Sept. 15, 1959 H. J. EMERSON 2,904,174

IDENTIFICATION OF SENSITIZED PAPER OR FILM DEFECTS WITH MAGNETIC MATERIALS

Filed Jan. 27, 1956 2 Sheets-Sheet 1

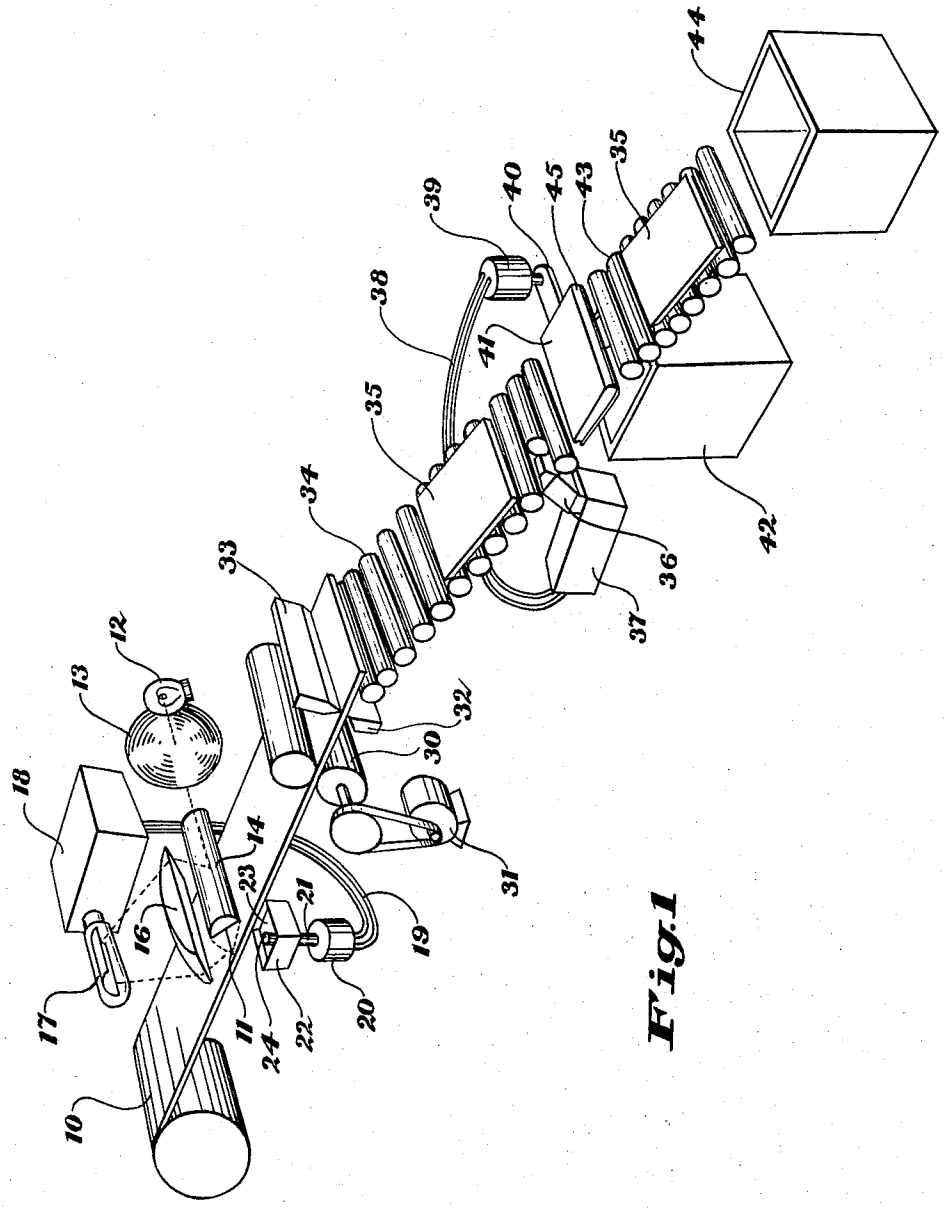

Fig. 1

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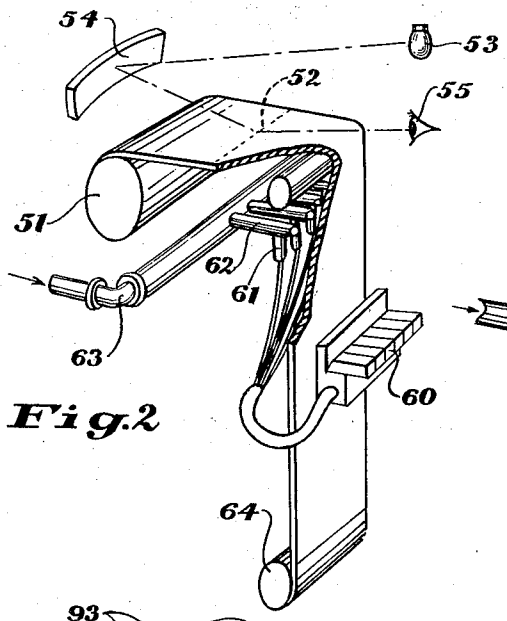

Fig. 2

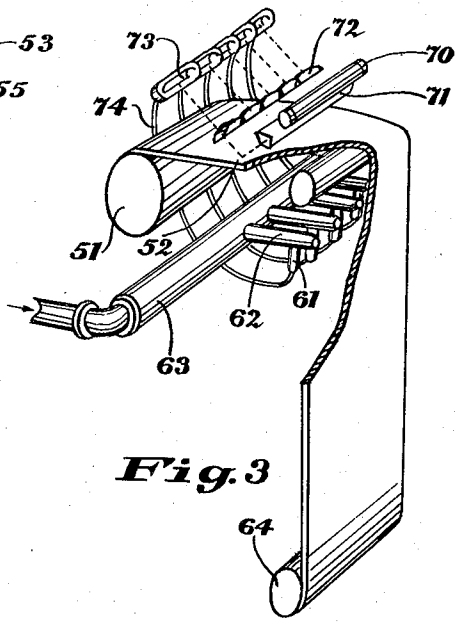

Fig. 3

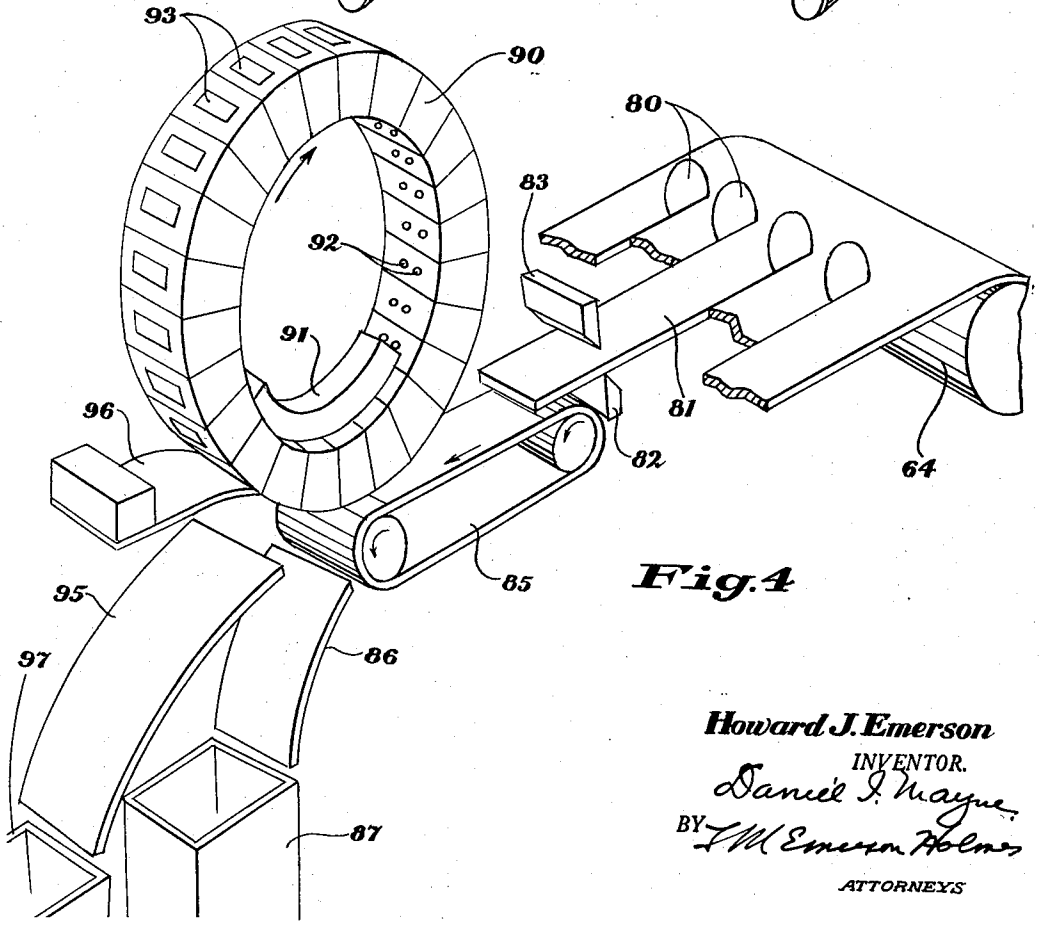

Fig. 4

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2,904,174

IDENTIFICATION OF SENSITIZED PAPER OR FILM DEFECTS WITH MAGNETIC MATERIALS

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Application January 27, 1956, Serial No. 561,850

5 Claims. (Cl. 209—72)

This invention relates to the inspection and sorting of sheet materials. It relates particularly to the inspection of sensitized photographic materials such as sensitive film or paper.

The object of the invention is to provide a simplified method of identifying defects in photographic materials, particularly a method which is not only useful with a narrow roll of material which is to be chopped into sheets of uniform length, but which lends itself particularly well to the inspection of wide rolls which are to be slit into several strips before being chopped into individual sheets.

Prior systems for the inspection of wide rolls of sensitive photographic paper have involved the punching of a hole at or near each defect which hole is later detected photoelectrically or by electrical contacts for sorting of small sheets cut from the large roll. However, holes through the sheets are objectionable, particularly if the hole extends partly into a good sheet or if a defective sheet inadvertently passes through the sorting system and reaches the ultimate user. Obviously the hole in the sheet is, in most cases, much worse than the slight defect identified thereby. The user might never notice or object to the slight defect, but would find the perforation most objectionable. Furthermore, the ultimate detection of the holes during sorting involves either electric current or a light beam, either of which may tend to fog the sensitive material. Also, a defect may be near the edge of a sheet, so that when the roll is chopped into sheets, the cut passes right through a hole making it into two edge notches on adjacent sheets. It is difficult to provide a photoelectric detection system which will respond consistently both to holes and to various size edge notches.

The present invention has all of the advantages of this perforating system with none of the disadvantages and has several additional advantages. For example, the present invention involves magnetic material and the actual sorting may be done either in accordance with the response of a magnetic sensing member or, in special cases, directly magnetically. Also, the magnetic material may be easily removed at any time so as to restore the photographic sheet to its original state.

According to the invention a photographic material such as sensitive film or paper having a photosensitive layer on the front surface is moved from a roll past an inspection station at which defects are detected. The inspection may be either visual or photoelectric. A highly permeable ferromagnetic adhesive material is deposited on the back of the film or paper support near each defect as the defect passes the inspection station. The material is then cut into discrete sheets which are passed through a sorting mechanism having a magnetic selecting means to reject the sheets having the ferromagnetic material on the back thereof. Sensitive photographic paper is, of course effectively opaque and sensitive film is also effectively opaque because of the emulsion layer even if no other opaque layers are included. Because of this opaqueness, the ferromagnetic material on the back is not visible from the front of the sheet.

When visual inspection is used, it is preferably in the form described in U.S. Patent 2,548,551, Morrison, which is particularly suitable for the inspection of wide rolls of sensitive material which are to be slit and chopped into small sheets. An equivalent photoelectric system employs a row of photoelectric cells each for inspecting the light from one of the strip areas. When the roll to be inspected is only one strip wide and when both maximum sensitivity and minimum illumination are desired, the single strip (or each of the strips in a wide roll) is preferably inspected by a scanning system such as that shown in U.S. Patent 2,719,235, Emerson.

A simple form of ferromagnetic material consists of powdered iron in a quick drying, preferably water soluble, vehicle. Powdered iron is commercially available under various trade names. "Permalloy" is quite satisfactory. It contains a high percentage of nickel and has no appreciable tendency to fog photographic emulsions, even when it is not in a vehicle and, of course, the vehicle would reduce any such tendency if it did exist. The requirement that the ferromagnetic material in its vehicle must be compatible with photographic emulsions is easily satisfied. Water soluble waves are well known and they constitute a suitable vehicle for the iron powder. Since the hardness of such waxes is commonly controlled by the addition of hardeners, it is pointed out that the range of hardnesses which are satisfactory is very wide. Of course, it should not be so hard as to be brittle or so soft as to be tacky and adhere to the next convolution in a roll, but anywhere between these extremes is satisfactory. "Carbowax" #6000 is an example of such a water soluble wax.

This adhesive material can be applied from a tube or jet, or may be applied by a brush normally resting in a supply of the material, or if the inspection is performed with the photosensitive side of the material facing downward, the magnetic identification may be simply dropped on top of the material. Another system which has been found satisfactory is to have the iron-wax combination coated on paper rolling on the back of the sensitive material and to make transfer by quick application of a hot die or stylus. By using a water soluble material, the resultant sheet is easily restored to its original state by immersion in an aqueous bath. Thus if a defective sheet is used photographically, the magnetic identification material disappears in the processing and the sheet is no worse than it was before the magnetic material was applied thereto. Also, any of the magnetic material which gets onto the back of good sheets does not spoil them provided, of course, the adhesive and the form of iron used are reasonably compatible with the photographic solutions. The sorting is greatly simplified since no further illumination is needed and since the magnetic material may be used either to trigger the operation of the sorter through some magnetic sensing device or, in special cases, to be actually lifted magnetically in the sorting operation.

Other objects and advantages of the invention will be apparent from the following description when read in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of the essential features of one embodiment of the invention;

Fig. 2 is a similar view partly cut away of a visual inspection system incorporating the present invention;

Fig. 3 is a similar view partly cut away of a multiple photoelectric inspection system incorporating the present invention;

Fig. 4 is a similar view partly cut away of a slitting, chopping and sorting mechanism for sorting sheets inspected by the method shown in Fig. 2 or the method shown in Fig. 3.

In Fig. 1 a strip of photographic film 10 with the emulsion side up is passed from a roll past an inspection sta-

tion 11 which is a line transverse to the film. In the arrangement shown light from a lamp 12 through a condenser lens 13 and a cylindrical lens 14 illuminates the inspection station uniformly. Greater sensitivity can be obtained with less danger of fogging the film by using a scanning system such as shown in U.S. Patent 2,719,235 Emerson mentioned above. Steady illumination is illustrated in Fig. 1 merely for simplicity of illustration. The inspection may, of course, be by either transmitted light or reflected light as shown. Light reflected by the film at the inspection station 11 is collected by a lens 16 onto a photoelectric cell 17 which creates a signal whenever a defect passes the inspection station. Through a suitable circuit 18 and wires 19, this signal operates a solenoid 20 to push a plunger 21 upward. Magnetic ink from a bath 23 (in a suitable container 22, through the bottom of which the plunger 21 extends) is carried by the top 24 of the plunger up to the back of the film 10. In the arrangement shown the magnetic identification mark is always placed near one side of the film. It could just as easily be in the center or right across the full width of the film. Any suitable brush could similarly be used for applying the magnetic material to the back of the film, or the hot stylus transfer from a transfer sheet as discussed above may be used.

A roller 30 driven by a suitable means illustrated as a simple motor 31 moves the film with its magnetic identification marks through a chopper consisting of knives 32 and 33 which cut the film into uniform lengths. In practice, the material is usually rolled up after inspection and then unrolled later to pass through the chopper and sorter (or through a slitter, chopper and sorter when the roll is several strips wide) but for simplicity Fig. 1 shows the inspected and marked material going directly to the chopper. The film sheets such as illustrated at 35 then pass down an incline formed of rollers 34. When a defective sheet comes along with magnetic material applied to the back thereof, the passing of the magnetic material over a magnetic sensing head 36 sets up a signal through a circuit 37 and wires 38 to operate a solenoid 39. This lifts the extension 40 on a deflecting plate 41 and rotates the plate 41 upward about one edge 45 thereof. The defective sheet then falls into a bin 42 below the incline.

However, as long as no defective sheets create a signal at the sensing means 36, the plate 41 remains in its normal position and the good sheets pass over the plate 41 onto rollers 43 and eventually into a bin 44.

This system is most useful with single strip inspection as shown in Fig. 1. Visual inspection or multiple photoelectric inspection as shown in Figs. 2 and 3 constitute preferable embodiments of the invention when applied to the inspection of wide rolls which are to be slit into narrower rolls before being choped into sheets.

In Fig. 2 sensitive paper from a roll 51 passes an inspection station 52 which is illuminated by a single low wattage lamp 53 and a concave mirror 54 which tends to focus the specularly reflected light onto the eye 55 of the observer. When the observer sees a defect somewhere along the inspection station 52, he presses one of the keys 60 corresponding to the transverse location of the defect. That is, he presses the lefthand key when the defect is near the left side of the paper and he presses the right-hand key when the defect is at the right side, etc. Whenever a key is pressed by the observer, it operates a corresponding valve 61 in a tube 62 through which magnetic ink is forced under pressure from a source represented by a pipe 63. This magnetic material applied to the back of the paper dries before the paper is rolled into roll 64.

Fig. 3 shows a similar arrangement in which the inspection is done photoelectrically rather than visually. Light from a fluorescent lamp 70 is focused by a cylindrical lens 71 to form a line of light which constitutes the inspection station 52. A row of juxtaposed lenses 72 selects the light from areas corresponding to the strips into which the paper is to be slit and directs this light respectively to photoelectric cells 73. Each cell 73 is connected through a wire 74 to operate the corresponding valve 61 whenever a defect passes the corresponding part of the inspection station 52. The paper is moved at fairly high speed and sufficient delay is involved in the operation of the valve 61 to insure that the magnetic material is applied at the defect. Actually the jets are placed very close to the inspection station 52 but are shown some distance therefrom for clarity in both Figs. 2 and 3.

The roll 64 with magnetic material on the back of the support at each defect is then slit as shown in Fig. 4 by suitable slitters 80, which are shown cutting the roll 64 into five strips. Four of the strips are broken away and the sorting mechanism for only one strip 81 is illustrated. The sorters for the other strips are identical therewith.

In practically all cases, the sorting is done by the system illustrated schematically in Fig. 1. That is, the presence of the magnetic mark is sensed by a suitable sensing head and the resultant signal suitably amplified is used to operate a sorting device. However, for very small, light weight sheets and fairly heavy application of the iron powder, the alternative type of sorter shown in Fig. 4 may be used.

The strip 81 passes between knives 82 and 83 which chop the strip into discrete sheets. These sheets are carried by a rapidly moving belt 85 under a magnetic wheel and into bins. If the sheet is a good sheet, there is no magnetic material on the back thereof. It passes from the belt 85 down the slide 86 into the bin 87 which receives all of the good sheets. When a sheet having magnetic material thereon passes under the magnetic roller made up of a rotating circle of juxtaposed electromagnets 90, it is picked up by the electromagnets and carried as far as the slide 95 so that it is deposited in the reject bin 97. Each of the electromagnets 90 is provided with electrical contact points 92 which pass under brushes 91 which supply current to the electromagnets. Thus the electromagnets near the top of the roller are not energized. They become energized as they pass the brushes 91 so that they attract the sheets having magnetic material thereon. They become de-energized when they reach the end of the brushes 91 and then the electromagnets drop the sheet onto the slide 95. A simple scraper 96 is provided to insure removal of the sheets from the poles 93 of the electromagnets 90. The drum is, in general, rotated much faster than the belt 85 is moving, so that the defective sheets are rapidly swept magnetically onto the slide 95. Thus it is seen that the present invention lends itself quite simply to magnetic sorting, providing the sheets to be sorted are small and light weight (as in the case of radiation detecting badges). For magnetic sorting the amount of magnetic material should be at 10% of the weight of the paper to be lifted, since otherwise an unwieldly magnet would be required. That is, it would be unwieldy compared to the size sheet it is to handle.

In the preferable arrangement, such as shown in Fig. 1, the ferromagnetic material is sensed without being specially magnetized, but the roll or sheets may be passed through a strong magnetic field, after the application of the magnetic material and before the sensing thereof. The magnetizing of the mark creates a stronger signal in the sensing head.

I claim:

1. Apparatus for sorting photosensitive sheet material having a photosensitive layer on the front surface of an effectively opaque paper support which comprises means for supporting a supply roll of the material, means for feeding material from the roll past an inspection station, means for illuminating the material at the inspection station to a degree adequate for inspection but not sufficient to fog the photosensitive layer, means for

receiving light from the illuminated material at the inspection station and for detecting defects in the material, whereby the front of said sheet is free from any visible evidence of the ferromagnetic material means for depositing on the back of the support near each defect as it is detected at the inspection station a highly permeable ferromagnetic water soluble adhesive material which is compatible with the photosensitive layer, means for cutting the material into discrete sheets after it has passed the inspection station and the material depositing means, means for passing said sheets through a sorter and magnetic selecting means in the sorter for rejecting sheets having ferromagnetic material on the back thereof, said cutting means, passing means and selecting means all being shielded from actinic radiation to which the photosensitive layer is sensitive.

2. Sorting apparatus according to claim 1 including photoelectric means for receiving illumination from the material at said inspection station and for setting up an electric signal to control said depositing means.

3. Sorting apparatus according to claim 1 in which the depositing means is for depositing a weight of material equal to at least 10% of the weight of the sheets and in which the magnetic selecting means includes magnets for lifting said sheets having ferromagnetic material on the back thereof from the sequence of sheets passing through the sorter.

4. In the method of inspecting, chopping and sorting sheets from a strip of photosensitive material having a photosensitive layer on the front surface of a substantially opaque non-metallic sheet support, the steps of depositing a highly permeable ferromagnetic water soluble adhesive material on the back only of the support near each defect as it is detected during inspection whereby the front of said sheet is free from any visible evidence of the ferromagnetic material and, after the material is chopped into discrete sheets, magnetically selecting for rejection those sheets having said permeable material deposited on the back thereof.

5. The method steps according to claim 4 in which said depositing deposits an amount of ferromagnetic material equal to at least 10% of the weight of one of said discrete sheets and in which said selecting is accomplished by magnetically lifting the sheets having such material deposited thereon, as all of the sheets are moved past a selection station.

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