Sept. 8, 1970 M. M. LABES 3,527,666

CONTACT COPYING MATERIAL

Filed Dec. 11, 1967

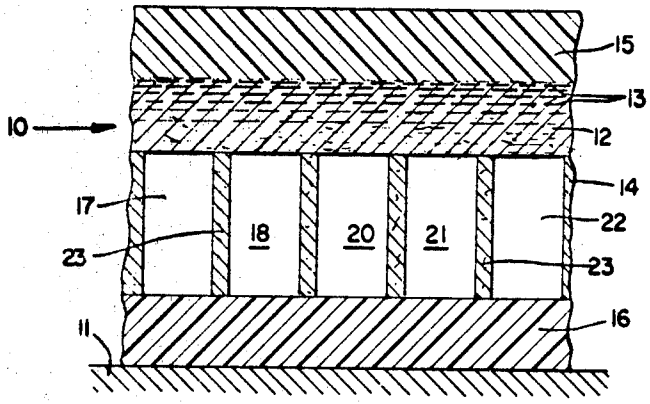


Fig. 1

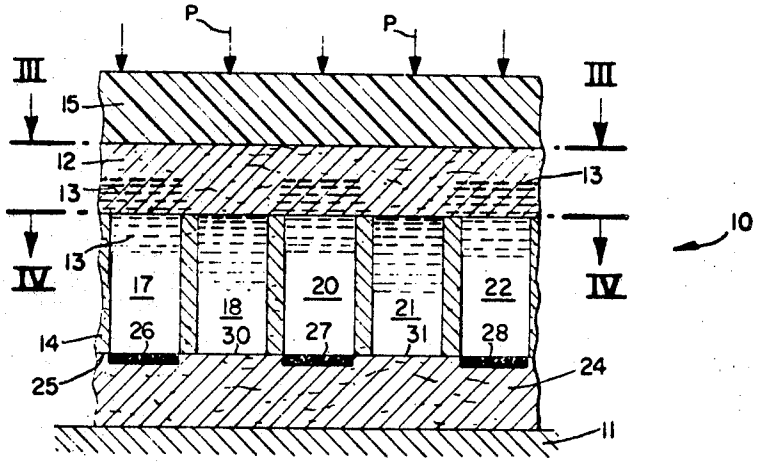


Fig. 2

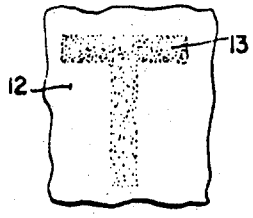


Fig. 3

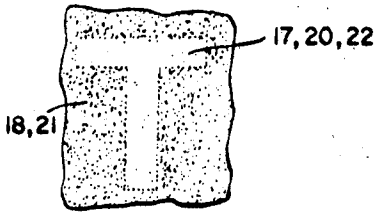


Fig. 4

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ABSTRACT OF THE DISCLOSURE

A pressure sensitive copying material is provided which utilizes a sheet of material having a plurality of capillary pores therein, for receiving and retaining an image-forming material from a carrier therefor, with the image-forming material being drawn into capillaries at different rates, depending upon whether the sheet to be copied is disposed with printed or other images adjacent ends of particular capillaries, or if an unprinted or unimaged surface portion of the sheet to be copied is disposed against ends of the capillaries.

BACKGROUND OF THE INVENTION

Prior art copying techniques which have been developed to provide a limited number of copies of each sheet to be copied have been principally of the photocopy type, requiring a light source, have required the use of stencils, or have been concerned with the application of toner particles to paper and the like by using carrier particles which are electrically charged. The copying techniques of the prior art are thus rather cumbersome, in many instances, in requiring expensive equipment, there being no provision for facilitating the copying of a limited number of sheets in a relatively simple and inexpensive manner. Also, the prior art is devoid of any such copying technique which is readily portable, and therefore adapted for use in environments other than those of a fully equipped office.

SUMMARY OF THE INVENTION

The present invention seeks to fulfill a need which exits in the prior art, in providing a composite pressure sensitive copying element in which a carrier layer has been impregnated with an image-forming substance, and a transfer layer having a plurality of capillary-like pores is adapted to receive the image-forming substance from the carrier layer, when the transfer layer is placed against the surface of a sheet to be copied. The surface to be copied will generally have unmarked surface portions, and marked surface portions which are either printed, typewritten, or the like. This invention utilizes the difference in porosity between marked and unmarked surface portions, to effect a difference in flow rates of the image-forming substance through capillaries which have one end disposed against the sheet to be copied, some of the capillaries terminating against a marked surface portion of the sheet to be copied, and other of the capillaries terminating against an unmarked surface portion of the sheet to be copied, such that the rate of flow of the image-forming substance is greater in those capillaries which are disposed with one end against an unmarked surface portion of the sheet to be copied. By applying pressure to the carrier layer, and appropriately timing the application of such pressure, an image, either latent or actual will appear in either the carrier layer or the capillary-structured transfer layer, or both, such image being responsive to the amount of flow of the image-forming substance through the capillaries of the transfer layer, hence responsive to the marked and unmarked surface portions of the sheet to be copied.

Accordingly, it is an object of this invention to provide a pressure sensitive copying element having a carrier layer which is impregnated with an image-forming substance, a transfer layer having a plurality of capillary-like pores therein, with both layers being sandwiched between fluid-impermeable layers, which prevent the transfer of an image-forming substance from the carrier layer to the transfer layer prior to removal of one of the fluid-impermeable layers.

It is another object of this invention to provide an element as set forth in the object immediately above, wherein that fluid-impermeable layer which is provided against the transfer layer is readily separable therefrom.

It is a further object of this invention to provide a novel copying method, wherein a pressure sensitive copying element such as that discussed in the objects immediately above is provided, and wherein pressure is applied to the carrier layer, after the transfer layer is applied into direct engagement against the surface of a sheet to be copied, and the pressure applied to the carrier layer facilitates the expulsion of entrapped air from the capillaries of the transfer layer, at a rate dependent on the porosity of the particular surface portion of the sheet to be copied, disposed immediately beneath the capillaries, such surface porosity varying between marked or indicia-bearing and unmarked or indicia-free surface areas, leaving an image on either of the carrier or transfer layers.

It is another object of this invention to accomplish the object described immediately above, wherein the time period of pressure application is discontinued prior to all entrapped air being forced out of any of the capillary pores.

It is a further object of this invention to accomplish the above objects, wherein the image formed on either of the carrier or transfer layers may be either latent or actual.

Other objects and advantages of the present invention will be readily apparent to those skilled in the art from the following brief description of the drawing figures, detailed description of the invention, and the appended claims.

In the drawings:

FIG. 1 is a highly enlarged schematic cross-sectional view through a composite copying element or material of this invention.

FIG. 2 is a view generally similar to that of FIG. 1, but wherein a lowermost fluid-impermeable layer has been removed, and the copying element has been placed in overlying relation to a printed sheet to be copied, with pressure applied.

FIG. 3 is a fragmentary view taken generally along the line III—III of FIG. 2, of an image formed in a substantially transparent carrier layer of a copying element of this invention, by complete flow of an image-forming substance from the carrier layer with only partial flow of the image-forming substance into some of the capillary pores of a transfer layer, leaving a generally T-shaped image in the carrier layer, corresponding generally to a marking or indicia on the surface of the sheet to be copied.

FIG. 4 is a view generally similar to that of FIG. 3, but taken along the line IV—IV of FIG. 2, wherein differences of depth of image-forming substance in capillary tubes create a difference in image shading between portions of the transfer layer which overlie printed portions of the sheet to be copied, and portions of the transfer layer which overlie unprinted portions of the sheet to be copied.

Referring now to the drawings in detail, reference is first made to FIG. 1, wherein there is illustrated a composite copying element, generally designated by the numeral **10**, disposed on a planar surface **11**.

The composite element **10** includes a carrier layer **12**, which is impregnated with an image-forming substance **13**, a transfer layer **14**, an upper fluid-impermeable layer **15**, and a lower fluid-impermeable layer **16**.

The carrier layer **12** may be constructed of any material suitable for liquid impregnation and retention, such as a fibrous or sponge-like material, or the like. The material **12** may be compressible and porous, such as a felted material, or may be of sponge-like Neoprene, latex foam, or of fibrous glass construction.

The image-forming substance **13** may comprise an ink or dye or any other suitable marking or coloring substance. Additionally, the image-forming substance **13** may be substantially colorless, leaving no visible indication to the naked eye, but which, when treated with chemicals, chemical solutions, heat or light would be transformed from a latent image to an actual image.

The transfer layer **14** is generally a soft capillary membrane material having an ordered pore structure preferably, but not limited to the range of 10^2 to 10^8 pores per centimeter^2. An exemplary but not limiting example of such transfer layer material may comprise that commercially available material known as "Nuclepore."

The fluid-impermeable or non-porous layer **15** may comprise an integral skin portion of the carrier layer **12**, or may comprise a separate layer of any suitable fluid-impermeably film. Exemplary materials for the layer **15** are those such as polyvinyl chloride, cellophane, or any of the various resin films, or the like, having desirable fluid-impermeable characteristics.

The lower fluid-impermeable or non-porous layer **16** is generally a distinct layer manually separable from the transfer layer **14**, and may be constructed from any suitable material such as those set forth above as exemplary constructions for the layer **15**.

In the fragmentary microscopic sectional schematic view of FIG. 1, the transfer layer **14** is illustrated as having 5 capillary pores **17**, **18**, **20**, **21** and **22**, each of the pores being separated from one another by a wall portion **23**.

With reference to FIG. 2, the element **10** is illustrated as having the lower fluid-impermeable nonporous layer **16** removed therefrom, with the element **10** being disposed in overlying relation to the sheet **24**, which is to be copied, with the lower-most open ends of the pores **17**, **18**, **20**, **21** and **22** of the transfer layer **14** disposed against an upper surface **25** of the sheet to be copied **24**.

The sheet **24** may comprise a sheet of paper or the like, having printed, typed, or other indicia-bearing surface portions **26**, **27**, and **28** thereon, and unmarked or indicia-free surface portions such as those **30** and **31**. It is to be noted, that while the sheet **24** is referred to as a sheet of paper or the like, any structure having indicia or other markings thereon may be copied, as long as such structure is sufficiently porous, to permit the passage of air from capillary ends disposed thereagainst.

While the printed surface portions **26**, **27** and **28** are illustrated in FIG. 2 as being disposed directly beneath the capillary pores **17**, **20** and **22**, for exemplary purposes, it is to be noted that a given printed or marked surface portion, such as, for example, the letter T may be disposed beneath hundreds or more individual capillary pores.

In a copying operation, with the non-porous sheet **16** removed from the composite element **10**, and the element **10** when being applied in overlying relation to a printed sheet **24** or the like, disposed on a generally planar surface **11**, pressure P is then applied to the upper surface of the element **10**, preferably by engagement of a pressure plate (not shown) against the upper surface of the layer **15**, such that pressure is transmitted to the carrier layer **12**, thereby forcing the image-forming substance **13** into the capillary pores **17**, **18**, **20**, **21** and **22**. As the image-forming substance **13** is forced into the capillary pores, captured air or the like is forced outwardly, through the lower ends of the pores, as illustrated in FIG. 2, through the porous sheet **24**, which is to be copied.

It has been found, that the porosity of a porous sheet **24** is decreased when such a sheet is marked or bears other indicia, such as is effected in a printing, typing or the like operation. In fact, it has been found that in some instances, the porosity of an unprinted portion of a sheet of material is twice as great as the porosity of a printed portion of the sheet of material. Employing this feature to advantage, it has been found that upon application of a pressure P in the manner above described, the image-forming substance **13** will descend or flow into capillary pores **18** and **21** which are disposed above unmarked or indicia-free surface portions of the sheet **24**, at a greater rate than will the substance **13** flow through the capillary pores **17**, **20**, and **22** which overlie marked or indicia-bearing surface portions **26**, **27**, and **28** of the sheet **24**. If the porosity ratio of unmarked sheet portions to marked sheet portions is represented by a factor of two to one, in a given time interval during which pressure P is applied to the element **10**, substantially twice as much image-forming substance **13** will descend into the capillary pores **18** and **21** as will descend into the capillary pores **17**, **20** and **22**.

It will be noted that the timing of the application of pressure P to the element **10** should be carefully controlled, such that the image-forming substance **13** descending in the capillary pores **18** and **21** will not descend an amount sufficient to contact the surface portions **30** and **31** of the sheet **24**, to undesirably mark the same.

When the desired predetermined length of time has passed, the element **10** may be removed from the sheet **24**, and the layers **12** and **14** may then be separated, thereby allowing the image-forming substance **13** which is then present in those layers to dry upon contact with air, substance **13** having previously been prevented from air contact and hence from drying in the composite element **10** due to the presence of the fluid-impermeable layer **15** and **16**.

The image formed in the layer **14** may appear substantially as that shown in FIG. 4, with the composite area formed by the liquid substance **13** which is dried in the plurality of capillary pores **17**, **20**, and **22** which were disposed over marked or indicia-bearing surface portions of the sheet **24** being substantially lighter than the area formed by the image-forming substance which is of greater depth in the pores **18** and **21**, such difference in depth of dried image-forming substance giving a visual indication such as that illustrated in FIG. 4 for the letter T, in which the lighter area comprising the T formation is effected by a composite formation of pores having an image-forming substance of lesser depth, and the outlining area for the letter T is effected by a composite of those pores of greater depth of dried image-forming substance **13**. It will be apparent that the image evidenced by FIG. 4 is a negative image as compared to the image or marking originally present on the surface **25** of the sheet **24** which is copied.

It is conceivable that the transfer layer **14** may be constructed of a double thickness sheet having an upper layer (not shown) which is penetrated by the image-forming substance **13** pressing into all of the capillary pores **17**, **18**, **20**, **21**, and **22**, and having a lower layer below the mating surface for such layer portions, such that the image-forming substance **13** penetrates below such mating surface only through those capillary pores **18** and **21** which are not disposed over marked surface portions of the sheet **24** to be copied. In such a structure, upon separation of the two layer portions of the transfer layer **14**, the negative image illustrated in FIG. 4 would be formed only by a composite of a plurality of pores **18** and **21**, in which the image-forming substance **13** had penetrated, leaving a void or completely blank area such as that which comprises the T formation in FIG. 4, formed by separating the lower layer portion of the layer **14** from its upper

layer portion prior to penetration of the pores **17**, **20**, and **22** of the lower layer portion by the image-forming substance **13**.

After discontinuing the application of pressure P, and separation of the carrier layer **12** from the transfer layer **14** and the fluid-impermeable layer **15**, a positive image is left on the carrier **12**, by the image-forming substance **13** which is not received completely within capillary pores of the transfer layer **14**, but which remains within the carrier layer **12**, such as that shown disposed above capillary pores **17**, **20**, and **22** in FIG. 2. Upon separation of the carrier layer **12** from the other layers, and drying of the image-forming substance **13** upon air contact, a mirror image of the printed indicia **26**, **27**, and **28** on the surface **25** of the sheet **24** appears on the under surface of the carrier layer **12**. However, should the carrier layer **12** be, for example, of transparent construction, and viewed from above, along the section line III—III of FIG. 2, a positive image would be available on the upper surface of the layer **12**, directly corresponding to the original marking or indicia which appears on the upper surface **25** of the sheet **24** which is copied. With reference to FIG. 3, there is illustrated the view which would appear along the section line III—III, or upon the upper surface of the layer **12**, if a letter T appeared on the surface **25** of the sheet **24**, the letter T being formed by the residual image-forming material which remains within the carrier layer **12**, disposed directly above those capillary pores which are, in themselves disposed directly above comparable portions of a marking or indicia represented by the letter T on the surface **25** of the sheet **24**.

As has been mentioned above, should the image-forming substance be of a type adapted to leave only a latent image, after termination of the application of pressure P to the composite element **10**, it may be desirable to subject either of the layers **12** or **14** to additional operations or processes, in order to develop a visible image thereon responsive to the differential flow rate of the image-forming substance **13** through the capillary pores. Such later procedures may or may not be necessary depending upon the type of image-forming substance **13** which is utilized.

It will be apparent that the terms "indicia" and "marking" should be read in the broadest sense, to include any marking, printing, writing, etc., which may be desired to be copied. Also, the various materials set forth herein are exemplary only, and this invention is not intended to be limited to the specific materials, or to specific manners

of operation. In some instances it may be desirable to place the sheet to be copied in overlying relation to the composite element **10**, and to exert pressure onto the sheet which is to be copied, which would be transferred downward for compression of the carrier layer, and consequently result in a rise of image-forming substance into the capillary pores. Such modifications and others as well, are to be considered to be within the scope of this invention.

The particular embodiments illustrated and described are exemplary only, and are not intended to limit the scope of this invetnion, as defined in the appended claims.

What is claimed is:

1. A pressure-sensitive copying element comprising a carrier layer impregnated with an image-forming substance, a transfer layer disposed with one surface against an adjacent surface of said carrier layer; said transfer layer comprising a material having a plurality of capillary-like pores therein, extending between opposite layer surfaces thereof, said carrier layer and said transfer layer each being provided with fluid-impermeable means on opposite non-adjacent surfaces.

2. The element of claim **1** wherein said fluid-impermeable means comprise separate film layers.

3. The element of claim **1**, wherein that fluid-impermeable means which is provided on said transfer layer is readily separable from said transfer layers.

4. The element of claim **3**, wherein said transfer member has an ordered pore structure in the range between 10^2 and 10^8 pores per centimeter^2.

5. The element of claim **3**, wherein said carrier layer is of fibrous construction.

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U.S. Cl. X.R.

101—468, 473; 117—37, 35.6, 301, 36.7; 161—406