Dec. 26, 1967 D. A. NEWMAN 3,359,900

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Fig. 1

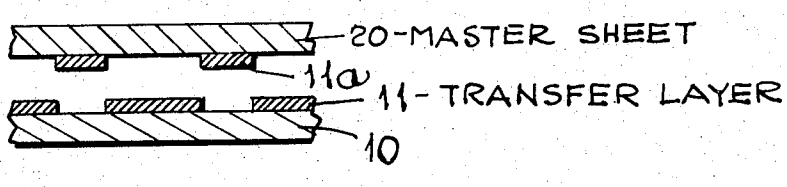


Fig. 2

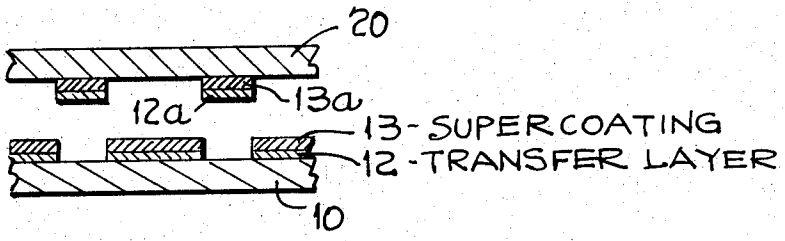


Fig. 3

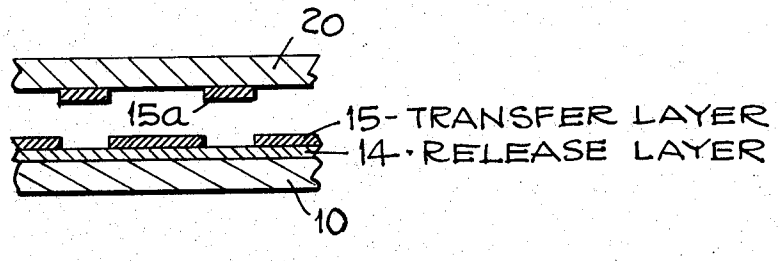
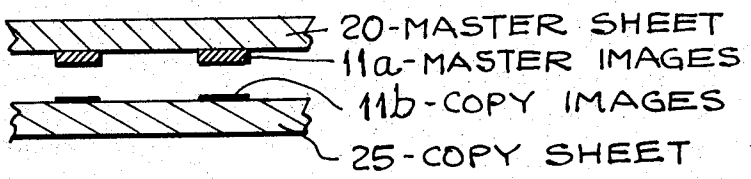


Fig. 4



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The present invention relates to a novel dry system for preparing duplicate copies from an imaged master sheet, and to the novel pressure-sensitive transfer sheets for preparing such master sheets.

The duplicating system of the present invention is adapted for the production of a limited number of copies, up to about 25 or so, or original subject matter pressure-applied to a master sheet, and is not intended to compete with multi-copy systems such as hectography where several hundred copies can be produced from imaged master sheets.

The conventional hectograph process enjoys widespread commercial success but is too expensive and inconvenient for use in certain applications where only a small number of duplicate copies are required and only at spaced intervals. The spirit duplicating machine is rather expensive and the dye solvents used therein are volatile. If such a machine is used only occasionally and only for the production of a few copies each time, then the cost per copy is high. Also the volatile dye solvent evaporates over a period of time so that the supply must be checked and refilled frequently.

Other limited number of dry copy systems have been proposed but these also have disadvantages which restrict their use to certain limited fields of application where the quality of the copy produced is not critical. According to these systems, a conventional hectograph master sheet is typed and then pressed against copy sheets to transfer dyestuff to each copy sheet. In all of these processes the images typed onto the master sheet are conventional hectograph images containing a major amount of undissolved hectograph dyestuff in a frangible binder material.

According to one of these processes the copy sheets pressed against the master images are ordinary paper sheets and the images formed on each sheet are merely portions of the master images which are pressure-transferred to the copy sheets and contain undissolved dyestuff and frangible binder material. Such images are soft and easily spreadable or smearable upon contact with the hands and are exceptionally dirty to the touch due to the presence of the undissolved dyestuff which has a high staining power.

According to other of these processes, the copy sheets carry a solid coating which contains a material having a dissolving power for the hectograph dyestuff. Unless the dye solvent requires heat activation, the formed copies are of very poor quality due to a broadening of the duplicate images as solvation continues with time. On the other hand, heat-activatable dye solvents require the use of a heat source in addition to the higher cost of solvent coated copy sheets as compared to conventional uncoated hectograph copy papers.

With all of these considerations in mind, it is the main object of the present invention to provide a duplicating process and duplicating materials which permit the user to make a limited number of high quality duplicate copies from a typed master sheet onto conventional untreated copy papers and in the absence of volatile dye solvents and expensive duplicating apparatus.

It is another object of this invention to provide a duplicating process which does not require the use of undissolved hectograph dyestuff and which therefore avoids the disadvantages thereof.

These and other objects and advantages of the present invention will be clear to those skilled in the art in the light of the following description, including the drawings, in which:

FIGS. 1, 2 and 3 are diagrammatic cross-sections, to enlarged scales, of transfer sheets and master sheets according to various embodiments of the present invention. In each case the sheets are shown in spaced relationship, for purposes of illustration, and illustrate the images formed on the face of the master sheet as a result of applying imaging pressure against the back of the master sheet while it is in intimate surface contact with the transfer layer of the transfer sheet.

FIG. 4 is a diagrammatic cross-section, to an enlarged scale, of the master sheet of FIG. 1 together with a copy sheet imaged therewith. The sheets are shown in spaced relationship, for purposes of illustration, and the duplicate images on the copy sheet were formed by pressing the master sheet against the copy sheet surface while the master images were in intimate surface contact therewith.

According to the present invention, a pressure-sensitive transfer sheet is provided which carries a pressure-transferable or frangible layer capable of being transferred in image form to a master sheet under the effects of localized imaging pressure and containing a supply of pressure-exudable ink capable of being metered to a succession of copy sheets under the effects of overall pressure.

According to one embodiment of this invention, the transfer layer is one which is so formulated and applied as to be frangible per se. FIG. 1 of the drawing illustrates such a transfer sheet having a foundation sheet **10**, such as paper or plastic film, carrying a pressure-transferable imaging layer **11**. When the transfer layer is faced against a master sheet **20** and typing pressure is applied against the back of the master sheet, layer **11** transfers to the face of the master sheet in the impressed areas in the form of mirror-reverse images **11***a*.

When the imaged master sheet is superposed with a porous copy sheet **25** such as an ordinary sheet of paper, and an overall pressure is applied against the back of the master sheet, images **11***a* exude a liquid non-drying ink which is absorbed by the surface of the copy sheet to form colored images **11***b* thereon which are direct-reading duplicates of the master images, as illustrated by FIG. 4.

The present invention is based upon the requirement that the imaging layer of the transfer sheet must have the apparently contradictory properties of being transferable from the transfer sheet under the effects of imaging pressure and being nontransferable from the master sheet under the effects of overall pressure. Once the images are formed on the master sheet they must be capable of exuding liquid non-drying ink to a succession of copy sheets under the effects of overall pressure rather than transferring in mass to the first copy sheet against which it is pressed. While these properties may appear to be contradictory thay are not, because of the fact that the types of pressure involve are quite different. Many resinous compositions are quite brittle as relates to high localized pressure but are simultaneously quite flexible and rubbery under the effects of lesser or overall pressures. Thus it has been found possible to produce resinous compositions, comprising resinous binder material containing liquid non-drying ink, which are transferable under the effects of localized imaging pressure but which exude liquid ink under the effects of lesser overall pressure or pressure applied simultaneously against the entire back of the transfer sheet or a large portion thereof.

According to other embodiments of the present invention, as illustrated by FIGS. 2 and 3, it is possible to use

imaging layers which have reduced frangibility and increased squeeze-out action by supplementing the poor frangibility of the imaging layer.

According to FIG. 2, this is accomplished by providing the transfer sheet foundation **10** with an imaging layer **12** carrying a supercoating **13**. The imaging layer may be one which either has poor frangibility per se, so as to be difficulty transferable per se to the master sheet, or which has greater frangibility than desired, so as to require some means to anchor it to the master sheet to prevent offset during the duplicating step. The supercoating **13** is a coating having good frangibility and having good adhesion properties for both the imaging layer and the master sheet. Under the effects of imaging pressure the supercoating transfers sharply and cleanly to the master sheet shown as images **13***a* and carries with it corresponding areas of the imaging layer shown as images **12***a*. The supercoating bonds to the surface of the master sheet and forms a strong anchor for the transferred portions of the imaging layer so that images **12***a* remain bonded to the master sheet and function to exude non-drying ink under the effects of the duplicating pressure.

Of course it should be understood that where the cost of coated master sheets is not objectionable, it is possible for the supercoating **13** to be present as a receptor coating on the master sheet rather than as a supercoating on the imaging layer. The affinity of the coating on the master sheet for the imaging layer causes the imaging layer to bond and transfer sharply and cleanly thereto in areas subjected to imaging pressure.

In still another embodiment, as shown by FIG. 3 of the drawing, the imaging layer **15** may be provided with a release layer **14** between it and paper foundation sheet **10**. This embodiment is of importance in cases where the imaging layer has poor frangibility per se and tends to form such a strong bond to a porous paper foundation that it resists transfer under the effects imaging pressure. In such cases the frangibility is improved by reducing the degree of bond permitted between the imaging layer. This is accomplished by either using a smooth plastic foundation sheet or by the embodiment shown in FIG. 3 in which a paper foundation is first coated with a smooth release layer based mainly or entirely upon a plastic binder material such as a vinyl resin.

The following examples are given as illustrations of compositions and methods suitable for the production of transfer sheets according to several of the embodiments of the present invention and should not be considered limitative.

Example 1

This example illustrates the preparation of a transfer sheet of the type illustrated by FIG. 1 of the drawing in which the imaging layer is one which has good frangibility per se.

Ingredients:	Parts by weight
Vinyl chloride-vinyl acetate copolymer (Vinylite VYHH)	7.7
Mineral oil	6.8
Lanolin	11.0
Lecithin	0.1
Alkali blue	3.8
Toned carbon black	5.2
Toluol	26.0
Ethyl acetate	22.5
Methyl ethyl ketone	16.9
Water	3.0

The above ingredients were mixed to a coatable consistency and applied to a thin paper foundation in conventional manner. The dried layer is transferable under the effects of imaging pressure but functions in a squeeze-out manner under the effects of an evenly-applied overall pressure to liberate oil and pigment as illustrated by FIGS. 1 and 4 of the drawing.

Example 2

This example illustrates the preparation of a transfer sheet of the type illustrated by FIG. 2 of the drawing in which the imaging layer is one which has poor frangibility per se and has its frangibility improved by means of a frangible supercoating.

Ingredients:	Parts by weight
Polyvinyl butyral (Vinylite XYSG)	10.0
Mineral oil	8.4
Lanolin	17.2
Alkali blue	3.6
Toned carbon black	5.8
Toluol	30.0
Ethyl acetate	85.0

The above ingredients were mixed to a coatable consistency and applied to a thin polyethylene terephthalate polyester film in conventional manner. After drying by evaporating the volatile solvents, the imaging layer has applied thereover a thin supercoating which has good frangibility and which is intimately bonded to the imaging layer. One manner of accomplishing this bonding is by employing a resinous supercoating composition containing a voltaile solvent which is at least a partial solvent for the vinyl resin of the imaging layer. The following composition is illustrative:

Ingredients:	Parts by weight
Ethyl cellulose	5.0
Methyl alcohol	50.0
Water	4.0

The supercoating is applied to the surface of the imaging layer and dried by evaporation of the solvents. The methyl alcohol softens the polyvinyl butyral and permits the supercoating to integrate with and bond to the imaging layer. The water serves to end good frangibility to the supercoating which, under the effects of imaging pressure, carries corresponding portions of the imaging layer to the master sheet as shown by FIG. 2.

Example 3

This example illustrates the preparation of a transfer sheet of the type illustrated by FIG. 3 of the drawing in which the layer of imaging composition is one which is not sufficiently frangible to transfer from a paper foundation and which is provided with a smooth plastic release layer from which it is readily transferable.

Ingredients:	Parts by weight
Vinyl chloride-vinyl acetate copolymer (Vinylite VYHH)	7.5
Polystyrene	3.5
Mineral oil	9.0
Lanolin	15.0
Toned carbon black	6.0
Alkali blue	4.0
Ethyl acetate	40.0
Toluol	25.0

The above ingredients were mixed to a coatable consistency and applied as a thin layer to the surface of a plastic release layer on a paper foundation and dried by evaporation of the volatile solvents. The foundation consists of a thin paper having on one surface a thin, smooth, homogeneous layer of polyvinyl chloride. The polyvinyl chloride layer may be applied as a coating by means of volatile solvent or may be bonded to the paper as a preformed film.

Since the polyvinyl chloride is not soluble in the volatile solvents used to apply the imaging layer, the imaging layer forms only a weak bond thereto and is transferable therefrom in the form of images under the effects of imaging pressure.

This same result may be obtained through the use of a clear plastic film foundation provided that the film is not soluble in the coating solvents of the imaging layer

and provided that the imaging layer has some degree of fragibility per se.

The master sheets imaged according to the present invention, such as those shown in FIGS. 1, 2 and 3, are used to produce duplicate copies in any number of conventional pressure devices. A conventional hectograph duplicating machine may be used without the usual spirit solvent provided that the pressure between the master sheet, mounted on the rotating drum, and the copy sheets is increased so that exudation of the ink to the copy sheets results. Similarly a Thermo-Fax or the like machine may be used provided that it has pressure rollers to compress the master sheet and copy sheet to the extent necessary to cause ink exudation. In such machines the infrared radiation source may be retained since heating of the master images tends to render the ink more fluid and thus more easily exudable under the applied pressure.

Other conventional pressure devices such as a flat press which applies overall pressure or a knife edge device which applies line pressure may be used.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. A duplicating process comprising the steps of:
(a) superposing a master sheet in surface contact with the imaging layer on a flexible transfer sheet foundation, said layer being mass-transferable under the effect of localized impact pressure and comprising a resinous binder material having dispersed therein an ink which is liquid at ordinary room temperatures and comprises coloring matter and an oil, the ink being incompatible with the said binder material and being exudable therefrom at ordinary room temperatures under the effects of overall pressure of lower magnitude than said localized impact pressure;
(b) applying an impact in the form of localized imaging pressure against the superposed sheets to cause the layer comprising binder material and dispersed ink to transfer in image form to the surface of the master sheet;
(c) superposing the imaged surface of the master sheet with the surface of a copy sheet; and
(d) applying an overall pressure of lower magnitude than said localized impact pressure by compressing the images between the master and copy sheets to cause a portion of the said ink to flow from the binder material to the surface of the copy sheet and form mirror-reverse duplicates of the master images.

2. The process according to claim 1 in which the imaged master sheet is superposed and compressed with a succession of copy sheets to form several copies of the master images.

3. The process according to claim 1 in which the impact pressure is applied by means of a type bar.

4. The process according to claim 1 in which the overall pressure is a line pressure applied by compressing the sheets between rollers.

5. The process according to claim 1 in which the overall pressure is a coextensive pressure applied by compressing the sheets between pressure plates.

6. The process according to claim 1 in which the binder material comprises vinyl resin.

7. The process according to claim 1 in which the imaging layer is one which is not impact-transferable per se but which is rendered impact-transferable by means of a smooth non-transferable plastic coating which is present on the transfer sheet between the foundation and the imaging layer and functions to release the imaging layer under the effects of impact pressure.

8. A duplicating process comprising the steps of:
(a) superposing a master sheet and an imaging layer present on a flexible transfer sheet foundation and having a supercoating of film-forming binder material over said imaging layer which has a good affinity for the surface of the master sheet, the imaging layer being non-transferable per se under the effects of localized impact pressure but having greater affinity for said supercoating than for said transfer sheet foundation and comprising a resinous binder material having dispersed therein an ink which is liquid at ordinary room temperatures and which comprises coloring matter and oil, the ink being incompatible with the said binder material and being exudable therefrom at ordinary room temperatures under the effects of overall pressure of lower magnitude than said localized impact pressure;
(b) applying an impact in the form of localized imaging pressure against the superposed elements to cause the supercoating to bond the imaging layer to the surface of the master sheet and to cause the imaging layer and supercoating to transfer in image form to the surface of the master sheet upon separation of the sheets;
(c) superposing the imaged surface of the master sheet with the surface of a copy sheet; and
(d) applying an overall pressure of lower magnitude than said localized impact pressure by compressing the images between the master and copy sheets to cause a portion of the said ink to flow from the binder material to the surface of the copy sheet and form mirror-reverse duplicates of the master images.

9. A duplicating process comprising the steps of:
(a) superposing a master sheet having thereon a receptor layer of film-forming binder material and an imaging layer present on a flexible transfer sheet foundation, the imaging layer being non-transferable per se under the effects of localized impact pressure but having greater affinity for the receptor layer on the master sheet than for said transfer sheet foundation, said imaging layer comprising a resinous binder material having dispersed therein an ink which is liquid at ordinary room temperatures and which comprises coloring matter and oil, the ink being incompatible with the said binder material and being exudable therefrom at ordinary room temperatures under the effects of overall pressure of lower magnitude than said localized impact pressure;
(b) applying an impact in the form of localized imaging pressure against the superposed elements to cause the imaging layer to bond to the surface of the receptor layer and to transfer thereto in image form upon separation of the sheets;
(c) superposing the imaged surface of the master sheet with the surface of a copy sheet; and
(d) applying an overall pressure of lower magnitude than said localized impact pressure by compressing the images between the master and copy sheets to cause a portion of the said ink to flow from the binder material to the surface of the copy sheet and form mirror-reverse duplicates of the master images.

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