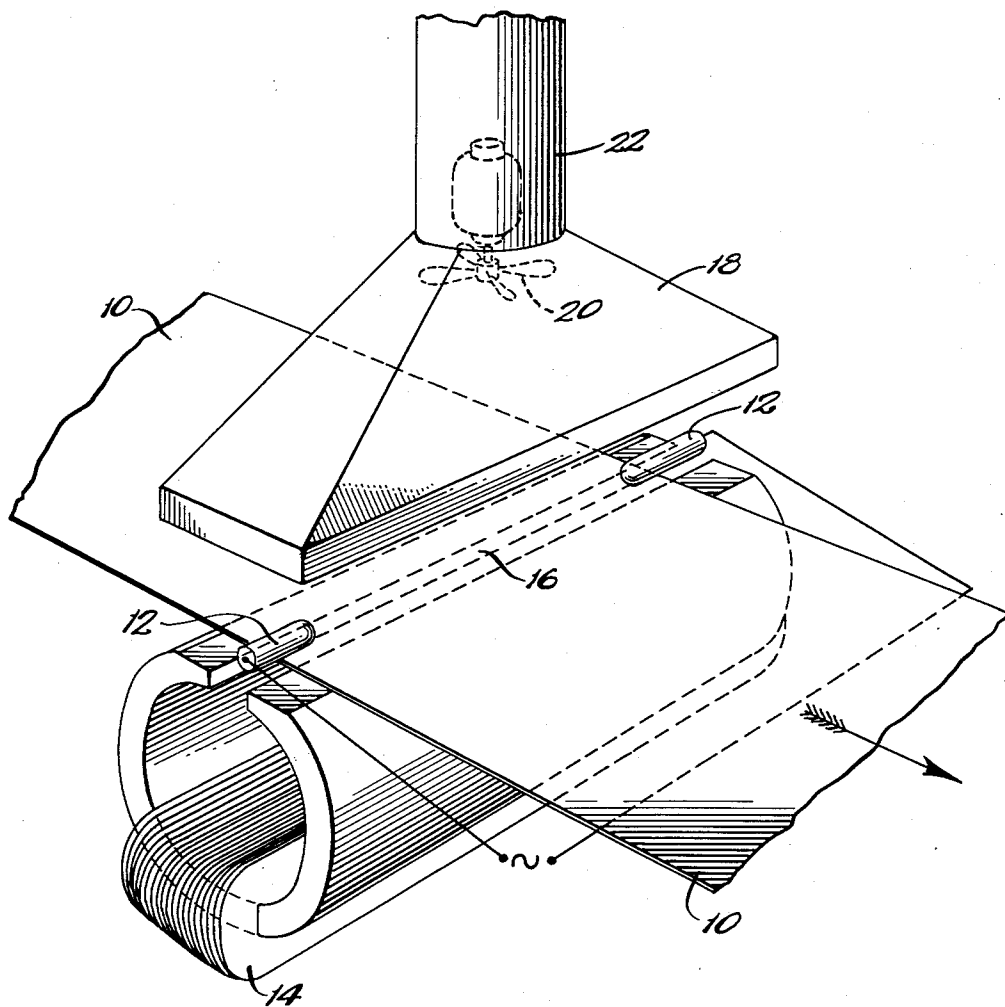


Feb. 21, 1961

H. C. EARLY ET AL
METHOD OF DRYING PRINTED WEBS
Filed July 22, 1957

2,972,196



INVENTOR:
Harold C. Early
and *David B. Miller*
BY *Dair, Freeman & Molinare*
ATTORNEYS.

1

2,972,196

METHOD OF DRYING PRINTED WEBS

Harold C. Early and David B. Miller, Ann Arbor, Mich.,
assignors to Meredith Publishing Company, Des
Moines, Iowa, a corporation of Iowa

Filed July 22, 1957, Ser. No. 673,436

7 Claims. (Cl. 34—1)

This invention relates to a method for drying printed webs. Modern web-fed rotary presses operate at web speeds in excess of 1000 feet per minute, and in some cases at speeds in excess of 1500 feet per minute. One of the problems in connection with the operation of high speed presses of this type involves the drying of the ink. At the present time the webs are passed through an oven in which hot air at about 600° F. is circulated over the web. In order to dry the ink thoroughly the web must remain in the oven for a comparatively long time, which greatly increases the size of the oven and the press assembly. Multicolor rotary presses are already enormous and require considerable plant space. Consequently, it is highly desirable to reduce as much as possible the space which is now utilized for drying the webs. More seriously, however, at these drying temperatures the paper is substantially weakened due to exposure to heat. The paper reaches a temperature of about 300° F. Cellulose, when exposed to temperatures in this range, becomes considerably weakened and this frequently causes breakage of the web which, of course, is very aggravating as well as expensive in shut-down time while the web is being mended.

Another serious disadvantage which results from heating the web at these elevated temperatures is the considerable shrinkage which occurs. The shrinkage results in uneven web tension which causes difficulty in obtaining intracolor register on the multicolor rotary presses. Furthermore, the dehydrated paper subsequently re-absorbs the moisture lost in drying. Where the printed sheets are formed into magazines which are securely stitched along one edge, the re-absorption of moisture from the air causes expansion, which results in wrinkled pages and difficulty in opening the magazine.

Another disadvantage in shrinkage is the waste of paper which necessarily results.

The primary object of this invention is to obviate these difficulties by drying the ink without heating more than the very surface of the web.

Another object is to provide a method for instantaneously flash drying the ink by moving the ink-coated web rapidly past an electrical heat source.

Another object is to provide a method of instantaneously drying all ink colors on a multicolored printed web.

In a preferred form of the invention an electric arc plasma (high temperature ionized gas) is brought into contact with the coated surface of the rapidly moving web. The intense heat of the plasma causes instantaneous evaporation of the solvent in the ink coating. The flash vaporized solvent is dissociated and ionized by the arc into monatomic molecules which recombine to form diatomic molecules at the paper surface with the evolution of large quantities of heat. Hence, the vaporized solvent actually participates as plasma in the drying operation. The dissociation takes place near the center of the arc while the recombination occurs toward the edge, nearer the surface of the paper. This method provides a very important advantage over prior art meth-

2

ods of drying webs. In conventional drying with a gas flame or by means of hot air, the vaporized solvent driven from the surface of the paper forms an insulating vapor barrier over the surface. In accordance with the present invention this vapor barrier, which normally impedes drying, is utilized to accelerate drying.

It has also been recognized that swiftly moving webs carry an air film which acts as a thermal insulator. The electric arc method of the present invention causes this film to be penetrated with little difficulty and is, therefore, highly effective in drying high speed webs having the most tenacious air films associated therewith.

The arc plasma is produced by applying a high voltage of, say, 1000 volts per inch of arc length across a pair of electrodes slightly spaced above the surface of the printed web. The arc may carry a current of from one to three amperes, preferably between one and two amperes. Hence, the power output may range from one to three kilowatts. If the current is too high, there is a tendency to scorch the web. The arc plasma is brought into contact with the surface of the web by the force of a magnetic field which conveniently may be supplied by an electromagnet disposed beneath the web opposite the arc. The strength of the magnetic field may be in the order of several hundred gauss. The magnetic intensity is not highly critical but, preferably, should not exceed about 1000 gauss. Intensities in the range of 1000 gauss and over tend to cause the arc plasma to move along with the advancing web and then "snap" back, thus increasing the exposure time with the increased possibility of burning the web.

It also may be desirable to exhaust the space around the arc to remove volatilized material given off by the ink. Certain of the volatile ingredients have a tendency to carbonize in the presence of the arc and may discolor the paper. Hence, volatilized matter should be removed as soon as it is formed. This may conveniently be done by passing a current of air over the arc, or by any other suitable means.

The electric arc referred to in this specification is not to be confused with low current intermittent discharges such as corona discharges which are measurable in tens or hundreds of milliamperes at voltages of 75-1000. The total power input per inch of discharge in such cases is a small fraction of the 1 to 3 kilowatts useful in the arcs of the present invention. This distinction is discussed in some detail by William G. Dow in Fundamentals of Engineering Electronics, 2nd Edition, published by John Wiley & Sons, page 454. Electric arcs are well known in the art and are defined by Cobine as follows:

"An arc at atmospheric pressure and above is characterized by a small intensely brilliant core surrounded by a cooler region of flaming gases, sometimes called the aureole. The aureole is a region of intense chemical activity, but the core is at such a high temperature that all gases are largely dissociated. If the arc occurs between highly refractory electrodes, such as carbon or tungsten, both the anode and the cathode are incandescent." (Gaseous Conductors by James Dillon Cobine, 1941, 2nd Edition published by Dover Publishing Inc. in 1958, page 290.)

Referring now to the drawing in which the single figure illustrates diagrammatically an apparatus suitable for carrying out the process of the invention, the web carrying the printed matter on the surface thereof is designated by the numeral 10. It is advancing at the rate of, say, 1200 feet per minute in the direction of the arrow. Tungsten electrodes 12 are provided, one on either side of the web just above the surface thereof. The electrodes may be made of carbon or other suitable

material. The arc may be established conventionally by separation of the electrodes or by transition from a high voltage discharge. Voltage across the electrodes is of sufficient magnitude to provide approximately 1000 volts per inch of arc length at a current of about two amperes. For a twelve-inch web the potential would be 12,000 volts. The tungsten electrodes are mounted very close to the surface of the web but not in contact therewith. The intensity of the radiant energy is in the order of two kilowatts per square inch of web surface. For wide webs a series of staggered electrode pairs may be disposed across the width of the web to avoid the necessity of employing extremely high voltages. The ink on the web traveling at 1200 feet per minute is dried within a few milliseconds by the bombardment of the surface with ions, electrons and molecules in the plasma. Intense heat is also produced by the recombination of monatomic molecules to diatomic molecules. The intensity of the arc will vary, of course, with the speed of the web. Slower moving webs will require a lower voltage to prevent scorching. The amount of solvent in the ink also affects the drying rate.

Mounted beneath the electrodes and the web, coextensive therewith across the width of the web, is an electromagnet 14 for positioning the arc. The pole pieces 16 of the magnet terminate on either side of the electrodes. When power is applied to the electromagnet 14, the arc is pulled down into contact with the surface of the paper so that the column width is about $\frac{3}{8}$ to $\frac{1}{2}$ inch. The fringing magnetic field positions the arc so that it can deviate only slightly from the desired position with a magnetic field intensity of about 300 gauss.

Since the vaporized solvent from the arc is decomposed by the high temperature thereof, a comparatively cool flame is present around the arc column caused by burning constituents volatilized from the ink, including the solvent. In order to prevent carbon, which might be formed by burning these constituents in a deficiency of oxygen, from discoloring the paper, we have provided a hood 18 mounted directly over the electrode and extending across the width of the web. Disposed within the hood is an exhaust fan 20 which discharges volatilized materials to an exhaust duct 22. The hood also may serve as a reflector for the arc to intensify the radiation.

It will be appreciated that an apparatus of this kind requires little space as compared with a conventional long oven. In addition to saving space, the method of the invention reduces the cost of drying, and eliminates the problems resulting from shrinkage and broken webs. It effectively dries all colors of ink in a multicolored print substantially instantaneously.

Other modifications of the invention will occur to those skilled in the art. It is not our intention to limit the invention to the specific forms shown and described other than as necessitated by the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A method for drying ink on a printed web which comprises passing the web at a speed in excess of 1000 feet per minute immediately adjacent to a source of intense heat provided by an electric arc, while simultaneously subjecting the arc to a magnetic field to bring the arc column into contact with the surface of said moving web.
2. The method of claim 1 which includes the additional step of exhausting the space around the arc to remove products volatilized from the ink.
3. A method for drying a web having a coating thereon containing a volatile solvent which comprises passing the web immediately adjacent an electric arc while simultaneously subjecting the arc to a magnetic field to bring the arc column into contact with the surface of the moving web, thereby evaporating the solvent and immediately transforming it into an electrically conducting plasma to assist in heating the surface of the web.
4. The method of claim 1 wherein the power input to said arc is from 1 to 3 kilowatts per inch of arc length.
5. A method for drying ink on a printed web which comprises passing the printed surface of the web at high velocity adjacent an electric arc while simultaneously subjecting the arc to a magnetic field of sufficient intensity to hold the arc substantially stationary at said printed surface but not in excess of 1000 gauss.
6. The method of claim 5 wherein the power input to said arc ranges from about 1 to about 3 kilowatts per inch of arc length and the intensity of said magnetic field is about 300 gauss.
7. A method for drying ink on a printed web moving at high velocity which comprises contacting the surface of the web with an arc plasma formed by subjecting the ink, the surface of the web on which the ink is printed and the surrounding gas to an ultra-high-temperature electrical arc having a power output of one to three kilowatts per inch of arc.

References Cited in the file of this patent

UNITED STATES PATENTS

1,503,224	Blaine	July 29, 1924
1,557,730	Smith	Oct. 20, 1925
1,646,010	Clover	Oct. 18, 1927
2,042,145	Darrah	May 26, 1936
2,266,392	Durant et al.	Dec. 16, 1941
2,655,802	Ravich	Oct. 20, 1953
2,674,050	Pound	Apr. 6, 1954

FOREIGN PATENTS

25,117	Australia	Oct. 23, 1936
--------	-----------	---------------

OTHER REFERENCES

A. P. Peck, "Infra-Red Does the Trick," Scientific American, September 1941, pages 124-127.