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(54) Method for restoring works of art

(57) An analysis of the work of art and its state of conservation is made. This includes the characterization of damage, simulation of missing parts and a corresponding survey of details involving the construction of graphic aids, damage maps and/or black and white photographs.

Computer science techniques are used in this analysis.

Later the restored images are printed onto transfer medium and applied to the work of art in order to reintegrate the missing and/or damaged areas.

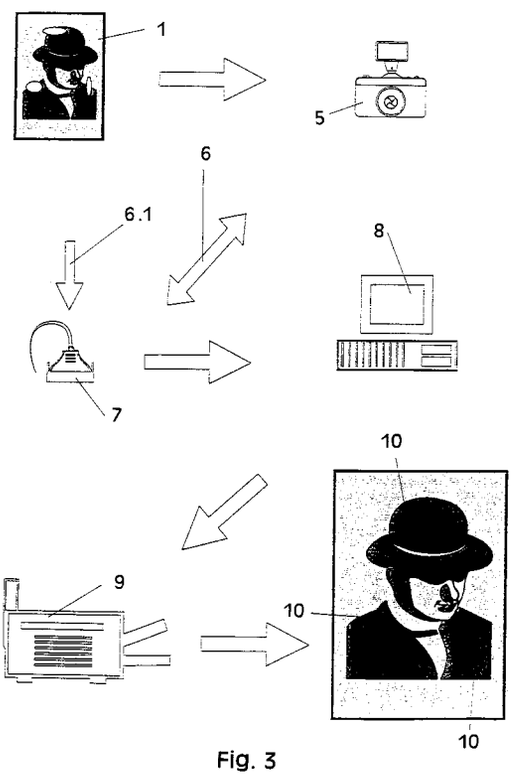

Fig. 3

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The sector of the technique involved in this patent is that of making new parts of works of art, replacing the lost or damaged pieces which initially formed part of the work.

Description of the prior state of the art.

The classic system that has been made use of in studies prior to the actual restoration of artistic works is, though diverse, widely known. Nevertheless, in this area there has previously been no research into the possibilities offered by the field of computer technology. In this work, as a result of a critical review of a number of commercial programmes for graphic design and photographic retouching available on the market, the use of some of these techniques is established in the sphere of this work, discarding applications which were offered by the programmes, but had no application in the later restoration work. The use of certain complementary techniques in the sphere of this work is described .

The aim of this invention is to provide a method for restoring works of art which, in several stages, covers the analysis of the damaged parts, the relationship of the setting of the work with these parts, the analysis of colouring and the morphological analysis of the parts missing; later on this includes the making of a piece with highly similar characteristics which becomes appreciable through a detailed analysis of the work and which nevertheless possesses the chromatic and formal techniques of the rest of the item to be restored, and a method for reintegrating the missing pieces of a work of art by means of a computerized process and its application through transfer.

In order to make the explanation that follows clearer, six sheets of drawings are enclosed, representing the essence of this invention in twelve figures.

Figure 1 shows a graphic example of a work of art with parts missing.

Figure 2 shows a schematic view of the damage obtained by computer.

Figure 3 shows a schematic view of the realization process.

Figure 4 shows the profile of the strata of the paper.

Figure 5 shows another profile of the strata of the paper.

Figure 6 shows the form of application.

Figures 7, 8, 9, 10, 11 and 12 show different examples of computerized reintegrations.

Figure 13 shows a view of the work of art that has to be restored.

Figure 14 shows an image which represents the computer treatment.

Figure 15 shows a view of the restored work.

In said figures 1 represents the pictorial work, 2 being the parts missing, and 3 an example of a background mass. 4 is a different chromatic background, 5 the photographed item, and 6 the process relating to photography. 6.1 indicates the process with regard to the original, 7 being the scanning of the photography 6, or of the original 6.1, and 8 the computer treatment, 9 being the printing of the computer file obtained, and 10 the application to the work, with 11 being the profile of the thermic transfer paper strata corresponding to the paper support, 12 being the profile of the paper strata for the resin part, and 13 the profile of strata of the printed paper, and particularly the resin with chromatism. 14 is the hot spatula for applying the thermic transfer paper. Figures 7, 8, 9, and 10 show different types of reintegration treatment, so that each one of these, containing a similar scheme, can adapt to the style of the work, properly matching the style of the artist who created this, and in the backgrounds, for example 3 and 4. 15 is the work, a pictorial item for example, 16 a well-defined missing area and 17 another well-defined missing spot. 18 shows the computer, and 19 the reintegration of the missing part 16, 20 being the reintegration of the missing part 17.

Explanation of one form of embodiment.

The methodology to be followed in this kind of treatment takes the original work as starting point. From thereon there are:

- Sequenced analysis of the painting 1 based on photographs, shown as 5, made in different light and scale techniques.
- Digitalization of the same photographic images 6 and/or of the pictorial work 6.1.
- Computerized treatment of the images 8.

  From the results stemming from this stage of the research the first results are obtained, such as:
  - Making of damage maps.
  - Making of graphics
  - Accentuation of parts missing and damaged parts.
  - Black and white photographic documentation of the different problems raised by the work before starting restoration work.
  - Viewing of the work by microdetails.

In some cases simulations were made on the chromatic reintegration monitor screen, in order to be able to preview the final finish of the work without actually applying any treatment to the same. This enables us to determine the type of reintegration required and optimize the results.

There is a great variety of resources available for previewing reintegration, in accordance with figures 7 to 12:

- choice of the crosshatching style, pointillism or neutral integration
- length of the stroke
- size of the brush
- number of brushes
- spacing
- colour variation

...long with other options used alongside the above resources, such as for example:

- emphasis
- merging colours
- softening
- contrasting
- creating the appearance of canvas, gesso or others.

The great help which can be provided by these computer applications is of a highly varied nature, bearing in mind too that no type of treatment is applied to the real work, this being a visual simulation, and all the information being up to now reduced to a computer file.

From this stage in the research we wish to put forward in this statement the possibility of an actual computer assisted chromatic reintegration, that is, a support which contains the colour with the basic characteristic of being able to transfer the reintegration seen in the monitor to the work of art.

The technique used is based on the juxtaposition of the computerized chromatic data previously obtained by means of printing a computer file 8 on a base of special paper which can be applied by heat to any support. Said support is known as "Thermic transfer paper".

The thermic transfer paper 11 is a material with a preparation of synthetic resin 12 which allows graphic printing 13. This graphic information is the computerized artistic analysis mentioned above and does not come out on a conventional printer, but on a support which, after being applied by thermic techniques harmless for the rest of the original work, provides as a result a piece of restoration which complies with the classic criteria of reversibility, stability, etc..

The first trials are made for the study of the paper, by compiling samples of already marketed types. The papers are applied on different preparations of more general use, for example:

- calcium carbonate plus rabbit skin glue
- lime and sand mix
- lime and marble dust mix
- industrial gesso

Assessing of its characteristics as regards:

- shine
- adhesion
- need for high temperature
- porosity
- stability
- yellowing
- flexibility
- reversibility

with the least suitable ones being rejected and concentrating the study on just one which complies with the essential requisites for application.

The form of chromatic printing for the thermic transfer papers is done by means of a colour laser printer. These have a high resolution of the image, which go up to 1.200 p.p.p.. The choice of this sort of printing is limited by the characteristics themselves of both the paper used and by the specific techniques of the actual laser operation.

When printing on a printer defined as "ink-jet" the same behaviour is not observed. The ink is liquid and cold, and furthermore, the preparation of the paper repels the ink, so that this is not suitable a priori for this kind of paper. In spite of this the resin layer has been isolated so that this can be converted into a perfect reception support for the ink, thus giving rise to a satisfactory later transfer. Nevertheless the image resolution will have less quality and less stability, due to the characteristics of the ink. In spite of the fact that an ink-jet printer is inferior to a laser printer, the human eye cannot distinguish in the choice of the printouts, but studies of contrasted optical techniques have shown that the most favourable one is the laser printout, not because of its actual resolution, but due to the stability of its final chromatic lamina.

The inks used in ink-jet printers are considerably affected in short periods of time when exposed to light, in an average of 50 hours direct exposure.

One of the problems solved is the chromatic change which can be brought about in the stages of the image treatment following. These are produced from the time the image is digitalized until it comes out on paper.

An adjustment of the different devices to be used is required, calibrating all the equipment with the same parameters. Calibration trials are carried out until a pure colour, as input, is correctly shown on the screen, and in turn with the same values in the measurement of the internal colorimeter of the computer. The output through the printer obviously has to have the same values chromatically after its analysis by a colorimeter.

Nevertheless, there is a margin of error in which a chromatic difference is not observed visually but can in fact be detected with a colorimeter.

If all the equipment's mechanisms are not consistent in their measurements, the correlation of the data will be incorrect and the computer processed reintegration will thus not be valid.

If the image is input to the computer by photography, one must also bear in mind the chromatic change stemming from the development processes and techniques used in the photo labora-

tory, which makes it necessary to carry out controlled regulation by using the informatic values which adapt the chromatic scale of the photographic image to a real scale, obviously considering this to be that of the pictorial work.

One example of the application. (Religious image, no known author, 17th century).

As was established above, the working method used in this system requires knowledge of both computer science and restoration, and, as in any classic restoration process, all the ethical and theoretical principles of restoring works of art have to be borne in mind when choosing a method for computer processed reintegration.

To put into practice all the concepts put forward a computer processed reintegration treatment was undertaken as an example.

Due to the state the painting was in it was necessary to take the following steps to restore this:

- protection of the work
- remounting
- cleaning
- application of grafts
- coating

After reaching this point chromatic reintegration was carried out by computer viewing of the zone to be reintegrated. Two techniques were used:
a- Pixel by pixel.
b. By adjacent similarity,
thus previewing different types of reintegration and choosing the one that seemed most suitable.

After printing this computer file on thermic transfer paper on a colour laser printer, the area printed was fitted exactly to the gap in the picture. A hot spatula was used to fix this on. After reaching the required temperature the paper support of the resin was removed, leaving only the part reconstructed in the gap.

In this case manual retouching had to be done on the small missing parts.

A layer of varnish was finally applied to the work as final protection.

The conclusions which can be obtained after completing this work are as follows:

1. A new restoration technique based on the optically accurate application of real (not subjective) chromatisms in damaged pictorial areas.
2. A technique that complies with the requisites demanded in traditional restoration work.
3. Less interference with the pictorial work than in traditional restoration processes, since all the chromatic trials are carried out on a computer and thus avoid repeated manipulation of the damaged work.
4. Use is made of the advantages of computer technology, such as speed, great filing capacity, variation and greater accuracy, amongst others, in such a highly manual field of work as restoration has been until now.
5. The treatment of images enables a study of the initial state of the works to be made, with greater accuracy in the results, as well as being a great help later on in carrying out different tasks, editing reports, etc.. Furthermore, the application of computer processed reintegration enables the following possibilities:
   - Greater quality
   - High resolution
   - Computer filed documentation
   - Chance to retouch
   - Exact definition of the parts missing
   - A posteriori checking of reintegration
   - Unification of the reintegration criteria according to types of gaps.

This method means that all the reintegration of a work can be done identically without the distinction involved in manual treatments.

Explanation of a form of embodiment according to the computerized process:

The image 15 is input to the computer by any of the methods presently existing: photographs, scans of the original, video or others.

Realization of reintegration using computer technology methods 18, choosing the reintegration variants which are thought most suitable according to personal criteria and the computer programme used.

Reintegration carried out with the computerized method will be applied in a medium which enables its transfer to the work.

Printing through this new procedure can be done in highly varied and different techniques, both pictorial, printing, photographic, laser etc., which depends on the transfer medium used, there being a broad range of these on the market, as well as being able to be done manually if the restorer considers this suitable or so prefers.

The application of this method to the work will depend on the means used, since due to the great variety existing, its fixing will depend on the nature of the same, the following thus being examples: damp, pressure and alcohol, amongst others.

In the prior studies, as tasks to be done by computer processes, we could mention:

- damage maps
- graphics
- details
- accentuation of parts missing
- black and white images
- others

The final finish of a work can also be previewed by means of chromatic reintegration simulation techniques through the following methods:

- pixel to pixel
- adjacent similarity

- per zones
- others

choosing in each zone or work the most fitting reintegration system according to the restorer's criteria:

- rigantino
- pointillism
- neutral integration
- illusionist

and with a great variety of options such as the size of the line or point, thickness, colour variety, spacing of the stroke, etc..

These options can be modified and improved with other tools such as profiling, emphasizing, evening, etc.

Computer processes furthermore offer the possibility to obtain chromatic measurement of the reintegration work carried out.

Until now the use of computers has facilitated and improved work or studies as well as offering the possibility to preview restorations.

From the preview stage the means for transferring the image viewed on the computer to the real work are analyzed and studied.

By "means for transferring" we understand any support which enables the printout made on the same to another medium which supports this, being in this case in particular any kind of work of art.

The methodology is carried out through certain stages, namely:

- input of the image into the computer, through existing methods. These can range from scanning the original work, scanning a photograph, taking images with a video camera, images on diskettes, etc.. This stage has to be carried out with sufficient assurance that the chromatism introduced in the computer is the original one or as accurate as possible. Depending on each one of the means there is a mathematical error which is tolerable for the system to be valid.
- selection of the zone to be reintegrated for its execution
- selection of the reintegration system
- execution of the same
- printing of the reintegration viewed on the transfer medium chosen
- application of the transfer onto the work of art. The form of application will vary depending on the system used, and could be through humidity, pressure, alcohol and others.
- elimination of the support holding the computerized reintegration, if there were any.
- protection of the chromatic reintegration if this were considered suitable.

This new method of reintegration is applicable in any kind of work of art, whatever its physical characteristics may be.

Claims

1. Method for restoring works of art, characterized in that this involves six main stages (A, to F) which include the following processes:

A - A prior study of the work, including:

a). Establishing of the work's state of conservation

b). Characterization of damage (2)

c). Accentuation of parts missing.

d). Realization of graphic aids, which include:

- Sequenced analysis of the painting 1 based on photographs (5), made in different light and scale techniques.
- Digitalization of the same photographic images (6) and/or of the pictorial work (6.1).
- Computerized treatment of the images (8).

e). Making of damage maps (Fig. 2).

f). Black and white photographs

B - Viewing of the work by microdetails.

C - Simulation of chromatic reintegration, for which purposes the following resources are used:

C1. As regards structure (Figs. 7 to 12), namely:

- choice of the crosshatching style, pointillism or neutral integration
- length of the stroke
- size of the brush
- number of brushes
- spacing
- colour variation

C2. As regards realization (Figs. 7 to 12)

- emphasis
- merging colours
- softening
- contrasting
- producing the appearance of bases, canvas, gesso or others.

C3. Preparation of a support, (11) made of thermic transfer paper (11), on which application (12) of preparations such as:

- calcium carbonate plus rabbit skin glue
- lime and sand mix
- lime and marble dust mix
- industrial gesso

C4. High resolution laser or ink-jet printing (9, 13) consisting of the following operations:

- calibration of the equipment with the same parameters

- correction of chromatisms stemming from the photographic development

D - Direct execution of reintegration, consisting of:

a. protection of the work
b. remounting if required.
c. cleaning
d. application of grafts and coating
- realization pixel by pixel
- realization through adjacent similarity

e. application by means of hot spatula (14)

E- Elimination of the thermic transfer paper.

F- Manual retouching, if required, and varnishing.

2. Method for restoring works of art, particularly for pictorial works of art, according to claim 1, characterized in that the realization of graphics is done by means of:

- inputting the image to the computer, by existing means: such as scanning the original work, scanning of a photograph, taking of images with video camera, images on diskettes, etc., determining the original chromatism by means of mathematical calculus, with tolerable errors as a function of each one of the media used.
- selection of the zone to be reintegrated for execution of the same.
- choice of the reintegration system
- execution of the same
- printing of the reintegration viewed on the chosen transfer medium
- application of the transfer on the work of art. The type of application is variable depending on the system used, and could for example be damp, pressure, alcohol and others.
- elimination of the support which holds the computerized reintegration if there were any.
- protection of the chromatic reintegration if this is considered to be required.

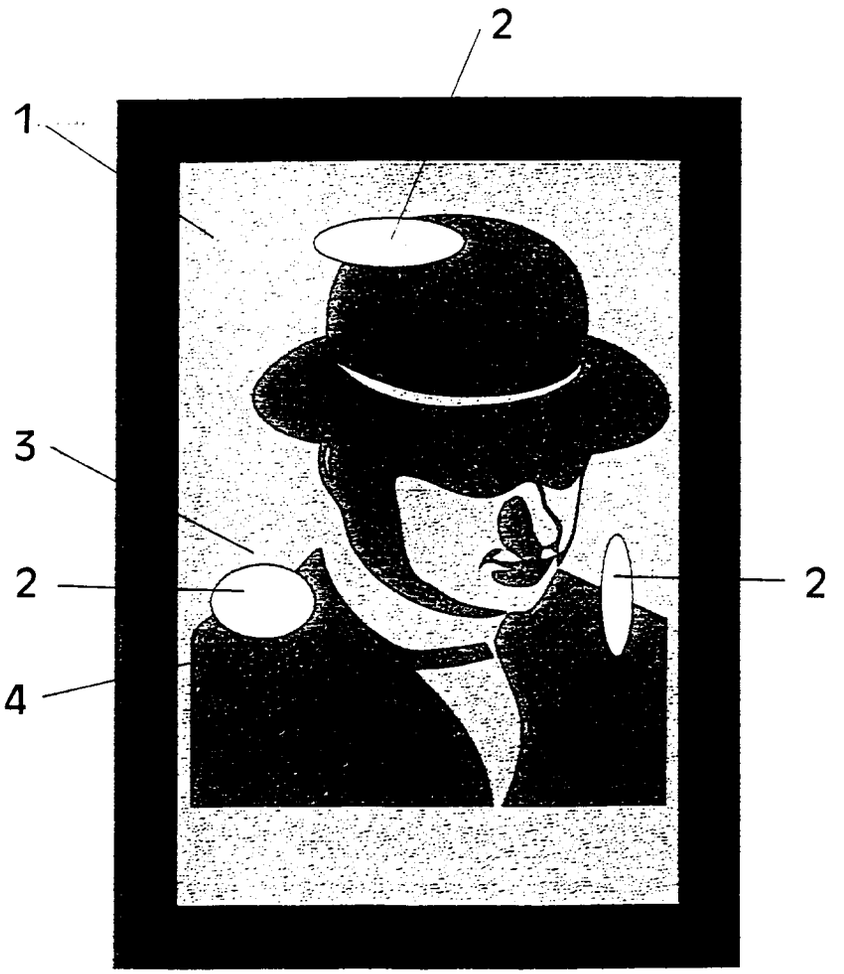


Fig. 1

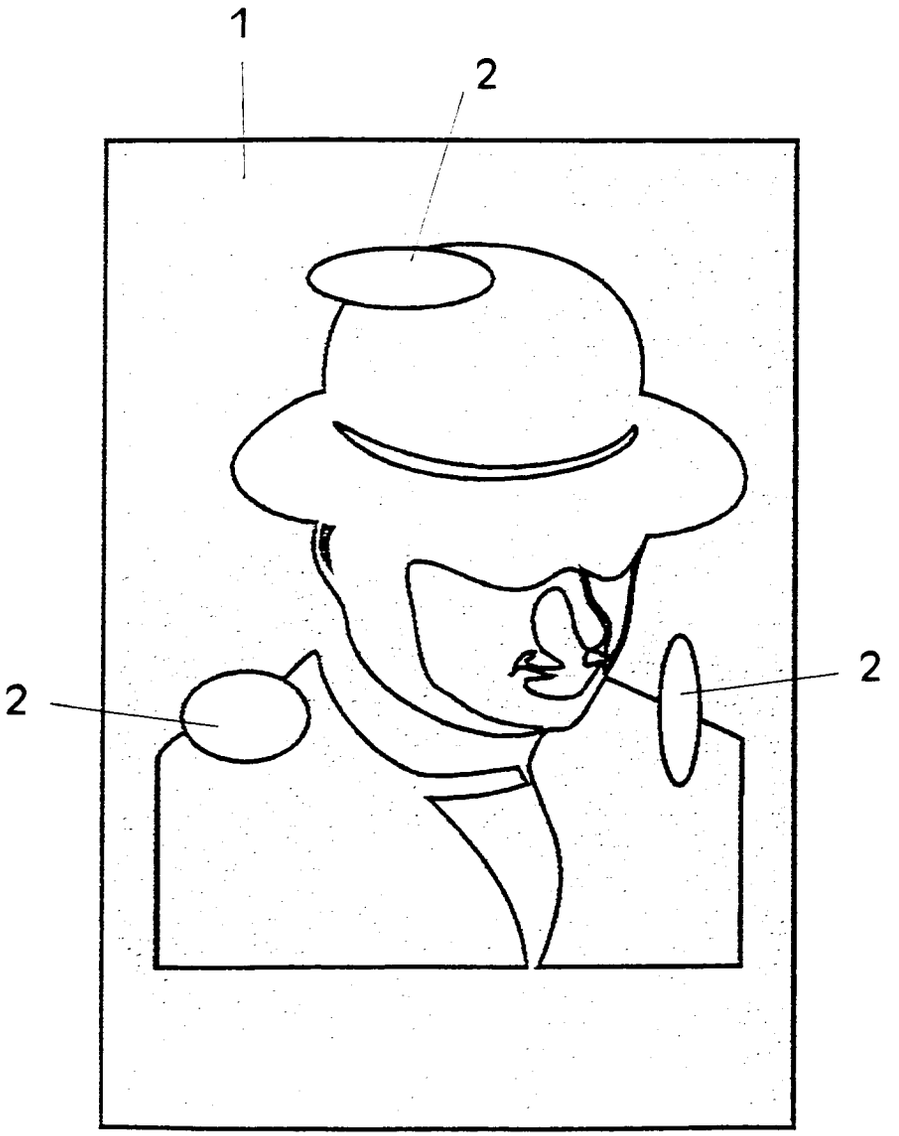


Fig. 2

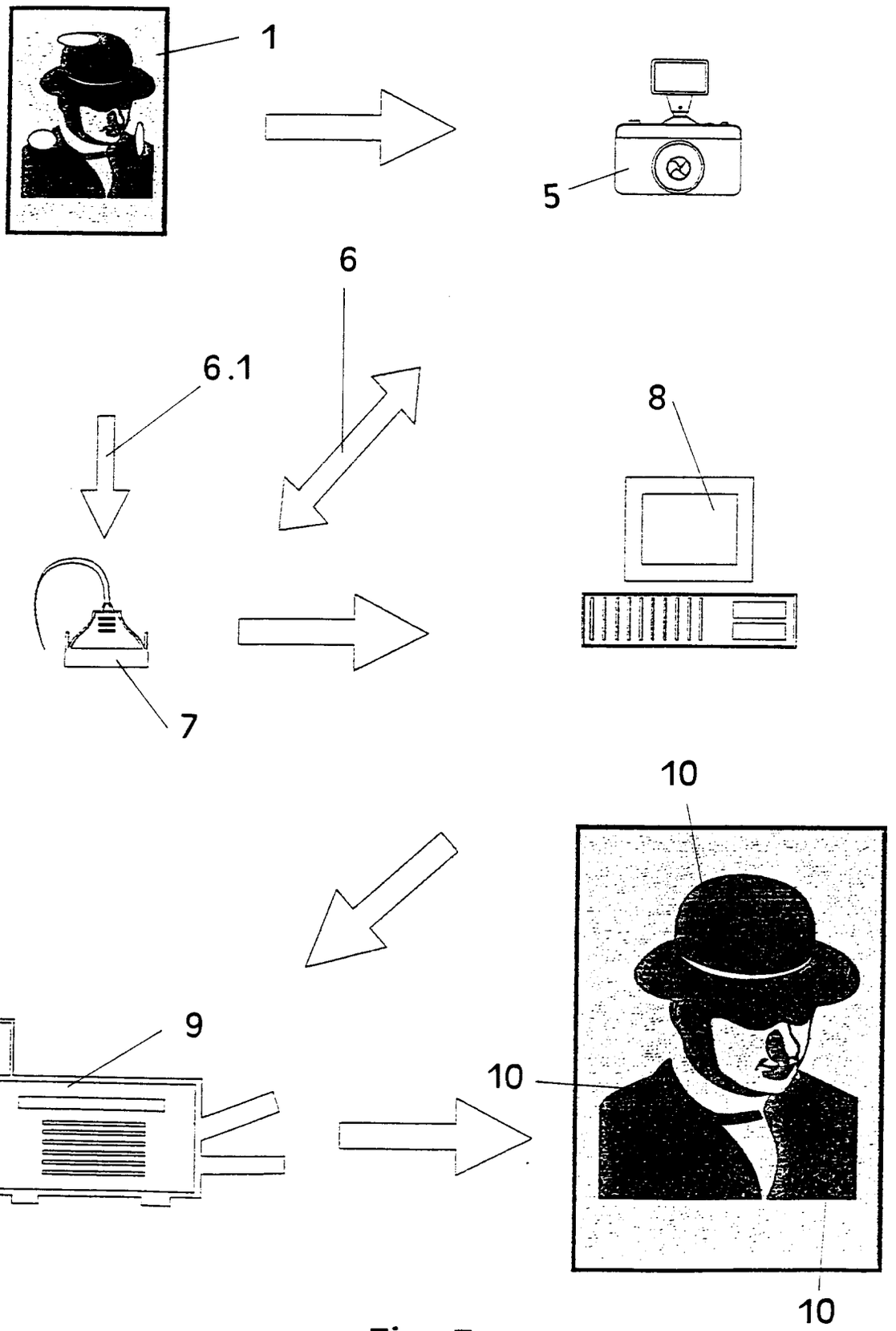


Fig. 3

Fig. 4

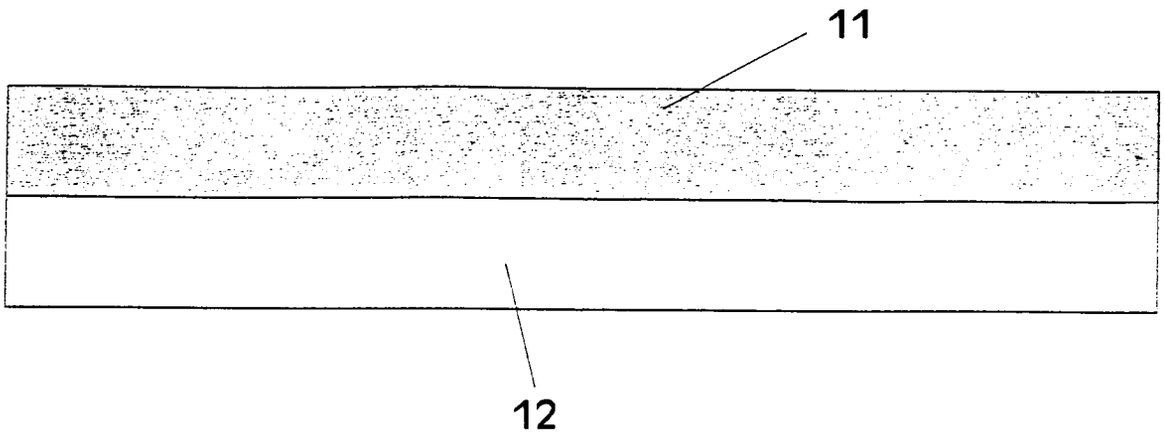
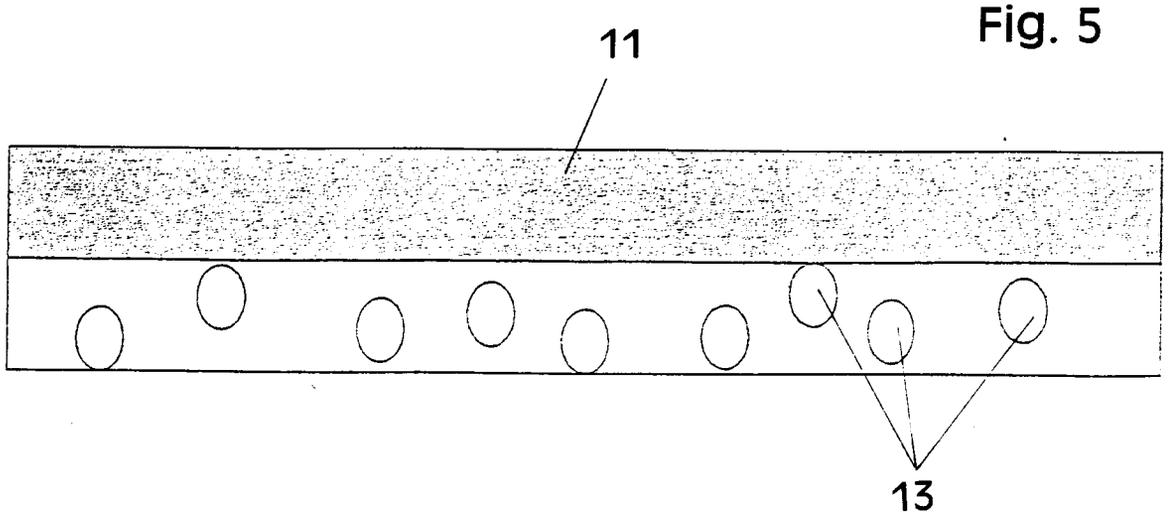


Fig. 5



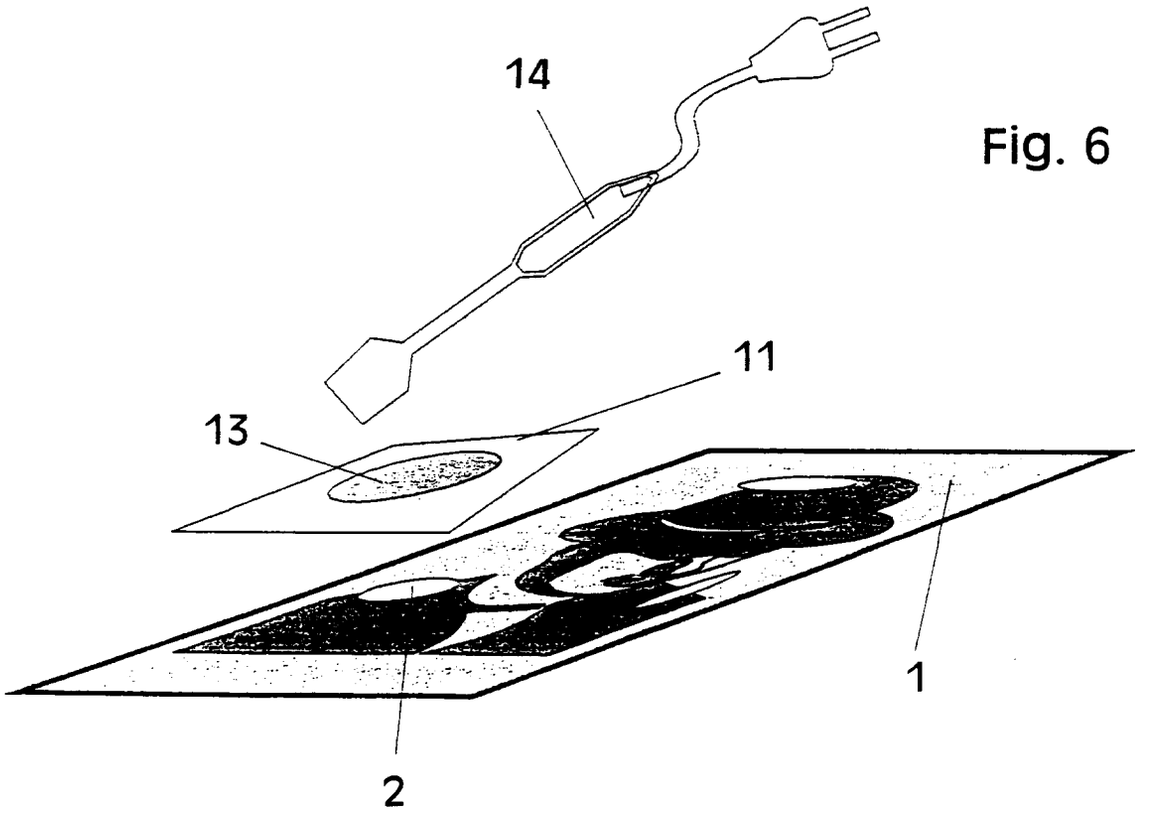


Fig. 6

Fig. 7

Fig. 8

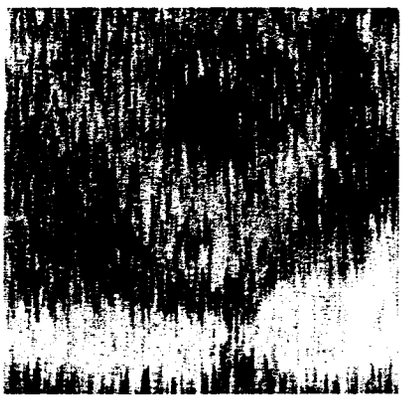


Fig. 9

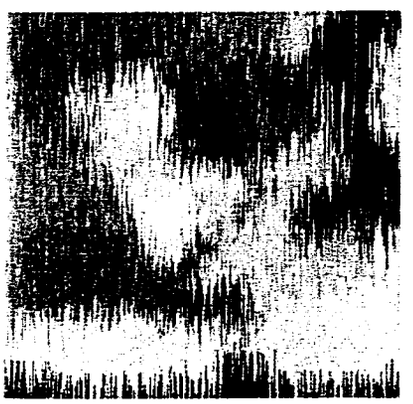
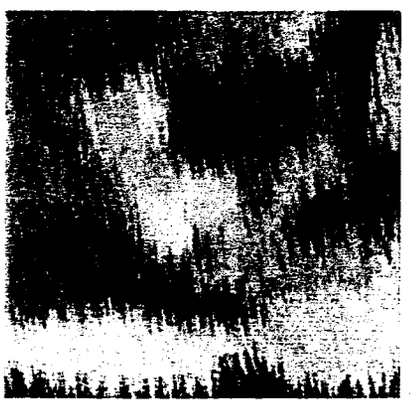
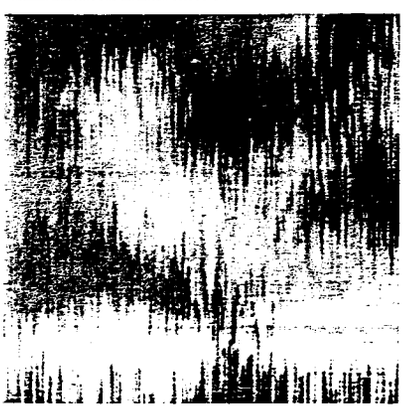


Fig. 10





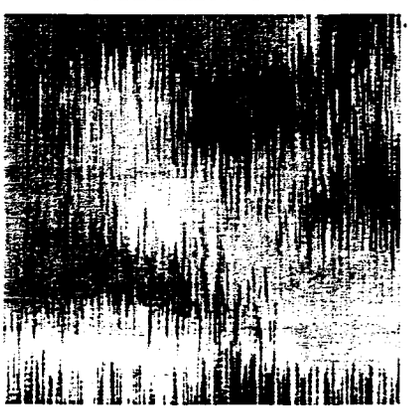


Fig. 11

Fig. 12

Fig. 13

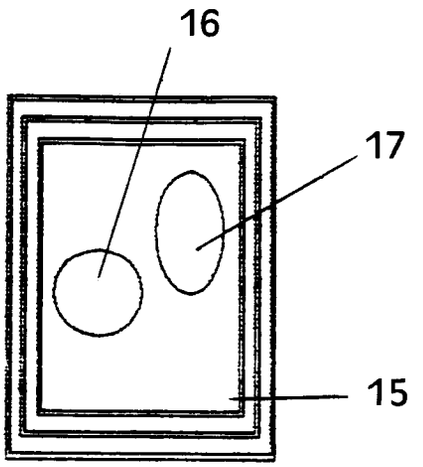


Fig. 14

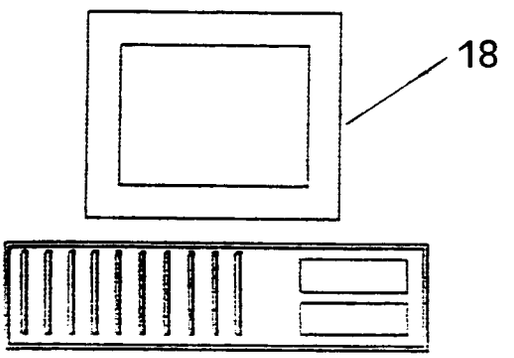
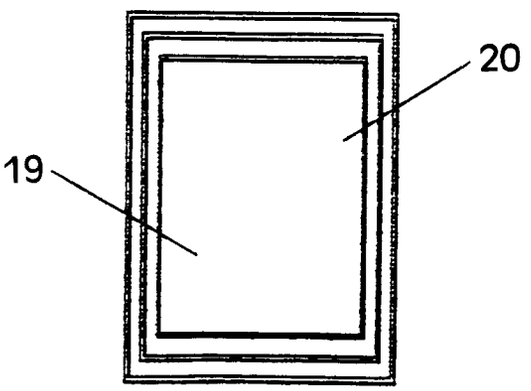


Fig. 15



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EUROPEAN SEARCH REPORT

Application Number
EP 95 50 0081

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 576 099 (RESCURA BV) * column 1, line 1 - column 6, line 15 *	1,2	B44D7/00 B44F11/02 B44C1/17
A	IEEE SPECTRUM, vol. 23, no. 6, 30 June 1986 NEW YORK, USA, pages 66-71, KAREN FREIFELD 'ART ANALYSIS: PROBING BENEATH THE IMAGE'	1,2	
A	BYTE, vol. 12, no. 3, 3 March 1987 ST PETERBOROUGH, USA, pages 151-165, J. F. ASMUS 'DIGITAL IMAGE PROCESSING IN ART CONSERVATION'	1,2	
A	FR-A-2 678 552 (R. BESSO ET AL) * page 2, line 23 - page 14, line 20 *	1,2	
A	FR-A-2 593 938 (J. P. CHARRAS) * page 1, line 1 - page 4, line 34 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B44D B44F B44C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 September 1995	Doolan, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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