

[54] **COPIER TEST SHEET**
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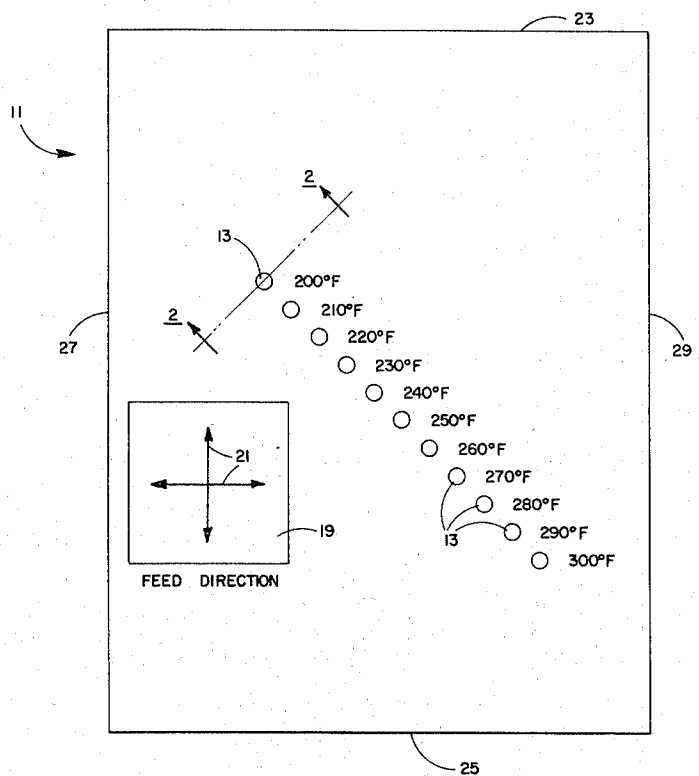
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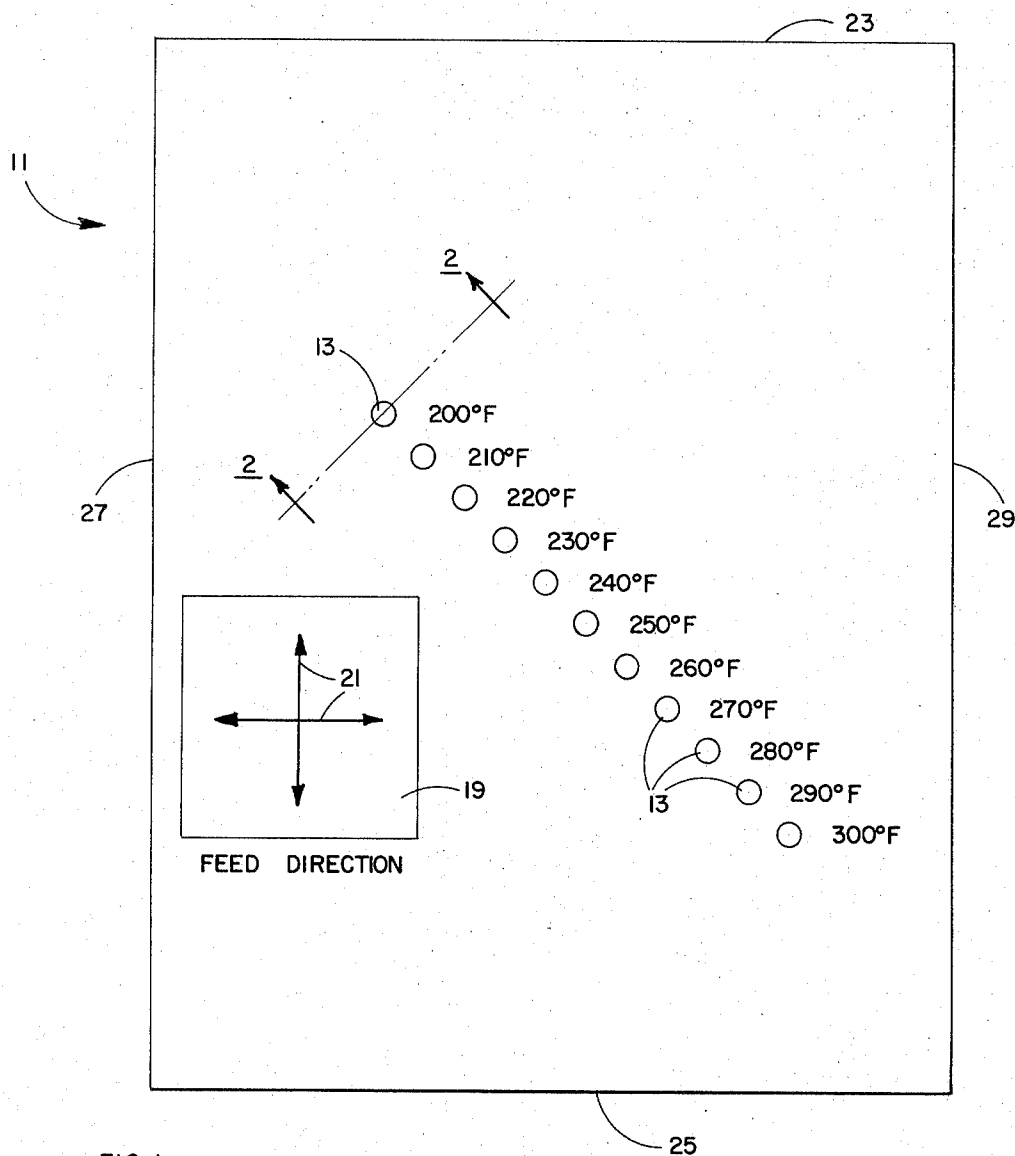
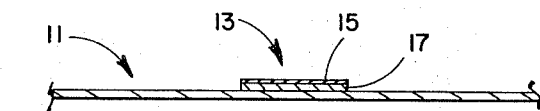
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[57] **ABSTRACT**
A copier test sheet and method for determining the copy sheet temperature of document copying machines, which comprises a sheet of paper to be fed through the copier, the sheet having a plurality of separate and distinct patches or coating of temperature-sensitive material thereon, each patch or area being sensitized to a distinct and different temperature level, covering increments across a temperature operating range which copy sheets will be subjected to in a copier, such that when the sheet is fed through the copier there will be a change in the color or physical condition of those patches or areas whose sensitivity lies either at or below the actual temperature that the paper encountered.

1 Claim, 2 Drawing Figures





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COPIER TEST SHEET SPECIFICATION

Briefly, the herein invention relates to a method and device for determining temperatures. Specifically, the herein invention relates to a test sheet and method of using same for determining the copy sheet temperature of electrostatic, thermographic, or other copying machines.

There are two major types of electrostatic copying processes. The first is known as transfer electrostatic copying or xerographic copying. The other process is normally defined as direct electrostatic copying. In the transfer electrostatic process, a charged photoconductive layer such as selenium or selenium alloy is deposited as an amorphous layer on the surface of a metallic drum. The process consists essentially of six steps: charging, exposure, development, transfer, surface reconditioning and fusing. The image in this process is transferred from the original document to a receiver sheet, which is usually ordinary paper.

Direct electrostatic processes are similar in principal to the transfer electrostatic process, except that the entire operation is carried out on a coated sheet of paper. The coating is a photoconductive layer which is used only once, with the image being formed thereon and them permanently fixed thereto.

In a typical xerographic copying cycle, the rotating drum is first given a uniform positive electrical charge by a closely spaced "corona" device. The corona consists essentially of a taut wire, usually tungsten, strung between terminal posts inside a grounded reflector; operating at about 6000 volts, the corona wire ionizes surrounding air and discharges a stream of ions, or charged species, which uniformly deposit onto the surface of the photoconductor.

Next, the charged element is exposed to a projected light image of the original document. In light-struck areas, the selenium layer becomes conductive, causing the charges immediately thereon to bleed through the photoconductive coating to the grounded metallic drum. The result is an invisible pattern of electrical charges corresponding to the printed or image areas of the original document; it is called a "latent electrostatic image."

In the third step, a quantity of minute, spherically shaped beads is cascaded over the drum surface. Each of these beads, which are perhaps one-half millimeter in diameter, carries on its surface a quantity of black, resinous toner powder comprised of much smaller particles, about 1 to 10 microns in diameter.

The carrier beads and toner powder undergo a unique "tribo-electric" effect such that through intimate mixing they develop opposite electrical charges and are thereafter held together by electrostatic attraction. This "tribo-electric effect" is attributed to an electron donor-acceptor relationship between the two materials; they are selected specifically for their ability to enter into this electron exchange.

Continuing with the third step, intimate contact between "toned" beads and photoconductor results in a loss of toner by those beads which contact charged areas of the drum surface. Where the charge on the selenium exceeds the electrostatic bond between bead and toner, the toner is released to the drum. This step is known as "development;" it produces a visible image corresponding to the original document. More specifi-

cally, it is called "cascade development" as the beads are literally cascaded over the rotating drum.

The carrier beads then fall into a reservoir at the base of the drum, are mechanically returned to that feed point where they were originally discharged over said drum, and are replenished with fresh toner powder.

The drum then rotates to the transfer station where the fourth operation is effected: the toned image is transferred intact from the selenium surface to a sheet of ordinary paper by electrical charge application to the back of the receiver sheet.

After transfer is completed, the drum is cleaned by a rotating brush or other device which contacts the surface. Excess toner particles are either drawn into a filter bag by vacuum or some other collection means is employed to gather up residual toner. The drum is then subjected to light exposure and/or a negative charge to neutralize residual charges, and to prepare it for the next printing cycle. These conditioning operations comprise the fifth step of the process.

Meanwhile, the toned image is fixed onto the paper surface in the sixth step by a fusing device. In some equipment, the fuser assembly is simply an infra-red lamp which instantaneously melts the toner into the fibers of the paper as the sheet passes through. Upon leaving the area of intense radiant energy the toner cools and resolidifies before the sheet exits from the machine. The net result is a permanent image which will not smudge or smear, will not fade out as carbon black is a primary pigment in the resinous mixture, and which is delivered to the operator completely dry.

Other fusing devices contain both a source of heat and a pair of smooth metal rollers; the imaged sheet passes through the heated nip and is fixed by the combination of heat and mechanical energy.

Fusing completes the xerographic process. It is a most critical step because the range of permissible temperature is narrow for any given machine. If copies do not receive heat and/or mechanical energy, then toner particles can be wiped off the sheet after delivery from the machine. Such copies feel gritty because they contain loose particles of toner, and the unfixed toner powder is free to soil hands, clothing, and machine components.

If, on the other hand, too much energy is applied, the copy paper can be scorched and will emit offensive odors. Scorching also presents a potential fire hazard. With excessive heat, fused toner, particularly in heavy image areas, can transfer to transport or fusing rollers in the machine and be redeposited in the molten state onto the copy sheet with each revolution thereby creating an undesirable multiple-image effect known as "off-setting."

Direct electrostatic copiers operate in a series of operations similar to transfer electrostatic machines except the process is reduced essentially to four steps: charging, exposure, development, and image fixation.

Paper bearing a photoconductive coating is subjected to the first three steps just as in a transfer electrostatic device. Machines using a dry toner powder accomplish the last step, image fixation, by fusing, while liquid toner machines render the developed image permanent by air drying. The drying operation in a liquid electrostatic copier may or may not use heated air.

Transfer or electrostatic copiers and direct electrostatic machines have delivered various levels of per-

formance, depending upon the nature of toner and copy paper material fed through the machine. One reason for this problem is a poor match between the fuser set point on the machine and the melting temperature of the toner. For example, if an individual changed brands of paper or toner, or both, the fuse point of his machine might need adjustment.

Once the fusing temperature is properly set on a given machine, it generally should not require changing.

Among the factors creating a need for temperature readjustment are changes in toner or paper, changes in ambient temperature or humidity, and variations in electrical power as might occur during those times other major electrical equipment items or appliances are in operation at the same installation. Further, it can go out of adjustment for various reasons, including improper adjustment by a serviceman.

Thermographic copying machines depend upon the absorption of radiant heat energy by the printed areas of a document to transfer heat to a temperature sensitive copy sheet. Original and copy sheet are superimposed and fed past an infrared source in one type of thermographic copier. The speed at which this set of sheets runs through the machine determines how dark or light the resultant copy will be. At high speed, the heat sensitive paper will not absorb as much energy as it would at the lower machine speed setting.

Obviously, the application for the copier test sheet of this invention would be to determine relative heating values of a thermographic copier when operated at various speed settings within the range of adjustment provided.

The water or moisture content of the copy paper has a substantial effect on the amount of heat required for fusing or fixing an image. High moisture content in the copy sheet will require a significantly greater amount of heat at the fusing temperature. Thus, such sheets will not properly perform in a copy machine where the fuse point is set for a paper with normal or average moisture content. Without delicate measuring instruments, the copier machine serviceman is unable to determine the moisture content of a given batch of paper when a complaint has been registered concerning the operation of a machine, and thus it is very difficult to determine what is the problem when, for example, it might be high moisture content and not the fact that the fuse point of the machine is incorrect or that the toner is bad.

Prior to the herein invention, there has been no relatively straightforward means for determining whether the fusing temperature or drying air temperature setting of a machine is properly set. Obviously, devices such as pyrometers and surface temperature thermometers could be utilized. However, this type of equipment is both expensive and requires a considerable degree of skill in order to successfully operate with relation to a copier. Additionally, the use of mechanical apparatus such as this positioned in copy machines is a delicate operation and can often break or cause damage to the copier, inherently making their utilization a very delicate and time consuming process.

Thus, an object of this invention is to provide a simple method and device for determining the fusing or fixing temperature of direct or transfer electrostatic copiers.

Another object of this invention is to provide a simple method and device for determining the operation temperature of thermographic copying machines.

Another object of this invention is to provide a device and method for determining the maximum temperature a copy sheet is subjected to in a copier which can be utilized without disassembling the apparatus.

One further object of this invention is to provide a device and method of obtaining a permanent record of the temperature a copy sheet is subjected to in a copier at the time the test was conducted.

The above and other objects of this invention are accomplished by a copier test sheet in accordance with this invention which consists of a base sheet of material made of paper or plastic. The sheet is coated with different patches of temperature sensitive compositions covering a wide temperature range above and below the maximum temperature encountered by a copy sheet passing through a copier. The patches will either be in the form of a coating, such as a paint or the like, at each spot for a given temperature, or will comprise a plurality of temperature sensitive patches which will be adhered to the sheet by adhesive or the like. The temperature at which each patch or spot will be affected is printed or marked on the sheet adjacent that spot. The material utilized for the patches or spots on the paper will change color or appearance in some manner when their critical temperature is reached. For example, a spot could change from white to black at its temperature sensitive level. The test sheet is then run through a copier machine as a normal copy sheet, while a black original document is correspondingly run through. When the test sheet is ejected from the machine, the temperature in the copier will have affected the temperature sensitive spots or patches such that one can determine the approximate maximum temperature the paper encountered in the machine. It is believed the invention will be further understood from the following detailed description and drawing in which:

FIG. 1 is a plan view of the test sheet of this invention.

FIG. 2 is a cross-sectional view taken along lines 2—2 of FIG. 1.

Turning to the drawings, the test sheet 11 consists of material such as paper or plastic. The test sheet 11 should be cut to the same size as the regular copy paper intended for the machine with which the test sheet is to be used. Disposed on the sheet are a plurality of patches 13 of temperature sensitive compositions, each spot or patch 13 on the paper will undergo a visible change at a specific critical temperature for that spot. As shown in the drawing, for example, a plurality of 11 temperature sensitive spots are disposed on the paper, each spot having a critical temperature ten degrees above the adjacent spot so as to cover a temperature range from 200° to 300°F. The spots 13 can be applied directly to the sheet 11 as in the form of individual coating, or more preferably, are patches as seen particularly in FIG. 2 of a coating 15 mounted on a base of paper or the like 17, which is adhered by adhesive or other material to the sheet 11. It has been found that the utilization of the individual patches greatly facilitates the assembling or formation of the test sheet 11 as compared to spraying or depositing a plurality of different coatings on a given sheet.

The composition of the spots 13 can vary widely. The patches can be of material such as disclosed in U.S. Pat.

No. 2,799,167, which consist of a fusible crystalline pigment which is normally white in color, dispersed in a binder and coated onto an absorbent base material, having a contrasting color such as black paper. Thus, the spots would appear white on the test sheet 11. When the critical fuse temperature is reached they are absorbed by the black paper 17, as seen in FIG. 2, and thus appear black to the eye. Thus, for example, if an electrostatic copier had a fuse temperature of 250°, the patches on the test sheet 11 from 200° through 250° would all change to black, while the remaining patches of 260°-300°F would remain white on the test sheet after it had been ejected from the copier.

Many differing temperature sensitive compositions well known in the art have been used in the past as indicia for temperature ranges or as temperature indicators. Attention is directed to the type of material, for example, disclosed in U.S. Pat. No. 2,269,038, which comprises a paper base having a colored face covered by a film of a color different from the base and obscuring the base. When this film is subjected to a minimum melt temperature, it becomes identified and reveals the in that of the underlying base. then be

As can be seen from FIG. 1, the series of temperature sensitive patches or spots 13 are arranged in a 45° angle, across the test sheet 11. Additionally, as can be seen, there is an indicia 19 on the test sheet or arrows 21 indicating the feed direction of the test sheet in the copier. The preferred alignment of the dots or patches 13 at a 45° angle is coordinated with the foregoing indicia 19, since it is preferred to run two test sheets 11 through a copier. Thus in performing the method of this invention on a sheet-fed copier, the sheet 11 is placed in the paper feeding compartment of the machine. In the case of a roll-fed copier, the copier test sheet of this invention can be affixed to the continuous web of pressure-sensitive tape or other suitable means.

A blank original is preferable to use as the test document because it assures that no toner is transferred to the treated areas of the test sheet. Such toner deposits are unwanted since they can be mistaken for the end-point on the test sheet. A first test sheet can, for example, be fed through the copier from the narrowest side 23. The arrow pointing in that feed direction will accordingly be circled so that the test sheet can be identified as being run in that direction. The next test sheet would be run through in the opposite direction, utilizing the narrow side 25 first, and the arrow pointing downwardly on the sheet would be circled to indicate that it had been fed in this direction. Alternatively, when the copier is made to receive paper being fed lengthwise side 27 would first be fed for example through the copier, and for a subsequent test sheet feeding side 29 would first be fed. Once again, the appropriate arrows are circled.

By aligning the patches at 45°, it assures that each patch will contact a different portion of the roller as it passes through the fusing section of the copier. This is desirable since, as is apparent, each patch absorbs a certain amount of heat energy. If the patches or dots were co-aligned such that they all would pass over the same spot on a roller or heated area of the fuser, then the successive dots in the co-aligned arrangement would not truly reflect the heat input since a significant amount of heat would be previously absorbed in that section of the roller. After the two test sheets are run

through the copier, depending upon whether the copier feeds from the short or long side of the paper as discussed above, they are compared and an average is taken of the end-points. Theoretically, the same end-point should appear on both sheets. However, where on sheet, for example, would indicate an end point of 250° and the other 260°, an average could be taken where the maximum temperature could be determined to be about 255°F for the copier.

It should be pointed out that for certain copiers, such as the "Copytron 2000" series machines, manufactured by Addressograph-Multigraph Corporation, access is provided to the fusing section so that the operator can by-pass charging, exposing, and development stations. For such machines, the copier test sheet of this invention can simply be run through the fusing section without initially placing it in the feed compartment.

In accord with the herein invention, a test sheet can have a very wide range of temperature sensitive patches so as to cover the operating range for virtually all copiers. Alternatively, different test sheets can have differing ranges of temperature sensitive patches depending upon the type of copier being tested and its normal operating temperature.

It is believed that the invention will be further understood from the following detailed examples:

EXAMPLE I

An 8½ × 11-inch sheet of 20-lb. Xerographic copy paper identified as "Xerox Copy Bond" was treated with three "Tempilaq" temperature sensitive lacquers, a product of Tempil Corp., New York, New York. The three deposits of lacquer were spaced about 2 inches apart across the 8½ inch width of the sheet, so that they were aligned perpendicularly to the feed direction of a Xerox Model 813, 914 or 720 copier.

These deposits or patches were placed on the paper by means of the brush-in-cap applicator furnished with each bottle of Tempilaq. The patches were each about one-half inch square and about 1-mil thick after drying.

One square consisted of Tempilaq which melts at 263°F; the second contained Tempilaq sensitive to 269°F; and the third patch was prepared with Tempilaq graded for 275°F.

The sheet was placed in the paper feed compartment of a Xerox 914 copier, treated side up, immediately beneath the top sheet of copy paper, that is, immediately beneath the first sheet to be fed into the machine. The side treated with temperature sensitive lacquer being face-up in the 914 copier is the one which would normally receive the toned image.

A white sheet of paper was set on the glass exposure platen where originals are normally placed for copying. The dial was set for one copy and the "Print" button depressed.

The copier test sheet of this invention emerged from the Xerox 914 copier with the 263°F patch fully melted and resolidified, the 269°F patch only partially fused, and the 275°F patch showing no indication of having been fused in the machine. When heated to its design temperature, the coating changed from a chalky, waxy surface to a thinner glossy layer that has penetrated through the test sheet paper and is visible on the back side. The test sheet is then rendered translucent in those areas in which fusion has occurred.

The above results indicate the fusing temperature of the machine to be in the 263°F to 275°F range.

EXAMPLE II

When the above procedure was repeated using the same paper and temperature indicating lacquers run through a Xerox 813 machine, identical results were obtained.

EXAMPLE III

Example I was repeated, except that the three patches were prepared from Tempilaq liquids having temperature sensitive levels of 182°F, 188°F, and 194°F, respectively, and the sheet was run through a Xerox 2,400 machine. Also, the patches were spaced across the 11-inch length of the sheet as the 2400 copier is fed in the cross-grain direction.

Results indicated the fusing temperature to be in the 182°F to 194°F range.

One of the problems in utilizing the foregoing types of temperature sensitive material is that the user of the test sheet cannot view the patches at the time fusion occurs but must infer from the appearance of the cooled patches the operating temperature of the machine. Additionally a source of potential error in utilizing the type of patches of Examples I-III is in the variation in the thickness of the applied coating. The liquids are typically formulated with a highly volatile solvent which thickens as it is brushed onto the test sheet. As a result, it is often difficult to obtain a patch having a uniform thickness. Areas containing a heavy deposit will not fuse as readily as those areas having a thin layer of material. In view of this, it is preferred to utilize a temperature-sensitive material which is uniformly thick and undergoes a distinct color change.

Thus, as indicated above, it is preferred to utilize separate patches of material which are adhered to the test sheet. A typical product that is suitable is called "Temp-Plate", and is known as a direct reading temperature indicating sticker manufactured by the William Wahl Company of Santa Monica, California. The stickers are available in 10°F incremental steps over a wide temperature range. A similar product is called "Thermo-Paper," manufactured by the Paper Thermometer Company of Natick, Massachusetts. The patches of these types of material can then be affixed to the test sheet by adhesive or cement, or double-coated adhesive tapes. It is important that the adhesive be compatible with the temperature sensitive patch so that its temperature will not change prematurely in storage or will change at a different level than its designed value. Generally, the manufacture of the test patches will recommend the most suitable types of adhesives to be utilized.

EXAMPLE IV

To an 8½ × 11 inch sheet of 20-lb. duplicator bond paper were affixed 11 one-fourth inch diameter circular "Temp-Plate" stickers extending diagonally across the sheet, spaced at a distance of three-fourths inch apart. These stickers were sensitive to eleven different temperatures at 10°F increments from 200°F through 300°F.

The assembly described in the preceding paragraph was placed at the top of the feed tray in a Xerox 3600 copier. A blank, white sheet of paper was used instead of an original document of the exposure platen of the

Xerox machine. The copier was activated to produce one copy of this blank original with the temperature indicating sheet of this invention run through the imaging mechanism in place of the usual copy sheets contained in the feed tray.

The test sheet of this example emerged from the copying machine with the stickers identified from 200°F to 230°F having turned black. The 240°F sticker was only partially darkened while the 250°F through 300°F stickers remained gray-white in color.

From this rapid test, it was determined that the fusing temperature of the copier was in the range of 230°F to 240°F.

EXAMPLE V

The same test sheet as Example IV was used, except that it was run through a Xerox 813 copier. The stickers sensitized to 200°F through 230°F all turned solid black.

The 240°F sticker had a black outer rim with the central portion of the circular patch still gray-black in color.

From this, it was determined the fusing temperature of that particular 813 copier was in the range of 230°F to 240°F.

EXAMPLE VI

The same test patches as Example IV were used, except that the supporting paper was a zinc oxide-resin coated sheet, such as is normally used in direct electrostatic copying machines. This particular paper was manufactured by the Bruning Division of the Addressograph-Multigraph Corporation under the name "Bruning 2000 Series Electrostatic Copy Paper No. 32-155."

The sheet thus prepared was run through the fuser section of a Bruning 2000 machine by inserting the sheet through the rear access port so that the charging, exposing and developing sections were by-passed.

The test sheet in this example emerged indicating the fuser section to be operating at a temperature between 270°F and 280°F.

EXAMPLE VII

The same test sheet as Example IV was used, except that it was run through a Minnesota Mining and Manufacturing Company desk-top, "Thermo-Fax Secretary" copier having the speed adjustment dial set at the maximum point. Only the sticker sensitized to 200°F turned black.

EXAMPLE VIII

Same as Example VII, except the speed adjustment dial of the 3M "Thermo-Fax Secretary" was set at the three-fourths point. The stickers sensitized to 200°F through 240°F all turned solid black.

Example IX

Same as Example VII, except the speed adjustment of the 3M "Thermo-Fax Secretary" was set at the one-fourth point. The stickers sensitized to 200°F through 290°F all turned solid black.

We claim:

1. A method of determining the maximum temperature a copy sheet is subjected to in a copying machine having a prescribed "feed direction" for processing sheets therethrough, said method comprising:

providing test sheets having individual temperature sensitive patches thereon which have differing critical temperatures covering an operating range for a copying machine, said sheets being arranged so that said patches are spatially disposed along a reference line disposed at about 45° with respect to said feed direction, with the patches being arranged in order of increasing critical temperature starting with the patch having the lowest critical temperature and ending with the patch having the highest critical temperature, feeding two of said test sheets separately through the said copying machine along said feed direction and

subjecting them to the operating temperature in the machine, said sheets being fed through said machine such that the patch having the lowest critical temperature on one sheet will first encounter a heated region of said machine, while on the second sheet the patch having the highest critical temperature will first encounter the heated region; and removing said test sheets from said copier whereby a change in appearance of said patches upon reaching their critical temperature indicates the maximum temperature the sheet encountered in said machine.

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