

PATENT SPECIFICATION

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321,222

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PROVISIONAL SPECIFICATION.



Improvements in or relating to Apparatus for Applying Coatings to Surfaces, particularly to the Surfaces of Flexible Strip Material.

(A communication from CHARLES BONAMICO, a French Citizen, of 10 bis, rue Champ Lagarde, Versailles (Seine et Oise), France.)

5 I, HAROLD WADE, a British Subject, of 111 & 112, Hatton Garden, London, E.C. 1, do hereby declare the nature of this invention to be as follows:—

10 This invention relates to devices and machines for applying liquid coatings to sheet material, particularly to long strips of flexible sheet material such as celluloid film, cellulose acetate film and the like. The invention provides devices and
15 machines which enable extremely thin coatings to be applied successfully and which enable liquid coatings containing very volatile constituents and coatings which in liquid form are physically
20 unstable, to be successfully used.

According to one feature of this invention, a device for applying liquid coatings to surfaces, particularly to the surfaces of
25 long strips of flexible sheet material, comprises in combination a trough the mouth of which is a narrow slot-like orifice, means for supporting the surface to be coated in close proximity to said orifice but not in contact with the lips thereof, means
30 for removing said surface continuously across the orifice and means for supplying coating-liquid to the trough in such manner that a meniscus is formed between each lip and the surface to be coated.

35 Preferably the lip on the "leading" side of the orifice is nearer to the surface to be coated than is the lip on the "trailing" side.

40 It is found in practice that if the gap between the "trailing" lip and the surface to be coated is the same width throughout the length of the orifice, the meniscus extends further from the orifice at the centre than near the ends of the
45 orifice, with the result that the coating tends to be thinner towards the margins of the surface than at the centre. According to a further feature of the invention the "trailing" lip of the orifice is so
50 shaped that the gap between it and the surface to be coated is wider at the middle

than towards the ends of the orifice. Thus the greater capillarity of the narrower parts of the gap will cause the meniscus at these parts to extend further from the
55 orifice, thereby tending to equalize the thickness of the resulting coating across the width of the coated surface. The "leading" lip may be similarly shaped if so desired. 60

The trough may be provided with a jacket through which a cooling or heating medium can be circulated.

65 Preferably the cross-section of the trough is the same, or approximately the same, as that of its orifice throughout its depth, that is to say the walls of which the free edges form the aforesaid orifice are flat and parallel to one another.

70 The orifice is preferably disposed in a horizontal plane with the depth of the trough vertical and the means for supplying coating-liquid thereto comprises a supply-conduit which, together with the
75 trough itself, constitutes a U-tube, and controllable means for supplying coating-liquid to the supply-conduit, whereby the level of the free surface of the liquid therein may be maintained at or about the
80 level of the orifice.

According to a further feature of the invention, a coating-machine for continuously applying liquid coatings to flexible sheet material is characterised by the fact that the sheet material, after coating, is
85 guided during the setting or drying of the coating along a path which is curved, is convex on the coated side (which side is preferably uppermost) and the chord of which is horizontal or approximately so. 90
A heating or cooling radiator may be disposed along the curved path aforesaid, or along a substantial part of it, facing the coated side of the sheet material and in
95 proximity thereto.

A coating-machine embodying the above and other features of the invention will now be described by way of example.

100 Sheet material in the form of a long strip is carried on a spool from which it is led over tensioning rollers to an ebonite supporting-roller about 6 cm. in diameter

[Price 1/-]

Price 4s 6d

around which it passes in a downward loop—that is to say the strip is in contact with the lower side of the roller.

5 Beneath the supporting-roller is supported a coating-trough which consists of two flat plates placed vertically with their opposed faces about 2 mm. apart, with suitable bottom and side walls. The upper edges of these plates constitute the lips of the narrow slot-like orifice of the trough, which is directly beneath the lower side of the supporting-roller and in the vertical plane containing the roller axis.

15 The "leading" lip, that is to say the lip which is first met by the moving strip supported on the roller, is higher than the other or "trailing" lip by about 0.5 mm.

20 The "trailing" lip is curved along its length (that is, from side to side of the strip) in such a way as to be concave upwardly, the depth of the curve being dependent on the width of the strip to be coated, being about 2 mm. in the case of a strip 26 cm. wide.

25 The distance between the strip supported on the roller and the "leading" lip is 0.25 mm.

30 Coating-liquid is supplied to the trough through a supply-tube which enters the trough near the bottom and extends above the level of the orifice, thus forming, with the trough, a U-tube. The upper end of the supply tube is preferably of glass, so that the level of the free surface of the liquid therein can be observed. Coating-liquid flows into the open end of the supply-tube through a pipe provided with a valve by means of which the supply can be regulated, and the operator manipulates this valve in such a way as to maintain the level in the supply-tube at about the level of the orifice of the trough.

45 In the case of coating-liquids containing very volatile materials, the pipe aforesaid is placed within the mouth of the supply-tube and is of such a diameter that there is only a small space between the walls of the two tubes, thereby minimising evaporation.

50 It will be appreciated that the liquid coating-material, flowing out through the orifice between the lips and the strip, will form a meniscus between either lip and the strip, and that, if the film is stationary, the meniscus on the "leading" side, owing to the narrower gap at this side, will be further from the orifice than on the "trailing" side. When the film is moving, however, this difference between the two sides tends to decrease.

65 When the coating-liquid is an ether-alcohol collodion solution of about 3% strength, the speed of the strip is about 1 metre per minute; when the coating-

liquid is a photographic gelatine emulsion the speed is about 3.25 metres per minute.

70 It will be appreciated that the surface of the liquid exposed to the atmosphere is very small, and consequently loss by evaporation (and therefore change in concentration) is slight. Moreover, as there is only a very small body of liquid in the trough, the flow is rapid during the coating operation, and consequently liquids which are physically unstable in that one or more constituents tend to settle or separate out can be used successfully.

80 Preferably one or both plates constituting the main walls of the trough are provided with an external water-jacket through which water at the desired constant temperature is circulated when the coating liquid is collodion solution, the temperature of the water is below that of the room, and is adjusted to such a point as to prevent the formation of bubbles in the solution. When the liquid is a photographic emulsion, the water is at the appropriate elevated temperature. The two plates may be made readily separable to enable them to be easily cleaned.

95 After leaving the supporting-roller, the coated strip passes, coated face uppermost, over a guide-roller or a series of guide-rollers, and then on to an endless fabric or like porous band which is guided over rollers in such manner that it possesses an arched shape, convex upwardly, the chord of the arch being horizontal or slightly inclined upwardly. The length of the arch is about 2 metres and its radius of curvature is about 2 metres. At its rear end there is provided beneath the band a suction-box through which air is drawn by means of a fan downwardly through the band, thereby causing the strip to adhere to the band and be carried along thereby. Finally the strip is led to a storage reel upon which it is wound.

110 Surmounting the fabric band is a radiator consisting of coiled or zig-zag water-tubes provided with radiating gills. This radiator is shaped to the same contour as the band, and its lower surface is in close proximity thereto. When the coating-liquid is collodion solution, warm water is circulated through the radiator; when a photographic emulsion is being used, cooled brine is used, and the radiator is covered by a blanket of asbestos or like heat-insulating material.

125 In an alternative construction particularly applicable to the coating of strips with collodion, the fabric band is replaced by a series of polished wooden guide-rollers disposed so that the strip follows the curved path aforesaid, and they are enclosed in a sheet-metal casing through which warmed filtered air is drawn. The

5 casing extends to a point immediately above the coating-trough, a narrow slit being provided for the entry of the coated strip. Immediately behind that part of the strip which extends between the slit and the first of the rollers aforesaid is placed a baffle-plate, and the air enters behind the baffle plate, passes around its edges, along the strip supported in the arch shape aforesaid, and passes out of the casing above the last rollers. After leaving the casing (through a narrow slit) the strip passes in succession around two large

internally heated polished metal drums, one of which is in contact with one face of the strip and the other with the other. After leaving the second drum the strip passes for some distance across a free space where it cools to room temperature and is finally wound upon a storage drum. 15
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Dated this 3rd day of August, 1928.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London,
E.C. 1,
Chartered Patent Agents.

COMPLETE SPECIFICATION.

Improvements in or relating to Apparatus for Applying Coatings to Surfaces, particularly to the Surfaces of Flexible Strip Material.

(A communication from CHARLES BONAMICO, a French Citizen, of 10 bis, rue Champ Lagarde, Versailles (Seine et Oise), France.)

25 I, HAROLD WADE, a British Subject, of 111 & 112, Hatton Garden, London, E.C. 1, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

30 This invention relates to devices and machines for applying liquid coatings to sheet material, particularly to long strips of flexible sheet material such as celluloid film, cellulose acetate film and the like. The invention provides devices which enable extremely thin coatings to be applied successfully and which enable liquid coatings containing very volatile constituents and coatings which in liquid form are physically unstable, to be successfully used.

45 According to this invention, a device for applying liquid coatings to surfaces, particularly to the surfaces of long strips of flexible sheet material, comprises in combination a trough the mouth of which is a narrow slot-like orifice, means for supporting the surface to be coated in close proximity to said orifice but not in contact with the lips thereof, means for moving said surface continuously across the orifice and means for supplying coating-liquid to the trough in such manner that an unbroken film of liquid is maintained between the lips of said orifice and the surface to be coated.

55 Preferably the lip on the "leading" side of the orifice is nearer to the surface to be coated than is the lip on the "trailing" side.

It is found in practice that if the gap between the "trailing" lip and the surface to be coated is the same width throughout the length of the orifice, the meniscus extends further from the orifice at the centre than near the ends of the orifice, with the result that the coating tends to be thinner towards the margins of the surface than at the centre. According to a further feature of the invention the "trailing" lip of the orifice is so shaped that the gap between it and the surface to be coated is wider at the middle than towards the ends of the orifice. Thus the greater capillarity of the narrower parts of the gap will cause the meniscus at these parts to extend further from the orifice, thereby tending to equalise the thickness of the resulting coating across the width of the coated surface. The "leading" lip may be similarly shaped if so desired.

65 The trough may be provided with a jacket through which a cooling or heating medium can be circulated. 70
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Preferably the cross-section of the trough is the same, or approximately the same, as that of its orifice throughout its depth, that is to say the walls of which the free edges form the aforesaid orifice are flat and parallel to one another. 80
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The orifice is preferably disposed in a horizontal plane with the depth of the trough vertical and the means for supplying coating-liquid thereto comprises a supply-conduit which, together with the trough itself, constitutes a U-tube, and controllable means for supplying coating-liquid to the supply-conduit, whereby the level of the free surface of the liquid therein may be maintained at or about the level of the orifice. 90
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After applying the coating to the

flexible sheet material the coated strip is dried by suitable means.

In the accompanying drawings which illustrate by way of example forms of coating machine embodying the above and other features of the invention:

Figure 1 is a vertical transverse section on the line 1-1 of Figure 2 of the trough with supply conduit:

Figure 2 is a front elevation on half the scale of Figure 1 of part of the trough without the supply conduit:

Figure 3 is a diagram in side elevation of one form of coating device showing means which may be employed for drying the coated sheet material; and

Figure 4 is a diagram in side elevation of one form of coating device and drying apparatus suitable for use with a volatile coating liquid.

Referring particularly to Figures 3 and 4, sheet material in the form of a long strip 12 is carried on a spool 13 from which it is led over tensioning rollers 14 to an ebonite supporting-roller 15 about 6 cm. in diameter around which it passes in a downward loop—that is to say the strip 12 is in contact with the lower side of the roller 15.

Referring to Figures 1 and 2, beneath the supporting roller 15 is supported a coating-trough 16 which consists of two flat plates 17, 18 placed vertically with their opposed faces about 2 mm. apart, with suitable bottom 19 and side walls 20. The upper edges of these plates 17, 18 constitute the lips of the narrow slot-like orifice of the trough 20, which is directly beneath the lower side of the supporting-roller 15 and in the vertical plane containing the roller axis:

The "leading" lip 171, that is to say the lip which is first met by the moving strip 12 supported on the roller 15, is higher than the other or "trailing" lip 181 by about 0.5 mm.

The "trailing" lip 181 is curved along its length (that is, from side to side of the strip) in such a way as to be concave upwardly, the depth of the curve being dependent on the width of the strip to be coated, being about 2 mm. in the case of a strip 26 cm. wide.

The distance between the strip 12 supported on the roller and the "leading" lip 171 is 0.25 mm.

Coating-liquid is supplied to the trough 20 through a supply-tube 21 which enters the trough near the bottom and extends above the level of the orifice, thus forming, with the trough, a U-tube. The upper end 22 of the supply tube is preferably of glass, so that the level of the free surface of the liquid therein can be observed. Coating-liquid flows into the

open end of the supply-tube through a pipe 23 provided with a valve 24 by means of which the supply can be regulated, and the operator manipulates this valve in such a way as to maintain the level in the supply-tube at about the level of the orifice of the trough.

In the case of coating-liquids containing very volatile materials, the pipe 23 aforesaid is placed within the mouth of the supply-tube 22 and is of such a diameter that there is only a small space between the walls of the two tubes, thereby minimising evaporation.

It will be appreciated that the liquid coating-material, flowing out through the orifice between the lips and the strip, will form a meniscus between either lip and the strip, and that, if the film is stationary, the meniscus on the "leading" side, owing to the narrower gap at this side, will be further from the orifice than on the "trailing" side. When the film is moving, however, this difference between the two sides tends to decrease.

When the coating-liquid is an ether-alcohol collodion solution of about 3% strength, the speed of the strip is about 1 metre per minute; when the coating liquid is a photographic gelatine emulsion the speed is about 3.25 metres per minute.

It will be appreciated that the surface of the liquid exposed to the atmosphere is very small, and consequently loss by evaporation (and therefore change in concentration) is slight. Moreover, as there is only a very small body of liquid in the trough 20, the flow is rapid during the coating operation, and consequently liquids which are physically unstable in that one or more constituents tend to settle or separate out can be used successfully.

Preferably one or both plates 17, 18 constituting the main walls of the trough are provided with an external water-jacket 172, 182, through which water at the desired constant temperature is circulated. When the coating liquid is collodion solution, the temperature of the water is below that of the room, and is adjusted to such a point as to prevent the formation of bubbles in the solution. When the liquid is a photographic emulsion, the water is at the appropriate elevated temperature. The two plates 17, 18 may be made readily separable to enable them to be easily cleaned.

Referring to Figure 3, after leaving the supporting-roller 15, the coated strip 12 passes, coated face uppermost, over a guide-roller 25 or a series of guide-rollers and then on to an endless fabric or like porous band 26 which is guided over 130

rollers 27 (the first and last only of which are shown in Figure 3) in such manner that it possesses an arched shape, convex upwardly, the chord of the arch being horizontal or slightly inclined upwardly. The length of the arch is about 2 metres and its radius of curvature is about 2 metres. At its rear end there is provided beneath the band a suction-box 28 through which air is drawn by means of a fan downwardly through the band 26, thereby causing the strip 12 to adhere to the band and be carried along thereby. Finally the strip is led to a storage reel 29 upon which it is wound.

Surmounting the fabric band is a radiator 30 consisting of coiled or zig-zag water-tubes provided with radiating gills. This radiator 30 is shaped to the same contour as the band, and its lower surface is in close proximity thereto. When the coating-liquid is collodion solution, warm water is circulated through the radiator, when a photographic emulsion is being used, cooled brine is used, and the radiator is covered by a blanket of asbestos or like heat-insulating material.

Referring to Figure 4, in an alternative construction particularly applicable to the coating of strips with collodion, the fabric band 26 is replaced by a series of polished wooden guide-rollers 31 disposed so that the strip 12 follows the curved path aforesaid, and they are enclosed in a sheet-metal casing 32 through which air is drawn through a filter 33 and a heating radiator 34. The casing 32 extends to a point immediately above the coating-trough 16, a narrow slit 35 being provided for the entry of the coated strip. Immediately behind that part of the strip which extends between the slit and the first of the rollers 31 aforesaid is placed a baffle-plate 36, and the air enters behind the baffle-plate 36, passes around its edges, along the strip supported in the arch shape aforesaid, and passes out of the casing 32 above the last rollers 31. After leaving the casing (through a narrow slit 37) the strip 12 passes in succession around two large internally-heated polished metal drums 38, 39, one of which is in contact with one face of the strip and the other with the other. After leaving the second drum the strip passes for some distance across a free space over rollers 40, 41 where it cools to room temperature and it is finally wound upon a storage drum 42.

Having now particularly described and ascertained the nature of the said inven-

tion and in what manner the same is to be performed, as communicated to me by my foreign correspondent, I declare that what I claim is:—

1. A device for applying liquid coatings to surfaces, particularly to the surfaces of long strips of flexible sheet material, comprising in combination a trough the mouth of which is a narrow slot-like orifice, means for supporting the surface to be coated in close proximity to said orifice but not in contact with the lips thereof, means for removing said surface continuously across the orifice and means for supplying coating-liquid to the trough in such manner that an unbroken film of liquid is maintained between each lip and the surface to be coated.

2. A device according to Claim 1 wherein the lip on the "leading" side of the orifice is nearer to the surface to be coated than is the lip on the "trailing" side.

3. A device according to Claim 1 or Claim 2 wherein the "trailing" lip (and, it may be, also the "leading" lip) of the orifice is so shaped that the gap between it and the surface to be coated is wider at the middle than at the ends of the orifice.

4. A device according to any one of the preceding claims wherein the trough is jacketed for the purpose of enabling it to be cooled or warmed.

5. A device according to any one of the preceding claims wherein the cross-section of the trough is the same, or approximately the same, as that of its orifice throughout its depth.

6. A device according to any one of the preceding claims wherein the orifice is disposed in a horizontal plane with the depth of the trough vertical and the means for supplying coating-liquid thereto comprises a supply-conduit which, together with the trough itself, constitutes a U-tube, and controllable means for supplying coating-liquid to the supply-conduit, whereby the level of the free surface of the liquid therein may be maintained at or about the level of the orifice.

7. A coating-trough and supporting-roller constructed and arranged substantially as described with reference to Figures 1 and 2 of the accompanying drawings.

Dated this 26th day of October, 1928.

BOULT, WADE & TENNANT,
111/112, Hatton Garden, London, E.C. 1,
Chartered Patent Agents.

2nd Edition

[This Drawing is a reproduction of the Original on a reduced scale.]

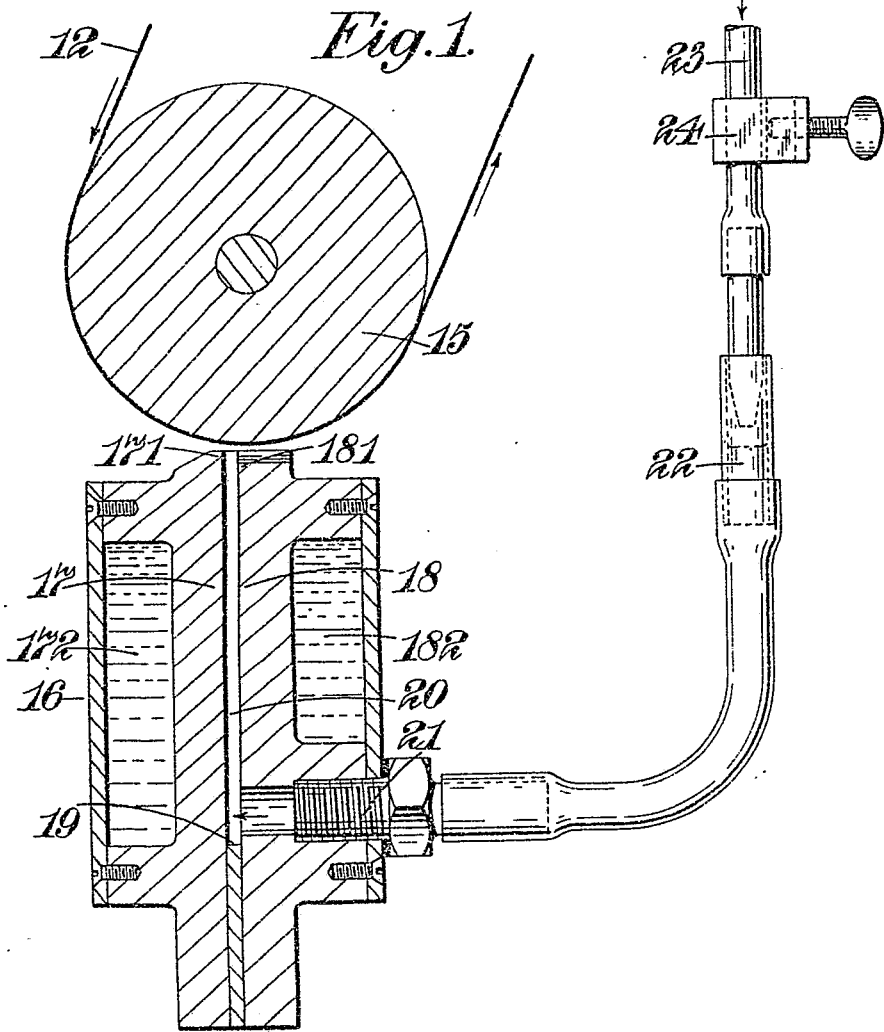
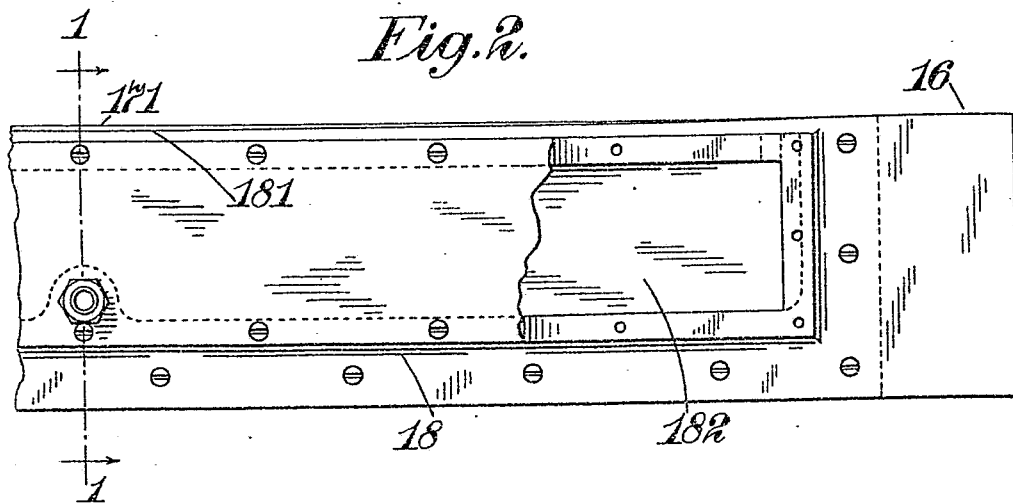


Fig. 2.



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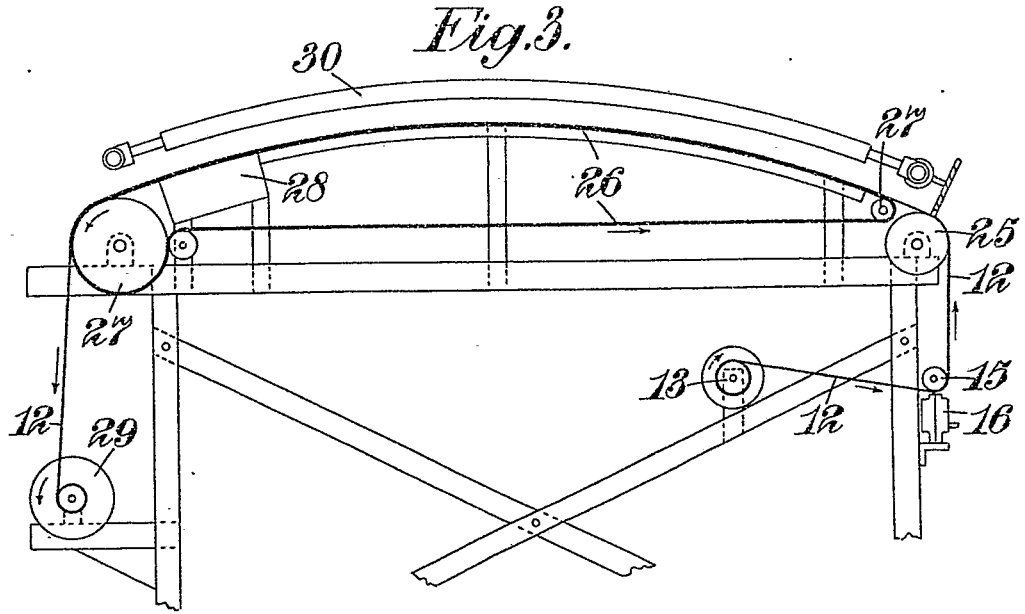
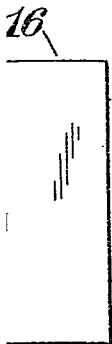
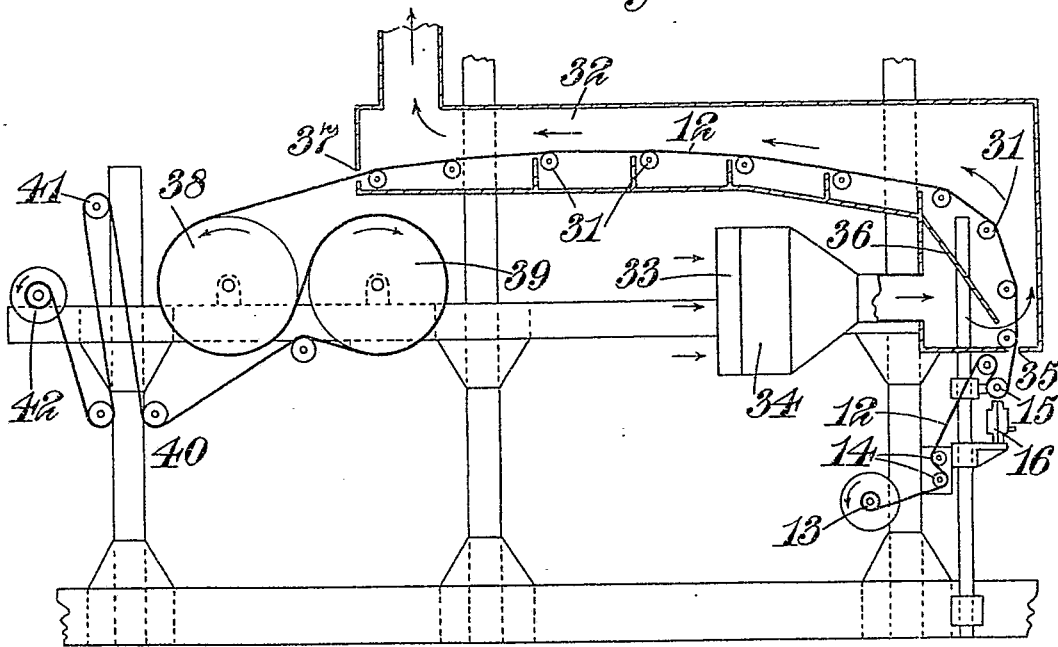


Fig. 4.



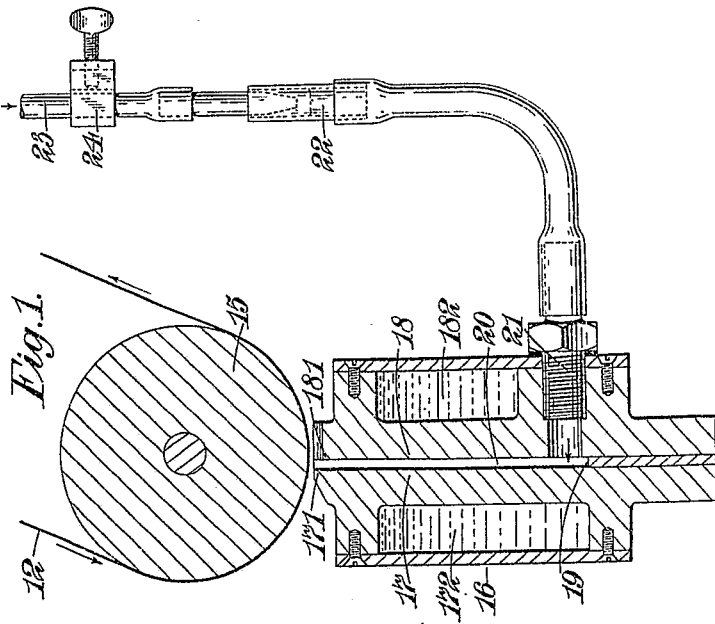


Fig. 1.

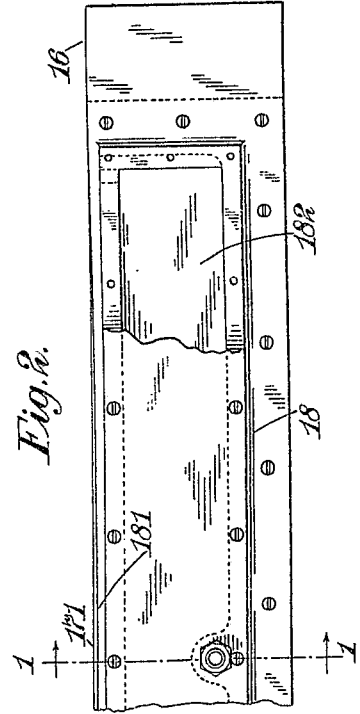


Fig. 2.

Fig. 3.

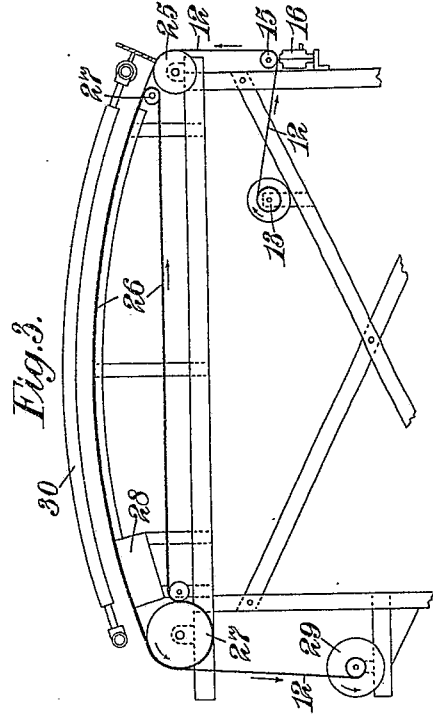
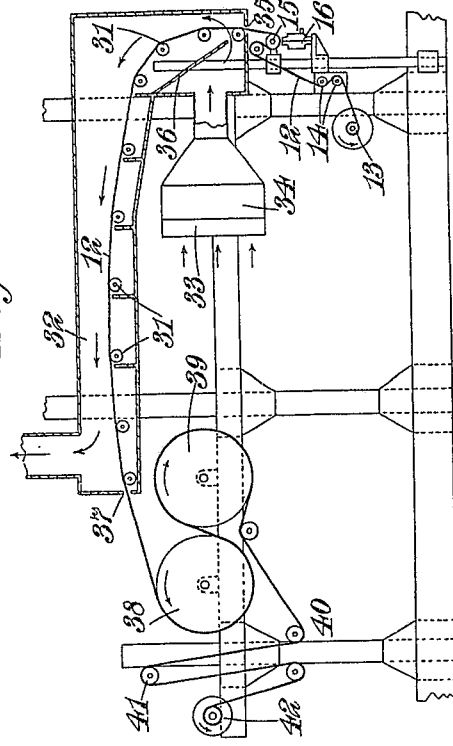


Fig. 4.



[This Drawing is a reproduction of the Original on a reduced scale.]