

PATENT SPECIFICATION

(11) 1268 144

DRAWINGS ATTACHED

- (21) Application No. 37978/70 (22) Filed 6 Aug. 1970
 (31) Convention Application No. 852599 (32) Filed 25 Aug. 1969 in
 (33) United States of America (US)
 (45) Complete Specification published 22 March 1972
 (51) International Classification B 05 c 5/00
 (52) Index at acceptance D1L 23X
 (72) Inventor CHI-YUAN LING



(54) IMPROVEMENTS IN OR RELATING TO A
 MULTIPLE COATING APPARATUS

(71) We, GAF CORPORATION, a Corporation organized and existing under the laws of the State of Delaware, United States of America, having its main office at 140 West 51st Street, City, County and State of New York, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a multiple coating apparatus, and more particularly to multiple-slide cascade hoppers.

A prior conventional multi-slide hopper, as disclosed in U.S. Patent Specifications Nos. 2,761,417 and 2,761,419, performs its coating operation by metering individual layers of coating fluid from a supply through a trough inside the hopper and then a narrow distributing slot which, as claimed in these U.S. Specifications, distributes the fluid uniformly across the top of a downwardly inclined slide. Such layer of fluid flows down the side surface by gravity and meets with the adjacent underlayers which are similarly metered and distributed through narrow slots. The combined multilayer then flows down the slide surface and forms a coating head across which the web to be coated is moved to pick up the multilayer of the fluid therefrom.

In actual practice, the slide hopper of the prior art is inconvenient to use in that (1) a considerable amount of time and coating liquid are initially wasted in order to flush out bubbles and foam trapped within and between the trough and the narrow distributing slot; and (2) even after it is visually judged to be free of foam and bubble streaks on the slide surface, streaks may appear suddenly and unnoticeably during production coating, because of the shift in the position of foam or bubbles initially present from a non-interfering position to the intersection between the trough and the narrow slot, because of foam introduced from the supply fluid and trapped in the narrow slot. These streaks persist until the trapped

foam is removed. The adverse effect of these defects on production costs may be significant. It is an advantage of the present invention that it provides a new multi-slide hopper in which these defects are minimized, and which gives coatings of superior quality.

We have now discovered that it is not necessary to employ the narrow distributing slot to achieve uniform coating weight. The elimination of these narrow slots in the hopper of the invention produces not only improved efficiency, but also better coating quality over conventional multi-slide hoppers.

The present invention is useful in coating a support in the manufacture of photographic film and/or paper by simultaneously applying a light sensitive emulsion layer or layers, sub-coating, protective layers and light filtering layers to the support at the same time, and maintaining a distinct layer relationship as well as desired thickness regulation of each layer, with improved efficiency and coating quality.

According to one aspect of this invention we provide a process of applying a streak-free multi-layered coating to a continuously moving web, which comprises: welling selected fluids upwardly through a plurality of substantially deep wells of rectangular cross section from top to bottom until such fluid spills over the lower edges of upper openings thereof in an inclined fluid flow surface having a slope that is less than 30° relative to the horizontal, the said upper openings being parallel to one another and extending at right angles to the direction of such inclined flow, cascading such fluids on such surface to form a multi-layer coating at the lower edge of the surface, and moving such web upwardly adjacent such lower edge so that it picks up the coating in a streak-free condition.

According to another aspect of this invention we provide a multi-slide cascade hopper for multiple coating apparatus comprising: an inclined fluid flow surface having a slope that is less than 30° relative to the horizontal, a plurality of horizontally spaced substan-

6h

tially deep fluid wells of rectangular cross-section from top to bottom thereof, the wells having upper openings in the inclined fluid flow surface which are parallel to one another and extend at right angles to the direction of such inclined fluid flow and in which the width of the upper openings is at least 1/8 inch, and the length of the openings is substantially equal to the width of such inclined surface, and means for supplying selected coating fluids to fluid inlets located adjacent the bottoms of such wells in sufficient quantity for such fluids to spill over the lower edges of such openings, and form a multi-layered coating fluid at the lower edge of such inclined surface. The openings may have a substantially equal cross-section and be substantially equally spaced from one another.

The invention will now be illustrated with reference to the accompanying drawings in which:

Fig. 1 is a schematic illustration, partly in side elevation and partly in cross-section, of a multi-slide cascade coating apparatus illustrative of the present invention, and

Fig. 2 is a horizontal cross-sectional view taken on line 2—2 of Fig. 1.

Referring to the drawing, which shows as an example a 3-layer slide hopper *H*, upper layer coating fluid *A* is metered by pump 1 and flows upwardly through open well 2. The geometrical construction of the well 2 is such that a fairly flat velocity profile is attainable as the fluid *A* reaches the upper part of the well. However, exact flatness is not necessary since uniform distribution, in the present invention, is achieved by the smoothing effect of the fluid as it flows down the inclined surface 3 by gravity. As fluid *A* passes the lower edge of the inclined surface 3, it meets with the middle layer coating fluid *B* (metered by pump 4 and flowing upwardly through well 5) flowing upwardly over the top edge of downward inclined surface 6, and is smoothed out to a uniform thickness as it flows down by gravity. The same sequence repeats for the bottom layer (*S* metered by pump 7 and flowing upwardly through well 8), and the final combined multilayer forms a coating bead 10 at the edge of surface 9 and is picked up by web 11 around roller 12.

While the above example relates to a 3 layer hopper of the invention, the present invention is applicable to other multilayer coatings.

For example, a plastics hopper embodying the invention was used to make two-layer coatings for a colour photographic film. A two-layer coating of blue emulsion layer and separation gelatin layer, a two-layer coating of Magenta emulsion layer and yellow filter layer, and a two-layer coating of yellow emulsion layer and a surface-protective gelatin layer were made. All three coatings showed

excellent physical quality. Initial bubbles and foam were flushed out instantly as the coating fluids reached the inclined surface. As a result, the coating operation started instantly without loss of time and coating fluid. Furthermore, fine foam introduced from supply during coating resulted in merely foam specks on the final coating, instead of persistent foam streak on coatings made with hoppers of the prior art.

The uniform distribution of the coating fluid is achieved by the smoothing effect of the fluid as it flows down the downward inclined surface by gravity. In order to maintain such uniformity as it flows on the adjacent under-layer (such as layer *A* on fluid *B* in well 5), the length *L* should be so chosen that the upper layer retains its uniformity while the bottom layer is smoothed out by the on-coming slide surface as the combined layer flows down by gravity.

It has been found that for fluids with viscosity in the order of 10 cps or larger, the dimension *L* suitable for multilayer coatings of photographic emulsion and gelatin layer is generally at least 1/8" and preferably ranges from 1/8" to 1/2". This is quite different from that of the narrow slot design of the conventional hopper.

Another advantage of the present hopper is the marked reduction of undesirable "pencil lines" (present in the process of U.S. Patent Specification 3,005,440) observed on the coatings made by the apparatus and process of the invention. These "pencil lines" are caused by interference of particulate solids of the bottom layer and, according to U.S. Patent Specification 3,005,440 are formed at the instant when the layers meet. It is clear that the chances of particulate solids reaching the interface at the instant the two layers meet are markedly reduced in the apparatus and process of the invention.

The wells 2, 5 and 8 are rectangular in cross section, as shown in Fig. 2; and they are parallel to one another and to the axis 20 of the drum or roller 12 carrying the web 11 as the latter is coated. The wells are substantially deep in the vertical direction *D*, so that the fluid in each is substantially free of turbulence as it reaches the corresponding upper opening in the inclined fluid flow surface 22. Such opening is relatively wide at dimension "*L*", and the latter dimension is substantially the same throughout the relatively deep dimension of each well. Also, the degree of inclination of surface 22 with respect to the horizontal is relatively low compared to that of the prior art; being, for example, about 15°, compared to 30°. Thus, while inclined, the sloping surface 22 is relatively flat, and must be inclined at less than 30°.

WHAT WE CLAIM IS:—

1. A process of applying a streak-free multi-

67



5 tially deep fluid wells of rectangular cross-
section from top to bottom thereof, the wells
having upper openings in the inclined fluid
flow surface which are parallel to one an-
other and extend at right angles to the direc-
10 tion of such inclined fluid flow and in which
the width of the upper openings is at least
1/8 inch, and the length of the openings is
substantially equal to the width of such in-
clined surface, and means for supplying se-
lected coating fluids to fluid inlets located
15 adjacent the bottoms of such wells in suffi-
cient quantity for such fluids to spill over the
lower edges of such openings, and form a
multi-layered coating fluid at the lower edge
of such inclined surface. The openings may
have a substantially equal cross-section and
be substantially equally spaced from one an-
other.

20 The invention will now be illustrated with
reference to the accompanying drawings in
which:

25 Fig. 1 is a schematic illustration, partly in
side elevation and partly in cross-section, of
a multi-slide cascade coating apparatus illus-
trative of the present invention, and

Fig. 2 is a horizontal cross-sectional view
taken on line 2—2 of Fig. 1.

30 Referring to the drawing, which shows as
an example a 3-layer slide hopper H, upper
layer coating fluid A is metered by pump 1
and flows upwardly through open well 2. The
geometrical construction of the well 2 is
such that a fairly flat velocity profile is attain-
35 able as the fluid A reaches the upper part of
the well. However, exact flatness is not neces-
sary since uniform distribution, in the present
invention, is achieved by the smoothing effect
of the fluid as it flows down the inclined
40 surface 3 by gravity. As fluid A passes the
lower edge of the inclined surface 3, it meets
with the middle layer coating fluid B (metered
by pump 4 and flowing upwardly through
well 5) flowing upwardly over the top edge
45 of downward inclined surface 6, and is smooth
out to a uniform thickness as it flows down
by gravity. The same sequence repeats for the
bottom layer (S metered by pump 7 and
flowing upwardly through well 8), and the
50 final combined multilayer forms a coating
bead 10 at the edge of surface 9 and is
picked up by web 11 around roller 12.

55 While the above example relates to a 3
layer hopper of the invention, the present
invention is applicable to other multilayer
coatings.

60 For example, a plastics hopper embodying
the invention was used to make two-layer coat-
ings for a colour photographic film. A two-
layer coating of blue emulsion layer and
separation gelatin layer, a two-layer coating
of Magenta emulsion layer and yellow filter
layer, and a two-layer coating of yellow emul-
65 sion layer and a surface-protective gelatin
layer were made. All three coatings showed

excellent physical quality. Initial bubbles and
foam were flushed out instantly as the coat-
ing fluids reached the inclined surface. As a
result, the coating operation started instantly
without loss of time and coating fluid. Further-
70 more, fine foam introduced from supply during
coating resulted in merely foam specks on
the final coating, instead of persistent foam
streak on coatings made with hoppers of the
prior art.

75 The uniform distribution of the coating
fluid is achieved by the smoothing effect of
the fluid as it flows down the downward in-
clined surface by gravity. In order to main-
tain such uniformity as it flows on the adjacent
80 under-layer (such as layer A on fluid B in
well 5), the length L should be so chosen
that the upper layer retains its uniformity
while the bottom layer is smoothed out by
the on-coming slide surface as the combined
85 layer flows down by gravity.

It has been found that for fluids with vis-
cosity in the order of 10 cps or larger, the
dimension L suitable for multilayer coatings
of photographic emulsion and gelatin layer
90 is generally at least 1/8" and preferably
ranges from 1/8" to 1/2". This is quite dif-
ferent from that of the narrow slot design of
the conventional hopper.

95 Another advantage of the present hopper
is the marked reduction of undesirable "pencil
lines" (present in the process of U.S. Patent
Specification 3,005,440) observed on the coat-
ings made by the apparatus and process of the
invention. These "pencil lines" are caused
100 by interference of particulate solids of the
bottom layer and, according to U.S. Patent
Specification 3,005,440 are formed at the in-
stant when the layers meet. It is clear that
the chances of particulate solids reaching the
105 interface at the instant the two layers meet
are markedly reduced in the apparatus and
process of the invention.

110 The wells 2, 5 and 8 are rectangular in
cross section, as shown in Fig. 2; and they
are parallel to one another and to the axis
20 of the drum or roller 12 carrying the web
11 as the latter is coated. The wells are sub-
stantially deep in the vertical direction D, so
that the fluid in each is substantially free of
turbulence as it reaches the corresponding
upper opening in the inclined fluid flow sur-
115 face 22. Such opening is relatively wide at
dimension "L", and the latter dimension is
substantially the same throughout the rela-
tively deep dimension of each well. Also, the
degree of inclination of surface 22 with re-
spect to the horizontal is relatively low com-
pared to that of the prior art; being, for ex-
120 ample, about 15°, compared to 30°. Thus,
while inclined, the sloping surface 22 is rela-
tively flat, and must be inclined at less than
30°.

WHAT WE CLAIM IS:—

1. A process of applying a streak-free multi- 130



layered coating to a continuously moving web, which comprises: welling selected fluids upwardly through a plurality of substantially deep wells of rectangular cross section from top to bottom until such fluid spills over the lower edges of upper openings thereof in an inclined fluid flow surface having a slope that is less than 30° relative to the horizontal, the said upper openings being parallel to one another and extending at right angles to the direction of such inclined flow, cascading such fluids on such surface to form a multi-layer coating at the lower edge of the surface, and moving such web upwardly adjacent such lower edge so that it picks up the coating in a streak-free condition.

2. A process according to Claim 1 substantially as herein described with reference to the accompanying drawings.

3. A coated web when obtained by the process claimed in Claim 1 or Claim 2.

4. A multi-slide cascade hopper for multiple coating apparatus comprising; an inclined fluid flow surface having a slope that is less than 30° relative to the horizontal, a plurality of horizontally spaced substantially deep fluid wells of rectangular cross-section from top to bottom thereof, the wells having upper openings in the inclined fluid flow surface which are parallel to one another and extend at right angles to the direction of such inclined fluid flow and in which the width of the upper openings is at least 1/8

inch, and the length of the openings is substantially equal to the width of such inclined surface, and means for supplying selected coating fluids to fluid inlets located adjacent the bottoms of such wells in sufficient quantity for such fluids to spill over the lower edges of such openings, and form a multi-layered coating fluid at the lower edge of such inclined surface.

5. The hopper claimed in Claim 4, in which the width of the upper openings is 1/8 inch to 1/2 inch.

6. The hopper claimed in Claim 4 or Claim 5, in which the openings have a substantially equal cross-section, and are substantially equally spaced from one another.

7. The hopper claimed in any one of Claims 4 to 6, in which means are provided for moving a web upwardly adjacent the lower edge of the inclined surface for progressively picking up the multi-layered coating as the latter flows over such edge, thereby applying a streak-free multiple coating to the web.

8. A multi-slide cascade hopper for multiple coating apparatus substantially as herein described with reference to the accompanying drawings.

MEWBURN ELLIS & CO.,
Chartered Patent Agents,
70—72 Chancery Lane,
London WC2A 1AD,
Agents for the Applicants.