;

bearings engaged by shafts on said rollers to locate said rollers in said tank,

means to drive said rollers in opposite directions with the upper surfaces of said rollers approaching each other, and at a speed sufficient to build up a stable standing wave of constantly replaced developer throughout the length of said trough, said standing wave extending above the upper surfaces of said rollers;

a first electrode positioned in the air space above said trough;

a second electrode positioned in said trough;

means to supply a direct current potential between said electrodes; and

means to guide elements bearing xerographic images to be subjected to said developer beneath said first electrode and over the upper surfaces of said rollers but in spaced relation to said rollers whereby said images are developed by said standing wave of constantly replaced developer formed between said rollers as said elements traverse said wave.

2. Xerographic development apparatus according to claim 1 in which the circumferential surfaces of said roller engage each other at the bottom of said trough.

3. Xerographic development apparatus according to claim 1 in which one roller is of substantially greater diameter than the other and the smaller roller is disposed above the liquid level in the tank.

4. Xerographic development apparatus according to claim 1 in which at least one of said rollers constitutes said second electrode.

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