

PATENT SPECIFICATION

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AND (54) IMPROVEMENTS IN OR RELATING TO ROLLERS

(71) We, AGFA-GEVAERT AKTIENGESELLSCHAFT, a body corporate organised according to the laws of Germany, of Leverkusen, Germany, 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 invention relates generally to a roller and more especially to a roller for use in apparatus for wet processing of photographic films.

For continuous photographic processing apparatus and especially those for the treatment of emulsion supporting material in sheet form, it has previously been proposed to guide the sheets of film along a U-shaped or straight path by means of a large number of rollers arranged singly or in pairs. Hitherto, feed rollers with different surfaces and made of different materials have been used, depending on the chemicals present in the tank. Thus, for example, rubber rollers with high-grade steel core have been used for developing tanks, whilst rollers made of other materials are used in the fixing and washing tanks. For the drying section, rollers with a phenol resin surface layer on a stainless core have frequently been used. For many applications, rollers made entirely of high-grade steel have been provided. This multiplicity of different types of rollers each chosen for their particular surface properties and resistance to chemicals has meant the production of only relatively small unit quantities of each roller type, leading to relatively high prices. The price has been further increased by the roller construction. In addition, there has been the possibility of confusion and consequent operating breakdowns.

The invention provides a roller which comprises a rigid tube, insert members comprising a thermoplastic plastics material each inserted in a different end of the tube, bearing journals, each mounted coaxially with respect to the tube in different insert

members, and a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material against access of liquid.

A roller constructed in accordance with the invention has the advantage that the rigid tube which serves to maintain the shape of the roller can be made of materials which are not themselves resistant to chemicals such as those used in photographic processing, since the insert members and the layer, which can themselves be made of materials which are resistant to such chemicals, together protect the inner tube. The roller of the invention can also be made entirely of lightweight materials, is simple to construct, and has a low manufacturing cost. Moreover it is possible to make a roller according to the invention which can be used in all stages of processing photographic films, thus avoiding the need for using several different types of roller.

The said layer preferably comprises a thermoplastic plastics material. The insert members may also be made of a thermoplastic plastics material. If desired, a mixture of plastics materials may be used. Examples of thermoplastic plastics materials which may be used include hard polyvinyl chloride, fine-crystalline polyamides, polypropylene, and polyethylene, or a mixture of some or all of said materials. Advantageously, the said layer and each inert member comprise the same material.

In general, the rigid tube will be made of metal, advantageously of aluminium.

The said layer may be made relatively thick in comparison with conventional protective layers for rollers, and is preferably at least 2 mm. in thickness.

The said layer may enclose both the tube and the insert members.

Instead, the said layer may cover only the outer cylindrical surface of the tube, in which case, the said layer may be joined to the adjacent periphery of each insert

member by glueing or by welding.

Each insert member is advantageously provided with ribs which engage the corresponding bearing journal, and the said layer may then extend to and fill the region between the ribs.

The length of the roller is advantageously larger than its diameter and is preferably at least six times as great as the diameter.

The surface of the roller is preferably smooth, and this may be effected in a variety of ways. Thus, preliminary smoothing may be effected by grinding or turning with a machine tool, and further smoothing may be effected by solvent or thermal treatment.

The invention also provides apparatus for processing photographic strip material which includes a roller according to the invention.

The invention further provides a method of producing a roller according to the invention which comprises inserting an insert member comprising plastics material into each end of a rigid tube, mounting a bearing in each insert member and forming a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material against access of liquid.

The said layer may comprise a thermoplastic plastics material and may be formed by extrusion, injection moulding or pouring.

When the layer is formed by extrusion, the tube may be rotated about its longitudinal axis while being advanced past a fixed extrusion nozzle at a constant distance therefrom.

Preferably, a portion of the bore of the tube adjacent one or each of the ends of the tube is increased in diameter before the insert members are inserted. The portion of the bore may be increased in diameter by drilling out.

Advantageously, one or each of the ends of the bore of the tube is provided with a bevel around its circumference to enable the insert member which is to cover the bevelled end, to contact the said layer.

The layer may be formed on the tube before the insert members are inserted in the tube, in which case, the tube on which the layer has been formed may be cut into two or more portions and insert members are then inserted into the ends of one or each of the portions. The insert members may be glued or welded to the said layer.

Alternatively, the insert members may be inserted in the tube before the said layer is formed.

One or each of the bearing journals may be mounted in its corresponding insert member by glueing or by being held in the required position during formation of the

insert member by injection-moulding.

Alternatively, one or each of the bearing journals is inserted into a hole in the corresponding insert member while being vibrated at such a frequency as to cause the adjacent surface of the insert member to flow.

Two forms of roller constructed in accordance with the invention and two methods according to the invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Fig. 1 is a side view, partly in section, of the first roller;

Fig. 2. shows an arrangement used in producing the roller shown in Fig. 1;

Fig. 3 is a side view, partly in section along lines III—III of Fig. 4, of the second roller, and;

Fig. 4 is a cross-section perpendicular to the longitudinal axis of the roller shown in Fig. 3 through the lines IV—IV of Fig. 3.

Referring to Fig. 1 of the accompanying drawings, a tube 1 has a layer 2 of thermoplastic plastics material on its outer surface. The tube may be made of metal(lic), and is preferably of aluminium but other materials, which may or may not have any great degree of resistance to corrosion by liquids used in photographic processing, may be used. It is important that the material of the tube should have a good connection with the layer 2 of plastics material. The material of the layer 2 may be hard polyvinylchloride, fine-crystalline polyamide, polypropylene, polyethylene, or a mixture of these materials. There are several methods available for the application of the plastics material to the metal tube 1 to produce a layer having a thickness of, for example, at least 2 mm. Fig. 2 shows as an example, a method of extrusion in which a long length of tube 1, mounted in a carriage (not shown) is rotated about its longitudinal axis and moved past an extrusion nozzle 3 in a direction parallel to its longitudinal axis. Abutting the tube 1 in the region approximately opposite the extrusion nozzle 3 is a support roller 10 arranged to maintain a constant distance between the outlet of the nozzle 3 and the tube jacket and thus to assist in producing a layer of plastics material of uniform thickness.

The metal tube 1 on which a layer of plastics material has been formed in the manner described with reference to Fig. 2 is then cut into the required lengths. A length of the tube is then held by gripping its periphery and the inner surface of the tube 1 is machined to increase the diameter of the bore along a portion 1a of the tube 1 to a diameter. The increased internal diameter is slightly greater than the outside diameter of

a plug 4 made of a plastics material which is to be inserted in the tube 1. The plastics material used for the plug 4 is preferably the same as that used for the layer 2. As well as drilling out of the end portion of the tube 1, the inner edge 1b of the metal tube is bevelled at a sharp angle to enable the plastics layer 2 to contact an end flange 4a of the plug 4. A large number of adhesives which produce a connection which is impermeable to liquids and resistant to chemicals are available for the joining of the plastics material used for the layer 2 and the plug 4.

The plug 4 is provided with a hole 4b which is coaxial with the outer surface of the plug 4, and in which a knurled end of a bearing journal 5 is mounted. The journal 5 may be so mounted by glueing, by being held in the required position during formation of the insert member by injection moulding, or by a vibration technique. The last-mentioned technique comprises subjecting the journal 5 to a force tending to push it into the hole 4b and simultaneously causing the journal 5 to oscillate at a frequency which is at least in the audible range. This oscillation causes heating of the plastics surface in contact with the journal 5, thus producing a surface flow which facilitates insertion and ensures that the journal 5 is firmly joined to the plastics after cooling.

Manufacture of a roller according to Fig. 1 is as follows:

First of all the metal tube 1 is enclosed in an extruded layer of plastics material of a slightly greater thickness than that ultimately required to allow for turning and smoothing of the plastics surface. The plastics-enclosed tube is then cut into the required lengths. The tube portions are then clamped into a chuck which engages the inner surface of the tube 1 and the plastics layer 2 is roughly turned initially so that its surface is substantially coaxial with the inner surface of the tube 1. Next, the bore of the tube 1 is drilled out along a portion 1a of the tube 1, which is of such a length that it corresponds to the length of the plug 4 which carries the journal 5, the tube being clamped on the surface of the layer 2. The edges 1b of the tube 1 are provided with the previously-mentioned bevel during the drilling-out operation. The plug 4, in which is mounted the bearing journal 5, is then inserted into the drilled-out portion of the tube 1 and the flange 4a is secured to the layer 2, for example, by glueing. As an alternative to glueing, the end face of the layer 2 can be welded to the flange 4a of the plug 4. Finally, the surface of the layer 2 is finished on a machine-tool, the roller being clamped by its bearing journals 5. This finishing operation can be carried out by grinding or by turning. For a rough-depth

tolerance, which is the peak to valley distance of any microscopic ridges on the surface of layer 2, of, for example, 4 μ ms very good results are obtained by fine turning with a diamond. The rough depth tolerance can be reduced even further if the plastics surface, after the machine-tool treatment, is smoothed chemically by moistening with a suitable solvent, or thermally by means of friction heat, blowing with hot air, or radiation heat. Practice has shown that rollers produced in this manner can be used for all applications connected with photographic developing apparatuses, and that the resistance of such rollers to chemicals is satisfactory.

The operation of drilling out of the bore of the tube 1 can be omitted if very accurately calibrated tubes having a constant wall thickness at their periphery are used.

Referring to Figs. 3 and 4, of the accompanying drawings a tube 6, which may be made of metal and preferably of aluminium, is, first of all, cut to a required length. A plug 7 in which is mounted a bearing journal 8 is then inserted in each end of the tube 6. The axial location of the plug 7 is effected by a flange 7a, whilst centring in a radial direction is effected by the periphery 7b of the plug 7. The plug 7 consists of a thermoplastic plastics material. The bearing journal 8 is held in the plug 7 by engagement with four ribs 7c. This form of plug has the advantage that the plug 7, can comprise a flexible material which allows flexible alteration in the shape of the plug 7 and thus enables the plug 7 to fit into a tube having a smaller internal diameter than the normal external diameter of the plug 7. In this way, drilling out of the bore of the tube 6 is unnecessary in certain circumstances.

The metal tube 6 provided with the plugs 7 and the bearing journals 8 is then placed in an injection mould, the inner surfaces of which correspond to the outer contour of a plastics casing 9 around the tube 6 but allowing a slightly greater thickness than that ultimately required. The injection mould has apertures for receiving the bearing journals 8 and injection apertures in the region of the end faces of the roller. The injection mould can preferably be divided in a longitudinal direction. In the injection mould, the roller is covered on all sides in a single operation with a thermoplastic plastics material, which is preferably hard-PVC but may be any of the other plastics materials suitable for the layer 2 of the roller described with reference to Figs. 1 and 2. The liquid-proof connection between the bearing journal 8 and the plastics casing 9 is thus produced automatically. The bearing journals 8 of the injection-moulded article are then clamped and the surface of the

layer 9 is finished by turning, possibly in two operations as described in the case of the roller shown in Figs. 1 and 2.

5 The second form of roller is capable of being produced at even lower cost than the first form but a high quality of injection moulding is required since inclusions of gas in the layer 9 is undesirable and is only acceptable to a very limited extent.

10 Evacuation of the moulding mass before the moulding operation is therefore advisable. The rollers produced in this manner have a very high surface quality and are therefore superior to the rubber rollers used previously, in that gelatine residues do not accumulate on them. The removal of such residues from rubber rollers raises considerable difficulties. Rollers according to the invention can also be made with a high resistance to photographic film or leading edges thereof so that wear arising from repeated contact with film is very small.

WHAT WE CLAIM IS:—

25 1. A roller which comprises a rigid tube, insert members comprising a thermoplastic plastics material, each inserted in a different end of the tube, bearing journals, each mounted co-axially with respect to the tube in different insert members and a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material against access of liquid.

30 2. A roller as claimed in claim 1 wherein the plastics material is resistant to attack by photographic processing fluids.

3. A roller as claimed in claim 1 or claim 40 2, wherein the thermoplastic plastics material comprises polyvinylchloride, a polyamide, polypropylene, polyethylene, or a mixture of some or all of the said materials.

45 4. A roller as claimed in any one of claims 1 to 3, wherein the said layer and each insert member comprises the same material.

5. A roller as claimed in any one of claims 1 to 4, wherein the rigid tube is made of metal.

50 6. A roller as claimed in claim 5, wherein the metal is aluminium.

7. A roller as claimed in any one of claims 1 to 6, wherein the said layer is thick.

55 8. A roller as claimed in claim 8, wherein the thickness of the said layer is at least 2 mm.

9. A roller as claimed in any one of claims 1 to 8, wherein the said layer encloses both the tube and the insert members.

60 10. A roller as claimed in any one of claims 1 to 9, wherein each insert member is provided with ribs which engage the corresponding bearing journal.

65 11. A roller as claimed in claim 10 when

dependent on claim 9, wherein the said layer extends to and fills the region between the ribs.

12. A roller as claimed in any one of claims 9 to 11 wherein each insert member comprises a flexible material.

13. A roller as claimed in any one of claims 1 to 12, wherein the length of the roller is larger than its diameter.

14. A roller as claimed in claim 13, wherein the length of the roller is at least six times as great as the diameter.

15. A roller as claimed in any one of claims 1 to 9, wherein the said layer covers only the outer cylindrical surface tube.

16. A roller as claimed in claim 15, wherein the said layer is joined to each insert member by glueing or by welding.

17. A roller as claimed in any one of claims 1 to 16, wherein the surface of the roller is smooth.

18. A roller substantially as herereinbefore described with reference to, and as shown in, Figs. 1 and 2, or Figs. 3 and 4, of the accompanying drawings.

19. Apparatus for processing photographic strip material which includes a roller as claimed in any one of claims 1 to 18.

20. A method of producing a roller which comprises inserting an insert member comprising plastics material into each end of a rigid tube mounting a bearing journal in each insert member and forming a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material against access of liquid.

21. A method as claimed in claim 20 wherein the said layer is formed by extrusion, injection moulding or pouring.

22. A method as claimed in claim 20 or claim 21 wherein the outer cylindrical surface of the tube is covered with a layer of plastics material, an insert member is inserted in each end of the tube, the layer end insert members together preventing access of liquid to the tube.

23. A method as claimed in claim 22 when dependent on claim 21, wherein the layer is extruded onto the tube by rotating the tube on its longitudinal axis while moving the tube along its axis at a constant distance from a fixed extrusion nozzle.

24. A method as claimed in claims 22 or claim 23, wherein the layer is formed on the tube before the insert members are inserted into the tube.

25. A method as claimed in claim 24, wherein the tube on which the layer has been formed is cut into two or more portions and insert members are then inserted into the ends of one or each of the portions.

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layer 9 is finished by turning, possibly in two operations as described in the case of the roller shown in Figs. 1 and 2.

- 5 The second form of roller is capable of being produced at even lower cost than the first form but a high quality of injection moulding is required since inclusions of gas in the layer 9 is undesirable and is only acceptable to a very limited extent.
- 10 Evacuation of the moulding mass before the moulding operation is therefore advisable.
- The rollers produced in this manner have a very high surface quality and are therefore superior to the rubber rollers used previously, in that gelatine residues do not accumulate on them. The removal of such residues from rubber rollers raises considerable difficulties. Rollers according to the invention can also be made with a high resistance to photographic film or leading edges thereof so that wear arising from repeated contact with film is very small.

WHAT WE CLAIM IS:—

- 25 1. A roller which comprises a rigid tube, insert members comprising a thermoplastic plastics material, each inserted in a different end of the tube, bearing journals, each mounted co-axially with respect to the tube
- 30 in different insert members and a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material
- 35 against access of liquid.
2. A roller as claimed in claim 1 wherein the plastics material is resistant to attack by photographic processing fluids.
- 40 3. A roller as claimed in claim 1 or claim 2, wherein the thermoplastic plastics material comprises polyvinylchloride, a polyamide, polypropylene, polyethylene, or a mixture of some or all of the said materials.
- 45 4. A roller as claimed in any one of claims 1 to 3, wherein the said layer and each insert member comprises the same material.
5. A roller as claimed in any one of claims 1 to 4, wherein the rigid tube is made of metal.
- 50 6. A roller as claimed in claim 5, wherein the metal is aluminium.
7. A roller as claimed in any one of claims 1 to 6, wherein the said layer is thick.
- 55 8. A roller as claimed in claim 8, wherein the thickness of the said layer is at least 2 mm.
9. A roller as claimed in any one of claims 1 to 8, wherein the said layer encloses both
- 60 the tube and the insert members.
10. A roller as claimed in any one of claims 1 to 9, wherein each insert member is provided with ribs which engage the corresponding bearing journal.
- 65 11. A roller as claimed in claim 10 when

dependent on claim 9, wherein the said layer extends to and fills the region between the ribs.

12. A roller as claimed in any one of claims 9 to 11 wherein each insert member comprises a flexible material.

13. A roller as claimed in any one of claims 1 to 12, wherein the length of the roller is larger than its diameter.

14. A roller as claimed in claim 13, wherein the length of the roller is at least six times as great as the diameter.

15. A roller as claimed in any one of claims 1 to 9, wherein the said layer covers only the outer cylindrical surface tube.

16. A roller as claimed in claim 15, wherein the said layer is joined to each insert member by glueing or by welding.

17. A roller as claimed in any one of claims 1 to 16, wherein the surface of the roller is smooth.

18. A roller substantially as herereinbefore described with reference to, and as shown in, Figs. 1 and 2, or Figs. 3 and 4, of the accompanying drawings.

19. Apparatus for processing photographic strip material which includes a roller as claimed in any one of claims 1 to 18.

20. A method of producing a roller which comprises inserting an insert member comprising plastics material into each end of a rigid tube mounting a bearing journal in each insert member and forming a layer of plastics material which covers at least the outer cylindrical surface of the tube, the arrangement being such that the tube is completely protected by plastics material against access of liquid.

21. A method as claimed in claim 20 wherein the said layer is formed by extrusion, injection moulding or pouring.

22. A method as claimed in claim 20 or claim 21 wherein the outer cylindrical surface of the tube is covered with a layer of plastics material, an insert member is inserted in each end of the tube, the layer end insert members together preventing access of liquid to the tube.

23. A method as claimed in claim 22 when dependent on claim 21, wherein the layer is extruded onto the tube by rotating the tube on its longitudinal axis while moving the tube along its axis at a constant distance from a fixed extrusion nozzle.

24. A method as claimed in claims 22 or claim 23, wherein the layer is formed on the tube before the insert members are inserted into the tube.

25. A method as claimed in claim 24, wherein the tube on which the layer has been formed is cut into two or more portions and insert members are then inserted into the ends of one or each of the portions.



26. A method as claimed in claim 24 or claim 25, wherein the insert members are glued or welded to the said layer.

5 27. A method as claimed in any one of claims 20 to 23, wherein the insert members are inserted in the tube before the said layer is formed.

10 28. A method as claimed in any one of claims 22 to 27, wherein one or each of the ends of the tube is provided with a bevel around its circumference to enable the insert member which is to cover the bevelled end to contact the said layer.

15 29. A method as claimed in claim 20 or claim 21 wherein a bearing journal is inserted in an insert member which is inserted in each end of the tube and the tube and insert members are then covered by a layer of plastics material which prevents access of liquid to the tube.

20 30. A method as claimed in claim 29, when dependent on claim 21 wherein the layer is formed by injection moulding.

25 31. A method as claimed in any one of claims 20 to 30, wherein a portion of the bore of the tube adjacent to one or each of the ends of the tube is increased in diameter before the insert members are inserted.

30 32. A method as claimed in claim 31, wherein the said portion of the bore is increased in diameter by drilling out.

33. A method as claimed in any one of claims 20 to 32, wherein the said layer is finished on a machine tool.

34. A method as claimed in claim 33 35 wherein, after being finished on a machine tool, the said layer is further smoothed by one of the following methods:

(a) moistening its surface with a solvent, 40 or;

(b) heating its surface of the said layer by friction, contact with hot gas, or by thermal radiation.

35. A method as claimed in any one of claims 20 to 34, wherein one or each of the 45 bearing journals is mounted in its corresponding insert member by glueing or by being held in the required position during formation of the insert member by injection-moulding. 50

36. A method as claimed in any one of claims 20 to 34, wherein one or each of the bearing journals is inserted into a hole in the corresponding insert member while being 55 vibrated at such a frequency as to cause the adjacent surface of the insert member to flow.

37. A method of producing a roller substantially as hereinbefore described with reference to Figs. 1 and 2 or Figs. 3 and 4 of 60 the accompanying drawings.

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