United States Patent

[11] 3,593,661

[72] Inventor **Kenneth Franklin Tripp**
Hancock, N.H.

[21] Appl. No. **549,854**
[22] Filed **May 13, 1966**
[45] Patented **July 20, 1971**

[73] Assignee **Markem Corporation**
Keene, N.H.

[54] **DRY INK-FILM PRINTING**
1 Claim, 11 Drawing Figs.

[52] **U.S. Cl.** **101/175,**
101/40, 101/41, 101/177
[51] **Int. Cl.** **B41f 17/18,**
B41f 5/16
[50] **Field of Search** 101/426,
211, 175, 176, 177, 206, 170; 117/38

[56] **References Cited**

UNITED STATES PATENTS

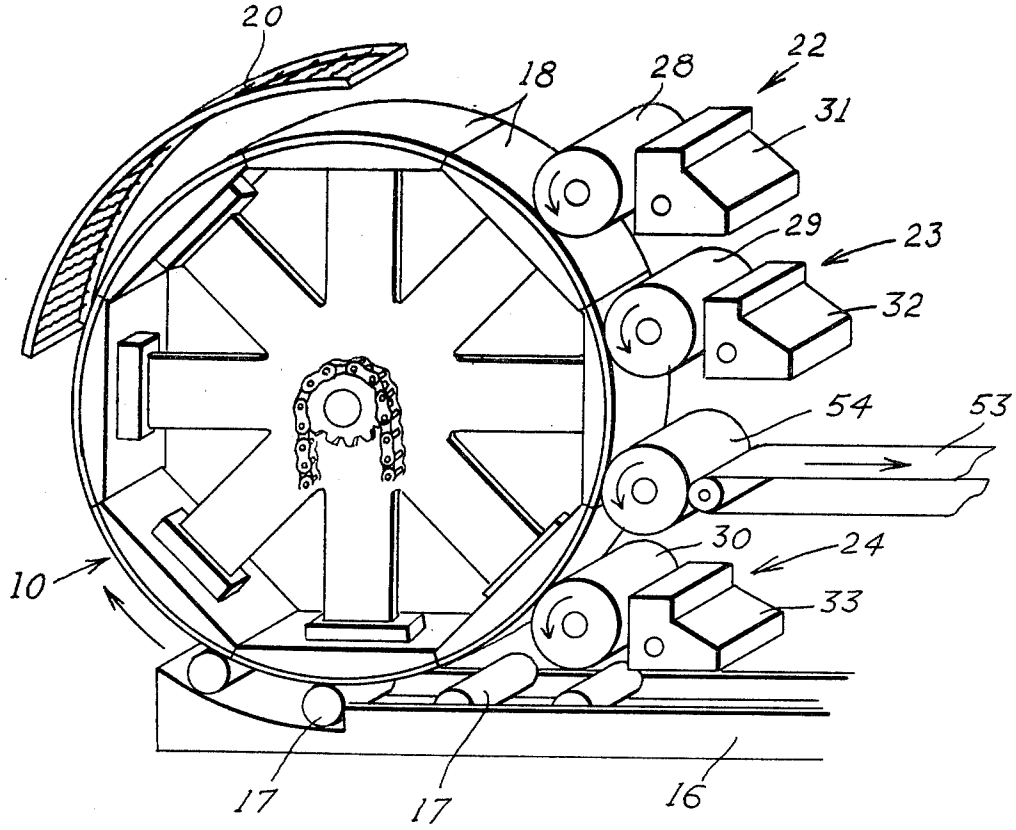
1,989,375	1/1935	Meyercord	101/175 X
2,060,801	11/1936	Eichstadt	101/154
2,711,132	6/1955	Viscardi	101/170

FOREIGN PATENTS

220,661	8/1924	Great Britain	101/426
439,522	12/1935	Great Britain	101/426

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—J. Reed Fisher
Attorney—Frederick D. Goode

ABSTRACT: This invention relates to ink film transfer and particularly to printing on surfaces by offset and direct printing techniques with an immediately dry image transfer of controlled thickness. When these techniques are employed in direct printing, the die or printing member is not inked directly with a fluent ink, but rather with a substantially dry ink-film, whereby small legend characters are not smothered or "filled-up."



PATENTED JUL 20 1971

3,593,661

SHEET 1 OF 3

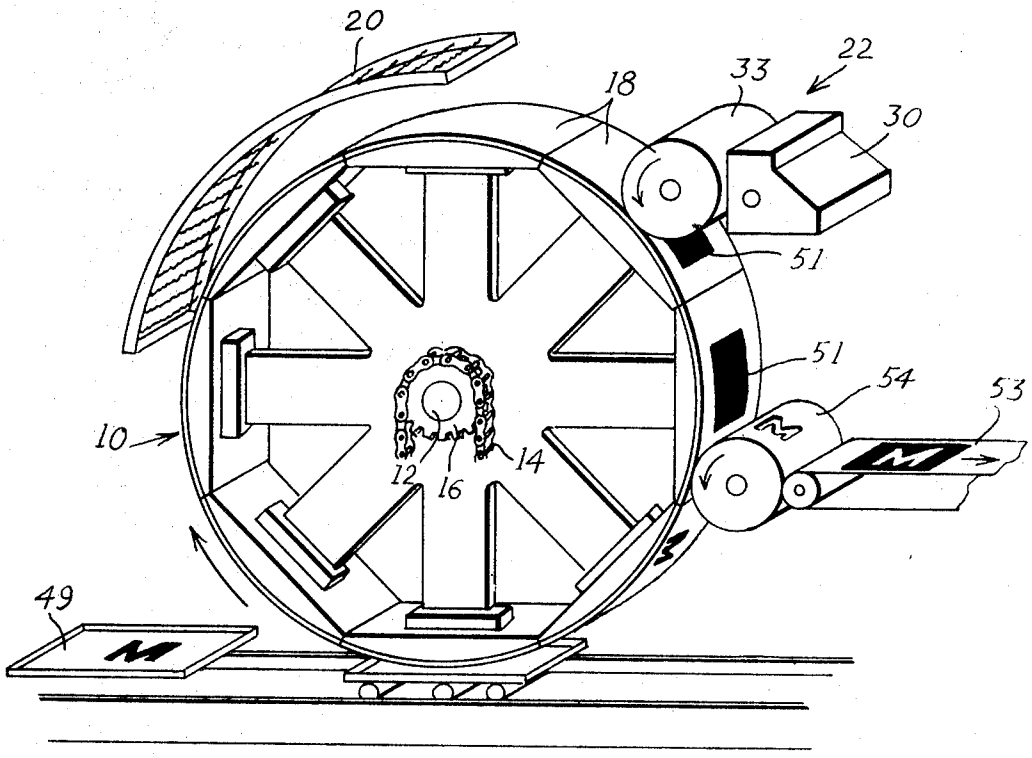


FIGURE 1

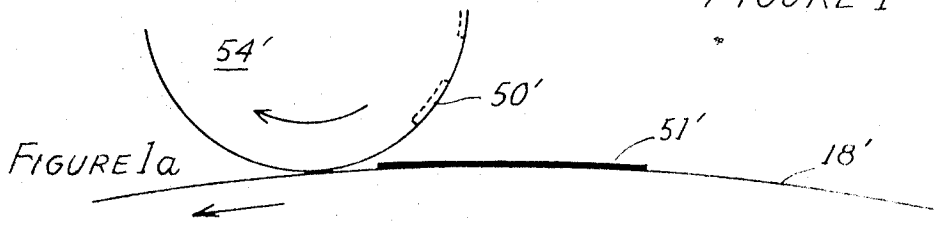


FIGURE 1a

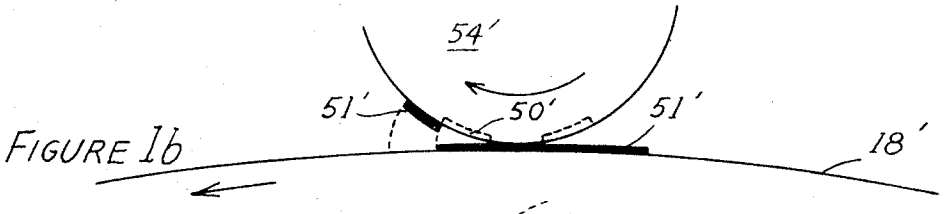


FIGURE 1b

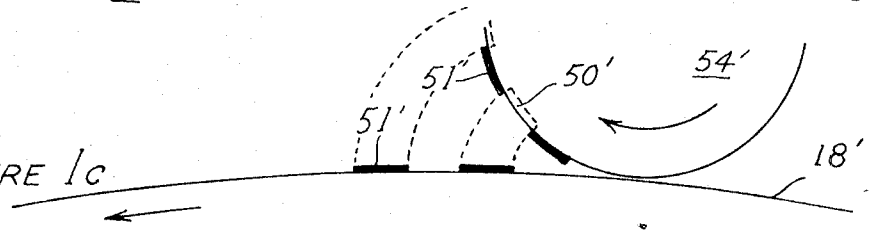


FIGURE 1c

INVENTOR.
KENNETH FRANKLIN TRIPP

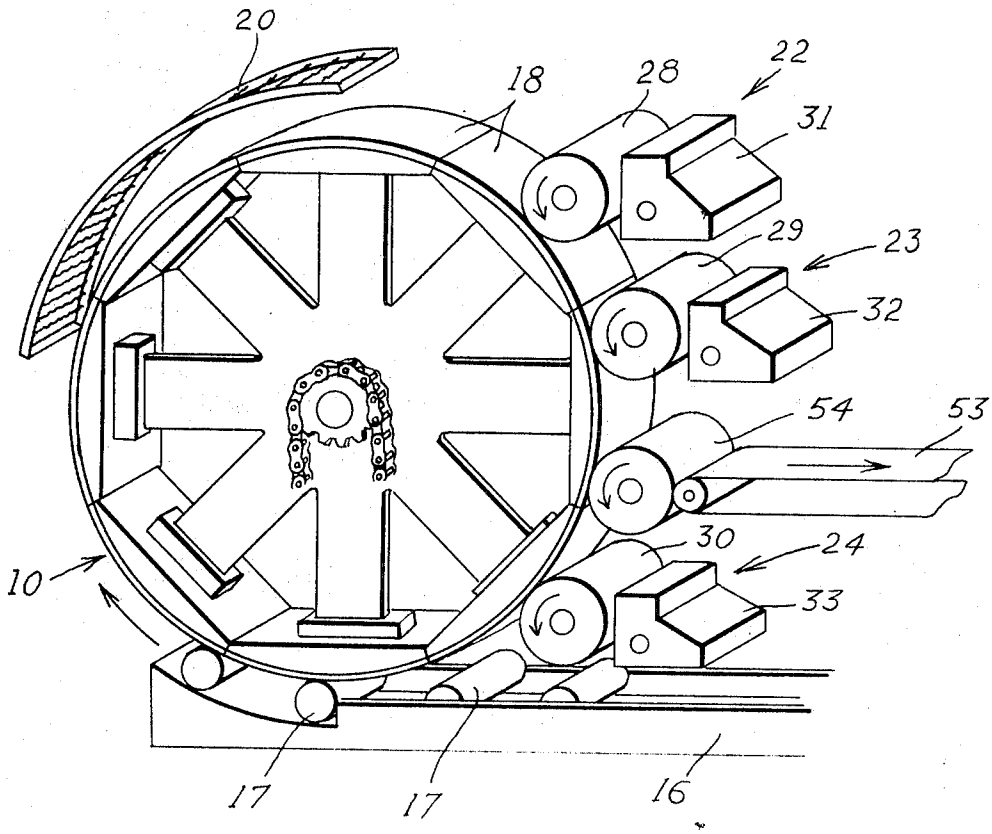


FIGURE 2

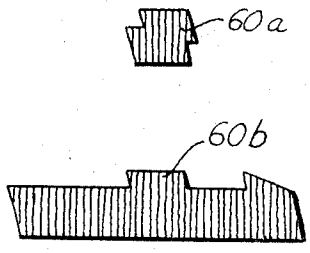


FIGURE 2a

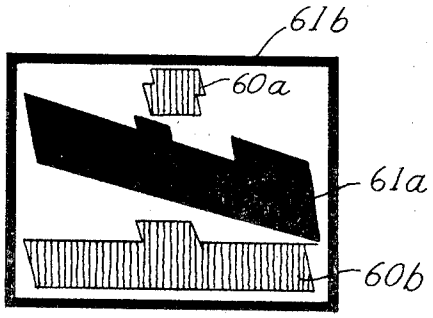


FIGURE 2b

INVENTOR.
KENNETH FRANKLIN TRIPP

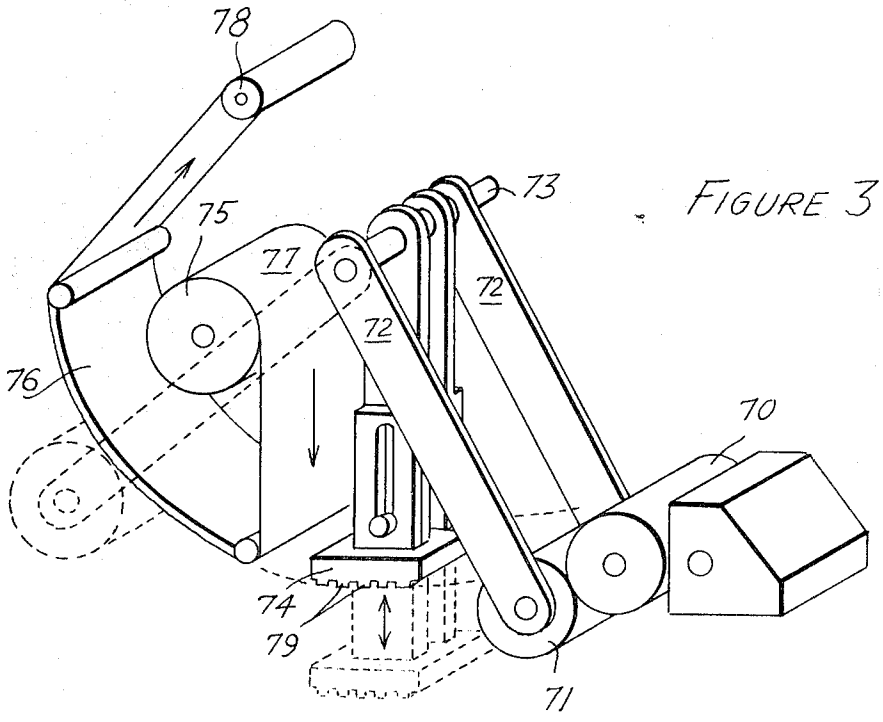


FIGURE 3



FIGURE 2c

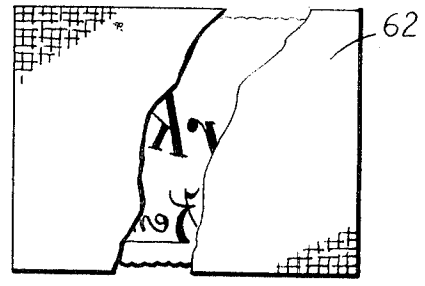


FIGURE 2d



FIGURE 2e

INVENTOR.
KENNETH FRANKLIN TRIPP

DRY INK-FILM PRINTING

This invention relates generally to the art of film formation and film transfer and more particularly to (1) a novel method and apparatus relating to the decoration of surfaces by offset and direct printing techniques with an immediately dry image transfer of controlled thickness, and (2) a novel method of inking a printing member with a substantially dry integrated film of ink. This invention constitutes an improvement over my joint copending application Ser. No. 361,584, now U.S. Pat. No. 3,255,695, filed Oct. 16, 1963.

In all instances of letterpress offset printing, after each cycle of printing operation, it is found that each impression results in a residual layer of ink left on the offset pad which, if not regularly removed, ultimately accumulates so as to render blurred and indistinct impressions. This, of course, imposes a burden on the press operator of having to perform a cleaning operation of the offset pad at regular intervals.

In letterpress offset printing, the quality of the image carried by the offset pad is determined in large measure by the uniformity and amount of contact pressure in laying down the image from inked relief dies. If the pressure between the inked die and offset pad is too great, ink "squishes" out around the edges of the dies and forms what is referred to as a "squeezeout", and makes itself evident as a surrounding border or "halo" conforming to the general shape of the image and separated therefrom by a visibly distinct area of reduced ink-film thickness. This is very difficult to overcome.

Also in conventional letterpress offset printing, as the die characters of legend become smaller, the inking of them has a tendency to smother or "fill-up" the dies with ink excesses resulting in poor image transfers. Direct letterpress printing techniques also exhibit these same shortcomings.

The present invention, however, overcomes these aforementioned deficiencies by introducing a novel concept heretofore unknown in the prior art. Generally this invention includes in its scope the feature that when a uniform fluent wetting layer of film-forming material is deposited upon a preselected carrying surface, and controlled film-forming transition is induced into such a fluid layer, this formation reaches a transitory condition of partial dryness whereby it becomes possible to completely separate this partially formed film intact, as an integral mass from its carrying surface without the use or aid of any film releasing agents.

Though these discovered principles have a wide variety of applications which will become more apparent in light of the following disclosures, we have for purposes of description and illustration selected the fields of letterpress offset printing and direct letterpress printing as typical of these areas of application.

Employing the aforementioned features of film-formation and separation, this invention improves over the prior art by providing a method and apparatus for (1) depositing on an offset pad one or more superimposed and/or coplanar "-patches" of film-forming ink covering an area corresponding to at least the maximum dimensions of the desired image, (2) converting this resultant "patch" or layer of film-forming ink to a transitory film condition exhibiting a desired cohesive integrity, and (3) removing selected portions of this film, intact, with a relief die, generating the desired ink-film image on the offset pad for transfer to an article being printed. In the case of direct letterpress printing, this invention follows steps 1 and 2 above, however, at step 3 when selected portions of the ink film are removed, intact, by the relief die, this in effect constitutes an inking of the die characters and this die itself may then be employed as the printing member to transfer its inked image to the surface of the article being printed. Since in either case the die is never inked directly with fluent ink, small legend characters are not smothered or "filled-up," resulting therefore in a final image from either the offset pad or die of exceptionally high quality. As used in this context, a "relief" die is one which is engraved, etched, or otherwise "relieved."

Because of the unconventional manner in which these dies of Embodiments I, II, and III are employed, special care should be taken in understanding the functional differences between these embodiments and conventional usage of such dies.

It is accordingly among the objects of this invention to provide a process and apparatus for depositing single or multicolored ink-films of controlled thickness at very high speeds on an object or series of objects being printed so that they may have the opacity or color density of silk screen process prints and yet are for all practical purposes immediately dry.

It is another object of this invention to provide a process and apparatus for generating a transferable single or multicolor image on an offset printing member by the selective removal of excesses of ink therefrom.

Another object of this invention is to provide a process and apparatus for offset or direct printing which produces a resultant image with a quality of definition heretofore unavailable except with the most expensive forms of printing techniques.

A still further object of this invention is to provide a means for inking a relief (i.e. raised) die with a substantially dry, nonfluent film of ink, preparatory to transferring this image by direct printing techniques to the surface being printed.

Yet another object of the invention is to provide a process and apparatus which retains the multicolor advantages of the dry offset principle in printing on various articles, but provides additional versatility by enabling the characters or decorations printed to be changed after each image transfer is made, as is required, for example, in consecutively numbering articles being printed with an automatic indexing printing head, without interrupting the cyclic operation of the process to remove residual deposits of ink from the offset pad.

A yet further object of this invention is to provide a process and apparatus for removing selective area portions of a partially dry film from its carrying support without the necessity or use of any release agents.

With these and other objects in view, as will hereinafter more fully appear, and which will be more particularly pointed out in the appended claims, reference is now made to the following description taken in connection with the accompanying drawings in which:

FIG. 1 shows a schematic view of a first embodiment of the apparatus of the herein invention, depicting single-color inked offset pads being presented sequentially to a die-roll which removes selective portions from this inked area leaving thereon the desired image to be transferred by offset;

FIGS. 1*a*, 1*b*, and 1*c* illustrate in schematic form the details of selective removal of ink portions from an ink patch;

FIG. 2 illustrates a second embodiment of this invention for use in multicolor printing;

FIGS. 2*a*, 2*b*, 2*c*, 2*d* and 2*e* illustrate in schematic form the sequence of operation of the apparatus shown in FIG. 2; and

FIG. 3 illustrates a third embodiment of this invention as employed in the inking and printing of relief dies, i.e. direct printing.

By way of background information, when a temperature controlled surface exhibiting a lower surface affinity for an ink-film than the film exhibits for the article to be printed is maintained within prescribed temperature limits, and has applied thereto a fluent layer of film-forming ink of suitable compounding, the predetermined time of exposure of such an ink layer on the temperature controlled offset pad so alters the physical state of the layer that it is converted from its initial fluid condition with little cohesive integrity to a partially dry ink-film which exhibits considerable cohesive integrity while concurrently attaining a transitory condition of substantial adhesive tack on its exposed surface.

During this transitory condition of substantial adhesive tack of the ink-film, this invention, insofar as it applies to letterpress offset printing, contemplates that three operations will be performed: (1) the tacky film on the offset pad, and an uninked relief-die are brought into intimate contact with each other and separated with the result that the ink-film intimately

contacted by the relief-die surface adheres thereto and is removed from the offset pad intact, leaving on the offset pad the remaining tacky film corresponding in shape and configuration to the relieved portion of the relief-die, i.e., corresponding to those areas on the relief-die which do not contact the ink-film; (2) as a second operation, the ink now on this relief-die is removed completely therefrom within a fixed time interval as will be hereinafter described in greater detail, leaving the die surface clean; and (3) as a third operation, the tacky ink-film remaining on the offset pad and corresponding to the relieved portions of the relief-die is brought into intimate contact with the surface of the article being printed, resulting in a complete image transfer thereto intact. In the case of direct letterpress printing, operation (2) above may be omitted and the ink-bearing relief-die may be used as the printing member whereby the inked image thereon may be transferred directly to an article to be printed. In both the above instances of intimate contact (operations 2 and 3) the ink-film in its converted state presents a film surface to the surface being contacted, which exhibits a greater adhesive tenacity therefor than the opposite film surface exhibits for the temperature controlled offset pad, which was preselected to exhibit a low affinity for the particular ink-film being employed.

An important result of this controlled occurrence is that selected portions of the partially dry ink-film can be completely transferred from the offset pad, intact, to, first, the relief-die, and second, from either the offset pad or relief-die (depending on which is employed as the printing element) to the item being printed, and this is achieved without the use of any release agents so that this film thereby leaves the offset pad or relief-die free of residual ink and immediately ready for the next ink application with no requirement for intermittent cleaning thereof. It has been demonstrated that this process can be carried out at speeds comparable to conventional dry-offset or letterpress printing presses. Because the transferred image is for all practical purposes immediately dry, this invention permits definite economies in equipment and floor space requirements by eliminating drying apparatus and moreover offers a versatility in film transfer techniques in general, and printing in particular, which has heretofore been unknown in the prior art.

In order to achieve these results, we have discovered that certain physical and chemical parameters relating to the (1) film-forming material (e.g. ink), (2) film carrying surface (i.e. offset pad), and (3) film receptor surface (i.e. article to be printed) should be established as follows:

1. The ink must necessarily be of film-forming composition and be capable of wetting the offset pad or other carrying surface when initially applied thereon in its fluent state.
2. At the moment of transfer, the film-carrying surface or offset pad should, in relation to the article being printed, exhibit a relatively nonadhesive (i.e. highly adhesive) characteristic for the particular converted film of ink or other film material carried thereon.
3. The film-receptor surface or article to be printed should exhibit characteristics opposite to those of the carrying surface, i.e. at time of image transfer, it should be highly adhesive to the film being transferred to it. In other words, at moment of film transfer, the film-receptor surface should exhibit a greater adhesive attraction for the film that does the film-carrying surface.

Film-forming compositions are well known in the art and no particular explanation of this parameter is deemed necessary.

However, predicting or ascertaining the conditions to fulfill the requirements of the remaining two parameters present definite problems. The interrelation between the ink-film and the carrying surface on the one hand are distinctly related though opposite in effect to the interrelation between the ink-film and the receptor surface on the other, in terms of adhesive attraction. It is thought that such adhesive attraction, or lack of it as the case may be, can be equated in terms of surface free energies, that is, the available molecular energy existing on the surface of one material for combination with compatible molecular energies existing on another surface brought in contact therewith, binding them together.

As an aid in understanding this invention certain findings relative to the adhesive behavior of surfaces in intimate contact with one another can be presented. Certain theories have been advanced which state that the extent or degree of mutual attractive affinity which materials exhibit for each other are due in great measure to the presence and interaction of so-called Van der Waal forces. For example, when two surfaces are brought into intimate contact, these Van der Waal forces, representing the residual surface energies of these surfaces, coact between their respective atoms and molecules in such a manner as to forcibly combine together. These theories further state that where a strong adhesive bond is required, the material on which the adhesive is spread should have a higher residual surface energy than the adhesive. Conversely, where a relatively weak bond is desired (that is, a high degree of releasibility), the residual surface energy of the material should be less than that of the adhesive. These residual surface energies are often times referred to as bonding energies. The behavior of a film-forming ink can in some ways be equated to the behavior of an adhesive, and notwithstanding that the current state of the art in adhesion theory is not well defined and is still in a state of scientific flux, it is my belief that the foregoing is responsible for the effects which permit the successful methods of film formation and transfer without the aid of release agents as herein disclosed.

In accordance with these principles, then, at the moment of film transfer either to the relief-die or to the article being printed, the bonding energy between the converted ink-film and the offset pad must be less than the bonding energy between that ink-film and the surface to which film transfer is to be made. Therefore, in order that these conditions exist, the residual surface-free-energy of the offset pad material must not exceed the residual surface-free-energy of the article to be printed, and as a practical matter, it is preferable that the residual surface-free-energy of the offset pad be less than that of the article to be printed.

EMBODIMENT 1

With this background in mind, reference is now had to the embodiment shown in FIG. **1** which comprises a drum **10** mounted on shaft **12** for rotation about its axis. A chain **14** and sprocket **16** are provided for rotating the drum in a clockwise direction at the desired rate of speed from any suitable source of power (not shown).

Mounted on the periphery of the drum are a series of offset surfaces or pads **18** of material displaying the following characteristics: (a) a totally polymerized material exhibiting a relatively nonadhesive characteristic for the particular ink or fluid film to be employed thereon (i.e. a material having a residual surface free energy which is less than that of the ink-film material) and yet by wetted thereby; (b) remains operative over a wide temperature range as dictated by the ink selected; and (c) should preferably be elastomeric in nature. In the preferred embodiment, a pad **18** may consist of, but is not limited to, any one of the following materials which exhibit these characteristics, in relation to the ink formulations desired to be used: chloroprene; polyvinyl chloride; carboxy methyl cellulose; polytetrafluoethylene, dimethyl siloxane; polyethylene-prophylene; polyester; polyurethane (isocyanate polymer); polyamide; polisobutylene; butadiene-acrylonitrile copolymer; and polyvinyl alcohol.

Fixedly positioned adjacent the peripheral surface of drum **10** is a thermostatically controlled radiant heater **20** conventionally adapted to maintain the temperature of the offset surface **18** at any desired value within the range from room temperature to 400° F. Also mounted along the periphery of the drum in a clockwise direction from heater **20** is an inking mechanism **22** comprised of an ink reservoir **30** adapted to carry a supply of fluent film-forming printing ink at room temperature (approximately 60° F. to 90° F.) and an ink applying roll **33**.

As drum **10** rotates in a clockwise direction, pad **18** heated as a result of having passed under **20**, is carried past ink-roll **33** and receives a solid "patch" or layer **51** of fluent ink. In the time interval before fluent ink layer **51** reaches relief-die **54**, this ink layer undergoes certain controlled changes achieving a film state herein before described whereby two conditions coexist; namely, (1) the cohesive forces within the ink-film reach a level which exceeds the adhesive force between the ink-film and the offset pad surface, and (2) the adhesive force or bonding energy between the converted ink-film and relief-die **54**, when placed in contact therewith, will be of greater magnitude than the adhesion or bonding between the ink-film and the offset pad surface.

In the illustrated embodiment, die **54** is a molded silicone die (i.e. a relief die) maintained at 150° F.—200° F. and which rotates a counterclockwise at the same peripheral speed as drum **10**. Molded into the surface of die **54** is a pattern which for exemplary purposes is an "M." As the solid layer **51** of converted tacky ink-rolls in contacting relation against die **54**, the ink-film is removed, intact, from pad **18** in all but the relieved areas of "M" thereby leaving an image on the surface of pad **18** corresponding to the "M" in relief on die **54**. This process is shown progressively in greater detail in FIGS. **1***a*, **1***b*, and **1***c*. These figures schematically depict corresponding elements shown in FIG. **1** and illustrate a side elevation view of a relief-die **54'**, and an offset pad **18'** carrying an ink patch **51'**. The relieved areas **50'** correspond to a molded image in relief-die **54'**. As die **54'** comes into intimate contact with the converted film of ink patch **51'**, the adhesive attraction therebetween is greater than between ink patch **51'** and offset surface **18'**. Accordingly, as die **54'** and ink patch **18'** become separated, that portion of **18'** contacted by the peripheral surface of **54'** adheres thereto and is removed from offset surface **18'**, as can be seen in FIG. **1***b*. Note also in FIG. **1***b* that the relieved area **50'** (corresponding to the "M" in FIG. **1**) does not contact ink patch **51'** and hence ink in these areas remains on offset surface **18'**. This feature is more clearly illustrated in FIG. **1***c* in which the inked areas **51'** remaining on offset surface **18'** correspond to the relieved portions **50'** of die **54'**, the remaining portion of ink patch **51'** having been removed by adhering to the nonrelieved surface of die **54'**.

Reverting now to FIG. **1**, in order to always present a clean relief-die surface to the tacky ink layer **51** so as to effect the desired transfer of ink thereto, die **54** must be cleaned within one revolution of rotation. This may be accomplished in a number of ways, e.g., the ink-film picked up by die **54** is still tacky and may in turn be "printed" or transferred completely to the surface of moving endless web **53**, rotating in a clockwise direction at the same peripheral speed as relief-die **54**, thereby cleaning and leaving this die surface clean preparatory to contacting the next succeeding ink patch on drum **10**; alternatively, the ink-film on die **54** may be removed by a conventional scraper blade mechanism, or exposed to a solvated environment.

The converted but still slightly tacky image remaining on pad **18** after separation from die **54** is then presented to the surface of the article to be printed, as for example, tray **49** where it will transfer, intact, in accordance with principles hereinbefore discussed.

An example of a typical ink composition which would perform satisfactorily in this embodiment is as follows:

BLACK POLYETHYLENE INK

Ingredients	% By Weight
Methyl Methacrylate	10—15
N-Butyl/methylmethacrylate	7—10
Diethylene Glycol Monoethyletheracetate	50—70
Butyl Benzyl Phthalate	8—11
Carbon Black	3—5

EMBODIMENT 2

Having thus disclosed the basic principles of a single-color image generation and transfer, this invention further contemplates the making and transferring of multicolored images by employing the same concepts. In this regard, reference is now had to the illustration of FIG. **2**, wherein is shown a rotatable drum **10** carrying a plurality of offset pads **18**. Fixedly mounted above drum **10** is a heater apparatus **20** adapted to maintain the offset pads **18** at a predetermined temperature level. Operatively spaced around the periphery of drum **10** in a clockwise direction are inking mechanisms **22**, **23**; die-roll **54**; and another inking mechanism **24**. Each of these inking mechanisms is comprised respectively of an ink-roll **28**, **29**, **30** and an ink reservoir, **31**, **32**, **33**. Positioned along the lower portion of drum **10** is a chute **16** carrying articles to be printed as for example, glass bottles **17**.

In operation, this device would perform as follows: As drum **10** rotates in a clockwise direction an offset pad **18** carried under heater **20**, is raised to a predetermined temperature level depending on the inks employed. As this pad **18** is carried past ink-roll **28**, one or more patches of first colored ink are applied thereon in a predetermined pattern, as for example, two solid colored patches **60***a*, **60***b* of red ink (see FIG. **2***a*). As this inked pad **18** with its two red ink patches passes ink-roll **29**, two black colored ink patch configurations **61***a*, **61***b* are applied by roll **29** whereby the composite patch now resulting appears as shown in FIG. **2***b*, and is substantially coplanar in nature. As wheel **10** continues to rotate, this composite fluent ink "patch" or layer comprised of **60***a*, **60***b*, **61***a*, and **61***b* is, because of the heated offset pad **18**, converted to the above-described cohesive mass exhibiting a slightly tacky outer surface. These multicolored converted ink-films are next brought into rolling contact with relief-die **54**. All areas of the multicolored ink-film which come into intimate contact with die **54** adhere thereto and are transferred intact from the offset pad **18** to the die surface **54**, leaving on offset pad **18** the desired configured two-color image corresponding to the relieved portions of the die as shown in FIG. **1***c*. Relief-die **54** is cleaned of ink in the same manner described in Embodiment 1. The offset pad **18** with its desired image (shown in FIG. **2***c*) is now carried into contact with ink-roll **30**, which overlays over the entire image on pad **18** a layer of, for example, yellow ink **62** which contrasts in color with the two previously applied colors to function as a background color, as shown in FIG. **2***d*. The view depicted in FIG. **2***d* is shown in breakaway merely to emphasize the overlaying of the complete image of FIG. **2***c*. It should be noted at this point that FIGS. **2***a*—**2***d* illustrate images as they actually appear on the offset pad **18** and hence will be upside down. As offset pad **18** now leaves ink-roll **30**, the multilayered, multicolored image continues to be —from its fluent noncohesive state to a cohesive condition with a slightly tacky exposed surface due to the temperature level of offset pad **18**. When these ink-films conditions reach an optimum level of cohesive integrity and surface tack, the image is brought into contact with the surface to be printed, for example, a glass bottle **17**, where the entire image is transferred intact as an integral mass from the offset-pad to the surface being printed. The last applied yellow ink layer **62** from ink-roll **30** then becomes the first layer of ink in contact with the bottle and serves as background color for the image whereas the initially applied coplanar patches of ink deposited from ink-rolls **28**, **29** then become the uppermost layers on the print as it finally appears on the bottle surface. The final transferred image on the surface being decorated appears as seen in FIG. **2***e*. No attempt has been made to depict the various colors in FIG. **2***e* as this would tend to confuse the illustration.

It should again be noted at this point that the functions of the relief-die and the offset pad hereinbefore described under Embodiments 1 and 2 may be reversed. That is, the relief-die **54** may be employed as the direct letterpress printing element to print on a surface which replaces endless web **53**, and the offset pads **18** may then be used to carry away and transfer the

waste portion of the ink-film to a waste removal web corresponding to web **53**. In such a device, the die may be of suitable elastomeric material or, if the printing is to be done on a surface which is yieldable, a metallic die of chromium or nickel plate, or other passivated surface may be employed.

An example of typical ink compositions which would perform satisfactorily in this embodiment are as follows:

Black Polyethylene Ink—as described hereinabove.

RED POLYETHYLENE INK

Ingredients	% By Weight
Methyl Methacrylate	15—20
N-Butyl/methylmethacrylate	7—10
Diethylene Glycol Monoethyletheracetate	45—55
Butyl Benzyl Phthalate	11—13
Naphthanil Red	11—13

YELLOW POLYETHYLENE INK

Ingredients	% By Weight
Methyl Methacrylate	15—20
N-Butyl/methylmethacrylate	10—12
Diethylene Glycol Monoethyletheracetate	45—55
Acetoacetanilide coupled Dichlorobenzidine	2—3
Titanium Dioxide	10—13
Butyl Benzyl Phthalate	10—13

This last described form of printing constitutes, in effect, the inking of the printing member (i.e. the die) with a non-fluent, substantially dry ink-film. As previously described, this die must also transfer its image, intact, within one revolution in order to present a clean surface to the next ink-patch on drum **10** which it will contact.

These two above-described embodiments thus disclose a process and apparatus for making a single color, or multicolor, multilayered image on an offset surface through the selective removal of ink excesses, and transferring the resultant image intact, to an article being printed. It should be particularly noted that each of these disclosures reveal a distinct departure from the conventional method and apparatus employed in offset printing where the desired image itself is transferred to an offset surface from a suitably inked die. The present invention generates the desired image on an inked offset surface through the selective removal of ink therefrom by use of a relief-die.

EMBODIMENT 3

This embodiment, schematically illustrated in FIG. **3**, discloses another form of apparatus for direct letterpress printing employing the concepts of this invention. This illustration depicts a stationary rotating reservoir roll **70**; a temperature controlled, silicone inking roll **71**, rotatably journaled between a pair of support arms **72** which oscillate about shaft **73**. Die-plate **74** is conventionally adapted to reciprocate in a vertical plane in timed relation to the oscillating inking-roll **71**.

Supply wheel **75** carries a roll of paper **77** which is fed in a web over shoe **76** to a takeup reel **78**. In operation this device would function as follows: Reservoir roll **70** would be set in operation to continually develop an ink film thereon. Oscillating support arms **72** driven by a conventional power means (not shown) bring heated inking-roll **71** into timed contact with reservoir roll **70** so as to develop an ink-film thereon. Because inking roll **71** is heated, the ink-film carried thereon will be converted to the partially dry film condition hereinbefore described in connection with Embodiments **1** and **2**. At this point in time, support arms **72** are actuated so as to carry the surface of inking-roll **71** across die-face **74**. The raised die characters **79** will remove the converted ink intact completely from inking-roll **71** in those areas where there is intimate contact therebetween, leaving ink on roll **71** where there is no contact with the die. Inking-roll **71** continues its motion past die plate **74** and comes into contact with paper web **77** supported on shoe **76**. Since the tacky ink-film condition is still present, the remaining ink on inking-roll **71** will adhere to web **77** and be completely removed therefrom as roll **71** rotates across the surface thereof. In point of time while inking-roll **71** is in rolling contact with paper web **77**, die plate **74** is actuated and vertically descends into printing contact with the surface being decorated, transfers its image, and retracts. When die plate **74** reaches its retracted position, inking-roll **71** then oscillates in a counterclockwise direction without contacting die-face **79** and again comes into contact with reservoir roll **70** to repeat this cycle.

Takeup roll **78** may be actuated in any conventional manner to wind up paper tape **77** in increments. Tape **77** corresponds in function to web **53** previously described in connection with Embodiments **1** and **2**. It should be noted that that portion of web **77** supported on shoe **76** need not always present an ink-free surface to inking-roll **71** in order to effect a complete removal of ink therefrom. Accordingly, takeup roll **78** may be operated in incremental fashion, that is to say, for example, on the counterclockwise return of support arm **72**, takeup roll **78** may move web **77** only one-third of the distance across shoe **76** thereby conserving the supply of waste print remover material without affecting the ink transferability from roll **71** due to the presence of residual ink layers from previous cycles.

Because the die characters on die plate **74** are inked with a substantially dry film of tacky ink from inking-roll **71**, there is a complete absence of so-called "filling up" of small character legends. When die plate **74** subsequently transfers its inked image to the surface being decorated, the resultant image-transfer exhibits exceptional character definition which is comparable to leaf or authentic engraved printing and the frequent "halo" effect observed around normal letterpress images is completely eliminated.

It should also be noticed that the amount of ink deposited on inking-roll **71** need only be of such extent as that required to cover the die characters on die plate **74**. The ink-film once developed on inking-roll **71** never experiences any further so-called "film splitting." The ink-film deposited on die-face **74** is a complete and integral transfer of ink-film from roll **71** to the die character without any film-split. That portion of the ink-film then remaining on roll **71** is subsequently cleaned off by transfer as an integral mass to the web **77** supported by shoe **76** so that inking-roll **71** then returns to reservoir roll **70** in a completely uninked surface condition.

Any of the above ink formulations will perform satisfactorily in connection with this embodiment.

Having thus achieved the object hereinbefore outlined, various modifications are contemplated and may obviously be resorted to by those skilled in the art, without departing from the spirit and scope of the invention as hereinafter defined by the appended claims, as only three preferred embodiments thereof have been disclosed.

I claim:

1. In offset printing apparatus, the combination comprising: a temperature controlled printing member; a plurality of ink-rolls for applying to said printing member a corresponding number of coplanar layers of film-forming inks; an uninked relief-die juxtaposed said printing member and adapted to intimately contact said coplanar layers and to completely remove selected portions thereof, intact, when separated therefrom, leaving an image on the printing member; means coacting with said relief-die to clean said die of any ink residue thereon before contacting another ink-film; and other ink-roll means for selectively overlaying the aforesaid image on the printing member with at least an additional layer of film-forming ink.