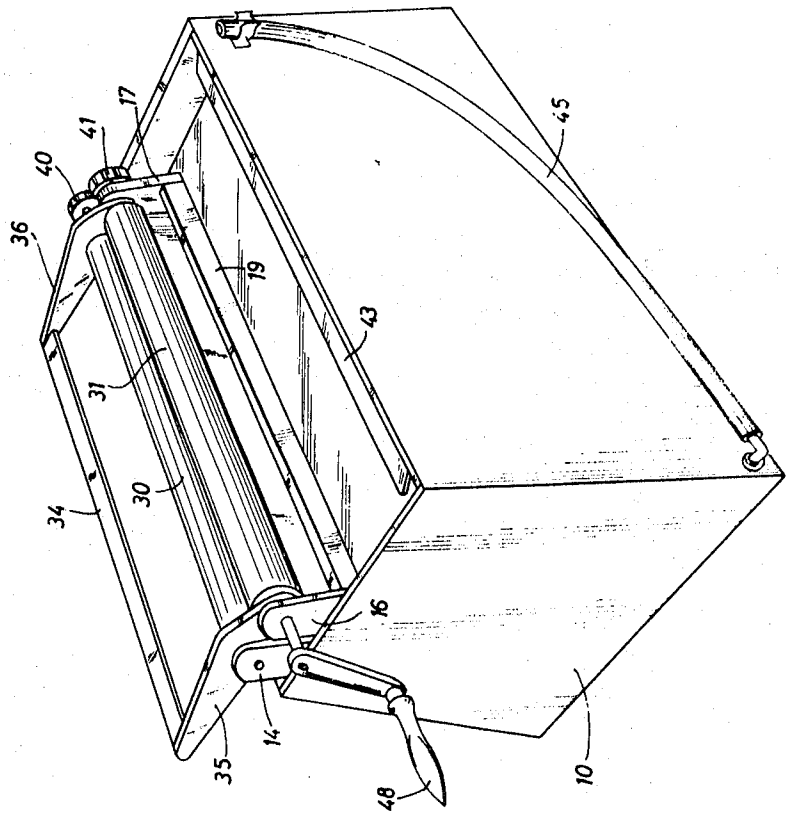
Nov. 23, 1971 E. F. STIEVENART ET AL 3,621,771

PHOTOGRAPHIC PROCESSING DEVICE

Filed May 7, 1969 3 Sheets-Sheet 1

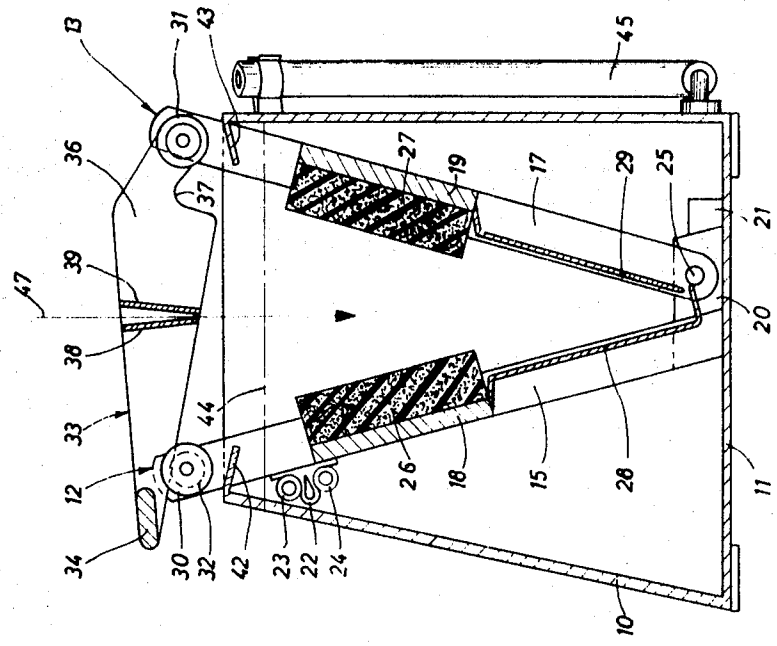
FIG. 1



PHOTOGRAPHIC PROCESSING DEVICE

Filed May 7, 1969 3 Sheets-Sheet 2

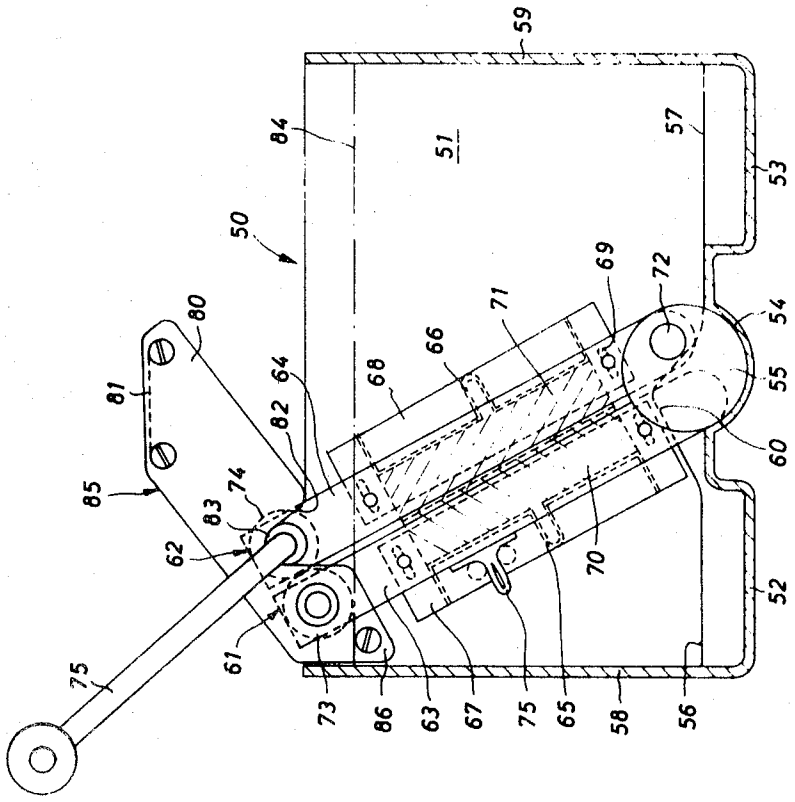
FIG. 2



PHOTOGRAPHIC PROCESSING DEVICE

Filed May 7, 1969 3 Sheets-Sheet 3

FIG. 3



United States Patent Office 3,621,771 Patented Nov. 23, 1971

3,621,771

PHOTOGRAPHIC PROCESSING DEVICE

Emile Frans Stievenart, Hoboken, and Marcel Nicolas Vrancken, Hove, Belgium, assignors to Gevaert-Agfa N.V., Mortsel, Belgium

Filed May 7, 1969, Ser. No. 822,378
Claims priority, application Great Britain, May 7, 1968, 21,654/68
Int. Cl. G03d 3/10
U.S. Cl. 95—89 R 7 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for developing sheet material including a recording layer having differentially solvent-soluble areas therein by removing the more soluble areas. The apparatus consists of cooperating sheet rubbing members and squeeze rollers which are carried respectively within and above a container of solvent on frame sections hinged together about a horizontal axis at their lower ends. The hinge permits the rubbing members and rollers to be separated for the admission of the sheet material and brought together for frictionally engaging the sheet material on removal thereof from the container by rotation of said squeeze rollers. At least one rubbing member has a surface of porous resilient material for contacting said recording layer.

The present invention relates to an apparatus for processing sheet copying material comprising a recording layer bearing information in terms of a difference in the solubilities in a solvent of different areas of such layer.

Certain materials of the kind mentioned are known, e.g. from published Dutch patent applications 6414226 filed Dec. 7, 1964, 6606719 filed May 17, 1966 and 6700359 filed Jan. 10, 1967 all by Gevaert-Agfa N.V. In the specifications thereof materials are described comprising at least one water-permeable recording layer comprising a dispersion of particles composed wholly or mainly of a hydrophobic thermoplastic polymer, solid at room temperature, in a hydrophilic binder. If such a material is sufficiently image-wise heated, a latent record is formed in said layer in terms of a difference in the water-permeabilities of different areas of the recording layer.

Image-wise heating may also result in image-wise differentiation of the recording layer in respect of some other properties, e.g. lyophility or meltability.

The latent record can be developed by removing, with the aid of water, the parts of the recording layer which have not been heated or which have not been sufficiently heated for their water-permeability to be substantially affected.

The object of the present invention is to provide an apparatus for processing copying material of the kind described.

More particularly, the invention aims at providing such processing apparatus which is simple of construction and maintenance and which operates independently of the main tap water and electric current supply.

The present invention provides apparatus for use in processing copying material in sheet form and comprising a recording layer bearing information in terms of a difference in the solubilities in a solvent of different areas of such layer, such apparatus comprising a container for holding a body of solvent, separable sheet handling, members which are located in the container and which can be separated to allow part of a sheet to be passed freely between them as it is inserted into the container and then closed to grip such sheet, at least one of such members having a resilient porous surface for frictionally

rubbing one side of said sheet, and a pair of rollers between which a part of a said sheet also passes when a part of such sheet is inserted into the container as aforesaid and by rotation of which a sheet which has been thus introduced into the container and gripped by said gripping members can be withdrawn from between such members while they remain pressed against the sheet.

The rollers may be on fixed axes so that a sheet to be processed has to be advanced into the container by rotating such rollers. It is much preferred however for the rollers to be movable into sheet-gripping position from a speed position in which a sheet can be passed freely between them. It is preferred to construct the apparatus so that closure of the gripping members within the container is achieved by movement of an exposed part or parts and so that this movement of such part or parts also closes the rollers. Preferably closing of the gripping members and closing of the rollers involves displacement of only one of the gripping members within the container, and only one of the rollers. That gripping member and that roller may be mounted on a common frame which is pivoted, e.g., at a position at or near the bottom of the container. The other gripping member and the other roller may conveniently also be mounted on a common carrier and the two carriers are preferably mounted so that they can be easily withdrawn from the container, and disconnected.

If only one of the gripping members within the container has a resilient porous surface suitable for rubbing soluble substance from the recording layer of a sheet recording material as hereinbefore referred to, then a sheet to be processed must be inserted into the apparatus with the recording layer at the side of that rubbing member. The other gripping member may, e.g., be a metal or plastics member with a smooth surface for contacting the sheet, preferably a surface which is convex in the direction of the sheet displacement. Such other gripping member may, e.g., be a roller with a non-resilient surface. It is much preferred however for both gripping members to have a resilient porous surface suitable for rubbing soluble substance from a said recording layer because it is then of no consequence which way a recording sheet faces when it is inserted into the container.

The invention in particular includes apparatus for processing sheet copying material of the type comprising a recording layer which when sufficiently image-wise heated exhibits an irreversible image-wise differentiation in solubility in at least one liquid, which apparatus comprises a container for containing a body of processing liquid, said container having an elongate opening above the level of the liquid for ingress and egress of an exposed sheet of copying material to and from said container, a pair of cooperating pressure rollers disposed proximate said opening, said rollers being displaceable from each other to free said opening for introduction of said sheet into the container the processing liquid and said rollers being biased together for withdrawing the sheet from the processing liquid upon their rotation and for squeezing the sheet, and displaceable rubbing means with a resilient and porous surface located in the processing liquid, the position of said rubbing means being controlled by the position of said pressure rollers to provide an unobstructed path for the introduction of a sheet in the liquid as the rollers are removed from each other and to make frictional contact with at least the lower half of the sheet as the rollers are biased together for removing parts of the recording layer of the sheet by means of the processing liquid.

The term "sheet material" used in the present description applies to material in the form of square of rectangular sheets.

The term "copying material" includes, besides material

which after processing yields the desired record or reproduction of the original to which it was exposed, either as a positive or a negative thereof, also material which after processing constitutes a planographic printing master, the remaining non-soluble portions of the recording layer being ink-receptive, or capable of being made so.

In a preferred construction of the apparatus there are provided two frames in the container which extend from said opening for ingress and egress in the processing liquid, and which each rotatably support one roller of said pair of cooperating pressure rollers above the level of the liquid. Each frame has a pressure plate which supports a strip of the rubbing material at the side facing the opposite frame, and one frame is pivotably hinged to the other frame near the lower extremity, the other frame being provided with means cooperating with positioning means in the housing for securing the position of the frame after it has been inserted into the container.

Preferably, one pressure roller is provided with a crank for rotation by the operator, while the other roller is provided with a gear which meshes with a corresponding gear on the shaft of the one roller when both rollers are biased together.

The apparatus according to the invention can be used with advantage in the processing of any recording material on which information has been recorded in terms of a difference in the solubilities of different areas of a recording layer of the material and, in particular, mention is made of recording materials which incorporate a substance capable of absorbing radiant energy of high intensity, e.g. high intensity light radiation, which is sufficient for the solubility differentiation to be imparted by information-wise exposure of the material to such radiation. Various such materials are described in the specifications referred to hereinbefore.

The invention will be described hereinafter by way of example with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of the processing apparatus according to the invention in the operative position.

FIG. 2 is a diagrammatic sectional view of the apparatus according to FIG. 1 in the inoperative position.

FIG. 3 is a diagrammatic sectional view of another embodiment of the apparatus according to the invention.

The apparatus, as shown in the operative position in FIG. 1 and in the in-operative position in FIG. 2, is mounted in a container **10** which is open at the topside, and which has a transverse section of trapezium-shape, the longer side being at the base **11** of the device to ensure a good mechanical stability of the apparatus.

In the container **10** are located two frames **12** and **13** which are formed by the legs **14**, **15** and **16**, **17** which are connected in parallel to the ends of pressure plates **18** and **19**.

Each leg of the frame **12** has at its lower extremity a projection **20** which abuts against a stop **21** fixed to the bottom of the container, and a locking member **22** which snaps between the elastic studs **23**, **24** fitted to the inner side of the lateral walls of the container, when the frame is lowered and inclined to take a position as shown in the drawing. At their lower extremity, the legs of the frame **13** are hinged by means of removable plugs **25** to the projections **20**. To the pressure plates are stuck the elongate and uninterrupted strips **26** and **27** of resilient and porous "Perlon" foam plastic. To the pressure plate **18** is further fitted a guide plate **28**, the lower end of which is bent at right angles towards the opposite guide plate **29** which is supported by the pressure plate **19**. The thickness of the foam strips is such that in the operation of the apparatus, they are depressed over a distance of some mm. each.

The legs of the frames rotatably support the cooperating pressure rollers **30** and **31**. The rollers comprise a hard core which is fitted to a shaft which is rotatably journalled in the mentioned frame legs, and a covering of a resilient material such as butyl rubber or the like.

At each end of the roller **30**, a small disc **32** is freely rotatably mounted on the shaft thereof, and separates the roller extremity from the legs of the frame **12**.

A latching arrangement for holding the frames in the operative position consists of a handle **33**, formed by a grip **34** and two parallel arms **35** and **36**, which pivots around the shaft of roller **31**. Each arm has a recess or detent **37** which closely fits over the discs or projections **32** when the handle is pulled from the in-operative position as shown in FIG. 2, in the direction of the stationary frame **12** to bias the pressure rollers together, and then lowered to take the operative position as shown in FIG. 1. Between the two arms are also provided guide means comprising two guides **38** and **39** which define a sheath (not shown in FIG. 1) which aids in introducing a sheet of copying material into the apparatus.

The shafts of the rollers **30** and **31** project at one side of the frames through the legs **15** and **16**, and they are provided at their extremity with the gears **40** and **41** which engage each other in the operative position of the frames.

The shaft of the roller **31** is provided at its opposite end with a crank **48** for rotation of said roller.

The longitudinal sides of the opening at the top of the container are provided with sloping plates **42** and **43** which catch liquid drops dripping from the rollers **30** and **31** and direct such liquid into the liquid bath in the container, and which prevent the liquid wave which is created by the movement of the frame **13** towards or away from the frame **12**, from passing over the longitudinal walls of the container. Difficulties in this respect are minimized by restricting the height of the pressure plates **18**, **19** and the strips **26**, **27**, and by providing the guide plates with a plurality of openings (not shown). The liquid in the container reaches a level which is above the maximum height of the strips **26** and **27** and which is indicated in FIG. 2 by the dash and dot line **44**. The described apparatus may contain **9** liters of water so that an excellent mechanical stability is obtained. In order to facilitate the cleaning and the removal of the apparatus, a flexible tube **45** is provided which communicates with the lower part of the housing and the free end of which may be withdrawn from a clip in order to empty the apparatus in a sink or a bucket.

The following is an example of the preparation and exposure of a sheet of copying material suitable for processing in an apparatus according to the present invention and of its processing in the illustrated apparatus.

A poly(ethylene terephthalate) support of 0.1 mm. thickness is coated with the following solution at a rate of 20 g./sq. m.:

	G.
40% aqueous dispersion of polyethylene having a particle size of less than 0.1μ and an average molecular weight comprised between 15,000 and 30,000	50
20% aqueous dispersion of copoly(vinylidene chloride/N-butyl-maleimide/itaconic acid) 83/15/2	50
Water	750
30% aqueous dispersion of silica having an average particle size of 25 nm.	50
Ethanol	100

After drying at 60° C., the subbing layer obtained is coated with a heat-sensitive layer from the following composition in a proportion of 18 g./sq. m.:

10% aqueous solution of poly-N-vinylpyrrolidone having an average molecular weight of 30,000—120 ml.
Water—420 ml.
40% aqueous dispersion of polyethylene (having a particle size of less than 0.1μ and an average molecular weight comprised between 15,000 and 30,000)—155 ml.
Pigment Red 146—C.I. 11,000 applied as Permanent Carmin FBB Colanyl Teig (a trade name for a red

pigment marketed by Farbwerke Hoechst A.G.—Frankfurt am Main, Germany)—75 g.

5% aqueous solution of n-hexadecyl-dimethylbenzyl ammonium chloride—40 g.

After drying at 50° C., the copying material obtained is exposed and processed as follows.

The original document having infra-red absorbing image markings is located with its image-side in contact with the heat-sensitive side of the copying material, and the sandwich of both materials is passed through a conventional thermographic copying apparatus, the support of the copying material facing the I.R.-exposure source in the copying apparatus.

After the exposure, the exposed sheet of copying material is introduced in the processing apparatus in the direction indicated by the arrow **47**.

When the sheet abuts with the leading end against the arrest or stop member formed by the bent portion of the guide plate **28**, or occasionally slightly before the sheet is inserted so far, the operator raises slightly the handle by means of the grip **34** so that the trailing end of the sheet comes free from the sheath.

The operator thereafter pulls the grip **34** to move the frame **13** towards the frame **12**, and firmly presses down the handle so that the recesses **37** fit over the discs **32**, so that the rollers **30** and **31** are biased together and the strips **26** and **27** of foam material are urged against the sheet. By means of crank **48** the rollers **30** and **31** are rotated to remove the sheet from the apparatus. The strips of rubbing material gently remove the non-exposed and still water-permeable parts of the recording layer of the sheet as the sheet slides between them, whereas the rollers **30**, **31** squeeze the liquid which adheres to the sheet so that the sheet is almost dry after its removal from the liquid. It appears that the sheet is effectively processed over about two thirds of its surface. The processing operation is now repeated, the sheet being inserted this time in reversed order in the apparatus so that what was the first time the trailing end now enters the processing liquid first.

The copy obtained shows a red positive transparent copy of the original image to which it has been exposed. Some tens of seconds after leaving the device, the copy sheet is completely dry.

The water supply contained in the container has proved to be capable for processing many hundreds of sheets. It should be noted that the apparatus operates in a completely satisfactory way even if two entirely differently coloured sheets were processed after each other. For instance, a sheet as described hereinbefore and which was not exposed to heat, was processed in the apparatus to uniformly remove its red coloured recording layer. Subsequently a green coloured sheet which also was unexposed, was processed. The examination of the processed second sheet showed that it was clear transparent with no or quite neglectable traces of red pigment.

Another embodiment of the apparatus according to the invention is shown in FIG. 3. The said apparatus shows the advantage over the apparatus described hereinbefore in that its height is reduced whereby the mechanical stability is increased. A sufficient length of the sheet path in the processing liquid of the container is obtained in making the leading edge of the sheet deflect near the bottom of the container so that the sheet may continue its path over the bottom of the apparatus until it abuts against a wall of the apparatus. Further the positioning of the frames in the container is ensured in an improved way.

The apparatus illustrated in the operative position, is mounted in a rectangular container **50**, the figure showing a section thereof in the transverse direction so, that the left lateral wall is seen at **51** and the front wall **58** and the rear wall **59** of the apparatus are located at the left, respectively at the right side of the figure. The bottom of the container is provided near the corners with recessed portions **52** and **53** which form four supports on which the apparatus is resting and which are provided with rubber pads at the underside. Between each two lateral recesses, a concave excavation **54** is provided. The portion of the bottom of the apparatus extending between the mentioned recesses near the lateral sides has a form constituted of two horizontal portions **56** and **57** and an elevated bridge portion **60**. The horizontal portion **57** is provided with ribs, not shown, which run almost normal to the wall **59** and which reduce the contact with the bottom of a sheet sliding thereover. The container **50** preferably is made by injection moulding from plastics, such as hard polyvinylchloride.

In the container are mounted two frames **61** and **62** which are formed by pairs of legs **63** and **64** which are parallelly spaced from each other by a pressure member. The pressure members comprise plates **65** and **66** folded in a form as shown by the broken lines, which extend longitudinally of the device and to the lateral ends of which are fitted the side plates **67** and **68**. The side plates are provided with elongate slots, such as indicated by the numeral **69**, through which pass screws for adjustably fitting said side plates to the legs of the frames. To the flat sides of the pressure members which face the film path are glued the strips **70** and **71** of resilient and porous "Perlon" foam plastic, which have been shown in the figure in hatched broken lines.

The frames are hinged to each other by means of circular nuts **55** which are stuck to the lower extremities of the legs of the frame **61** and which are connected through a rotatable pin **72** with the lower extremities of the legs of frame **62**. The nuts **55** fit in the excavations **54** when the frames are inserted in the container. The frame **61** is provided at either side with a locking member **75** which snaps between elastic studs, shown in broken lines, and fitted to the inner side of the lateral walls of the container, when the frame after having been lowered in the housing so that the nuts **55** are supported in the excavations **54**, is titled to the left according to the figure and pressed towards the wall **58**.

The upper ends of the legs of the frames rotatably support the cooperating pressure rollers **73** and **74**. The rollers comprise a hard core which is fitted to a shaft which is rotatably journalled in the mentioned frame legs, and a covering of a resilient material such as butyl rubber or the like. The shaft of roller **74** is provided at one end with a crank **75** for rotation of the rollers. The shafts of the rollers are further provided at one end with gears, not shown, which engage each other in the operative position of the frames.

A latching arrangement for holding the frames in the operative position consists of a handle **85**, formed by two laterally spaced arms **80** and a grip **81** extending between the ends thereof, which pivots around the shaft ends of roller **73**. Each arm has a recess or detent **82** which closely fits over free rotating discs or projections **83** provided over the shaft ends of roller **74** when the handle is pushed in the operative position as shown in the figure. The grip **81** is formed by a strip of aluminium, the longitudinal extremities of which are folded around two elongate rods by which the arms are held in parallel, and the flat portion of which is provided with a longitudinal slit to define a guide for the easy introduction of a sheet in the apparatus.

The liquid in the container takes a level which is indicated by the dash and dot line **84**. The described apparatus may contain about 7 liters of water.

The operation of the apparatus is as follows.

The handle **85** is lifted, the movable frame **62** is pivoted away to take a position which is almost laterally reversed in respect of the position of the stationary frame **61**, and the handle is lowered again so that it rests with the extremity **86** against the innerside of wall **58** to take the position which corresponds almost with the one shown. The image-wise exposed sheet of copying material is verti-

cally introduced through the slit in the grip **81**. The lower edge of the sheet is deflected by the sloping portion of the bridge **60** and the sheet slides further over the bottom portion **57** until the leading edge finally abuts against the wall **59**. The operator raises the handle so that the trailing end of the sheet comes free from the grip **81** and pulls the frame **62** towards frame **61**. The handle **85** is lowered again so that recesses **82** fit over the discs **83**. The rollers are biased together and the strips **70** and **71** of foam material are urged against the sheet. With the crank **75** the rollers are rotated to slowly pull out the sheet from the apparatus. The strips of rubbing material smoothly remove the soluble parts of the recording layer of the sheet as the sheet advances between them, and the rollers **73** and **74** squeeze the liquid which adheres to the sheet so that the sheet is virtually dry after its removal from the apparatus. The removed sheet is effectively processed over an area comprised between one half and two thirds of its surface. The treatment is now repeated, the sheet being inserted in reversed order so that what was first the trailing end now enters the processing liquid first.

An apparatus according to the present invention may be used also for processing copying materials which contain a substance or substances that are applied therein in order to heat the recording layer by the electromagnetic radiation used in the exposure. Said substances preferably absorb infra-red and/or visible light and convert it on absorption into heat. Best results are obtained by incorporating the said substances in finely divided state (dispersed or dissolved) in the recording layer itself. The image-wise exposure of such material when being a contact exposure is preferably an exposure of short duration, e.g. flash lamp exposure, preferably lasting no longer than 10^{-1} sec. and preferably of an intensity not less than 0.1 watt sec. per sq. cm.

As infra-red and visible light absorbing substance converts that light into heat preferably finely divided carbon is used.

A description of this and still other materials which are suitable for processing in the apparatus according to the present invention may be found in published Dutch patent application 6068711 filed June 23, 1966 by Gevaert-Agfa N.V., and in the British patent application 44,038/67 filed Sept. 27, 1967 for "Improvements Relating to Thermo-Recording" by Gevaert-Agfa N.V. and in the published Dutch patent application 6608504 filed June 17, 1966 by Gevaert-Agfa N.V.

The processing operation need not necessarily occur by means of water as described hereinbefore. In fact, the composition of the copying material may be such that processing can occur, e.g. by means of alcohol or a mixture of alcohol and water.

The guiding of a sheet into the apparatus may be improved when the sheath or the guide formed by the guide members of the handle is slightly curved in the longitudinal direction thereof, so that the sheet is stiffened in the direction normal thereto, i.e. in the direction indicated by the arrow **47** in FIG. 2.

Finally, the apparatus may be provided with extra guide means, e.g. for more accurately defining the lateral position of a sheet inserted into the container.

We claim:

1. Apparatus for processing sheet material including a recording layer having differentially solvent-soluble areas thereon, said apparatus comprising a container for a body of solvent, a supporting frame removably disposed within said container and formed of two generally upstanding sections hingedly connected at their lower ends for relative pivotal movement about a horizontal axis, said frame supporting opposed cooperating rubbing members, one on each section thereof, generally horizontally within the body of solvent, said members having a length substantially coextensive with the width of said sheet material and at least one of said members having a resilient porous surface for frictionally contacting said recording layer, said frame also supporting a pair of cooperating squeeze rollers, one on each section thereof, above the level of said solvent in generally parallel relation to said rubbing members, cooperating means provided on said container and one of said frame sections for positioning said section in place within said container, the other of said frame sections being pivotable between an inoperative position at which the rubbing member and squeeze roller carried thereby are spaced apart from the cooperating member and roller to permit said sheet material to be inserted therebetween into said container with one end projecting at least to the level of said squeeze rollers, and an operative position at which said rubbing members and squeeze rollers are pressed together whereby rotation of said squeeze rollers effects withdrawal of said sheet material from between the rubbing members while the same are pressed together.

2. The apparatus of claim **1** including latching means for detachably holding the free ends of said frame sections together in said operative position.

3. The apparatus of claim **2** wherein said latching means comprises a pair of spaced apart arms mounted for pivotal movement on the upper corners of one of the frame sections, said arms including detent means thereon, and cooperating projections provided on the upper corners of the other frame section for engagement by said detent means when said arms are pivoted to locking position to secure the free ends of said frame sections together and a handle extending between the ends of said arms.

4. The apparatus of claim **3** wherein said arms of said latching means support intermediate their ends sheet material guide means extending therebetween.

5. The apparatus of claim **1** including a stop member adjacent the bottom of said container for engaging the leading edge of sheet material introduced between the separated frame sections to limit the penetration thereof into the container and sheet material guide means for directing said leading edge of said sheet material towards said stop member.

6. The apparatus of claim **5** wherein said stop member comprises a vertical surface projecting from the container bottom and said sheet material guide means deflects said sheet material along a curved path into engagement with said vertical surface.

7. The apparatus of claim **6** wherein said guide means comprises ribs extending adjacent the container bottom.

References Cited

UNITED STATES PATENTS

2,117,828	5/1938	Soman	118—264
2,380,378	7/1945	Allen	95—89 X
2,775,933	1/1957	Malone et al.	95—89 X
2,950,215	8/1960	Slater et al.	118—427 X
3,261,277	7/1966	Limberger	95—89
3,461,787	8/1969	Pfaff	95—94

SAMUEL S. MATTHEWS, Primary Examiner

F. L. BRAUN, Assistant Examiner

U.S. Cl. X.R.

118—427