May 25, 1965 R. K. NORTON 3,185,088

METHOD AND APPARATUS FOR PREDETERMINING SETTINGS FOR INK FOUNTAIN KEYS

Filed Dec. 1, 1961 3 Sheets-Sheet 1

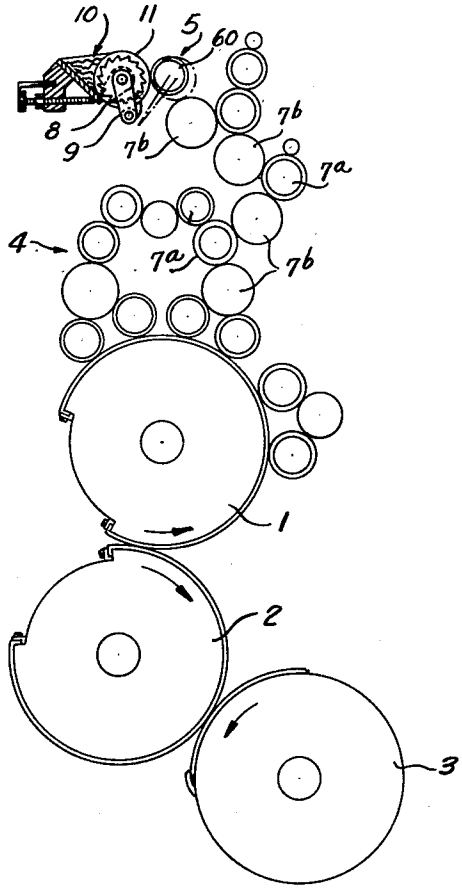


FIG. 1

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METHOD AND APPARATUS FOR PREDETERMINING SETTINGS FOR INK FOUNTAIN KEYS

Filed Dec. 1, 1961 3 Sheets-Sheet 2

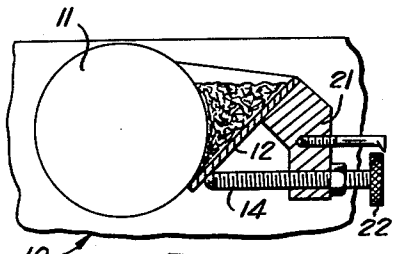


FIG. 2

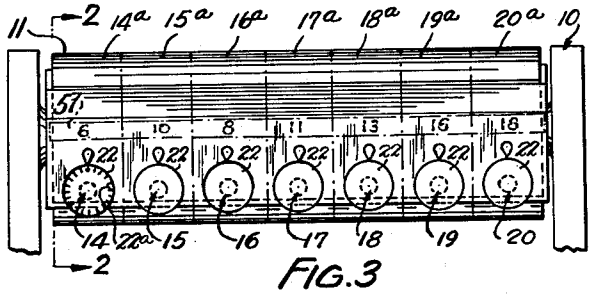


FIG. 3

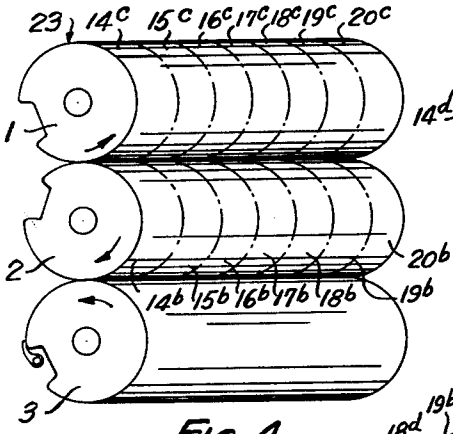


FIG. 4

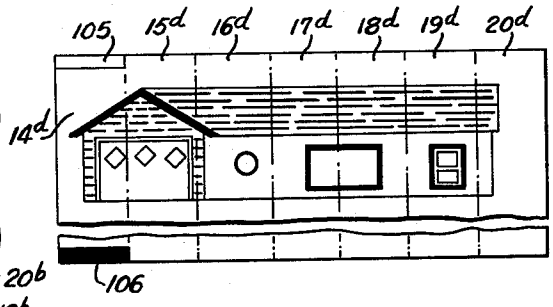


FIG. 5

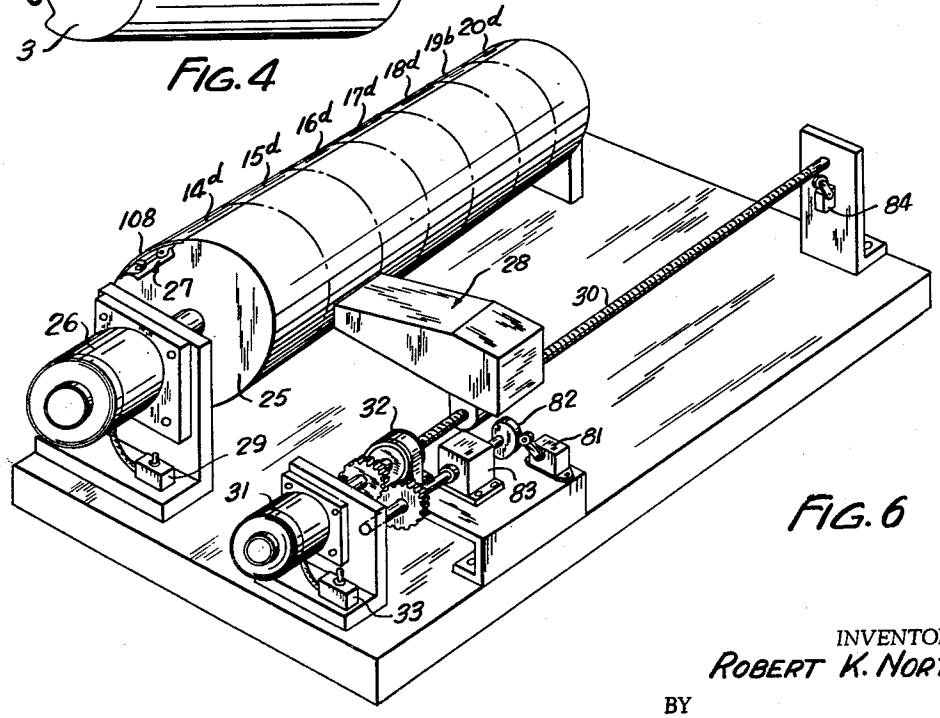


FIG. 6

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METHOD AND APPARATUS FOR PREDETERMINING SETTINGS FOR INK FOUNTAIN KEYS

Filed Dec. 1, 1961 3 Sheets-Sheet 3

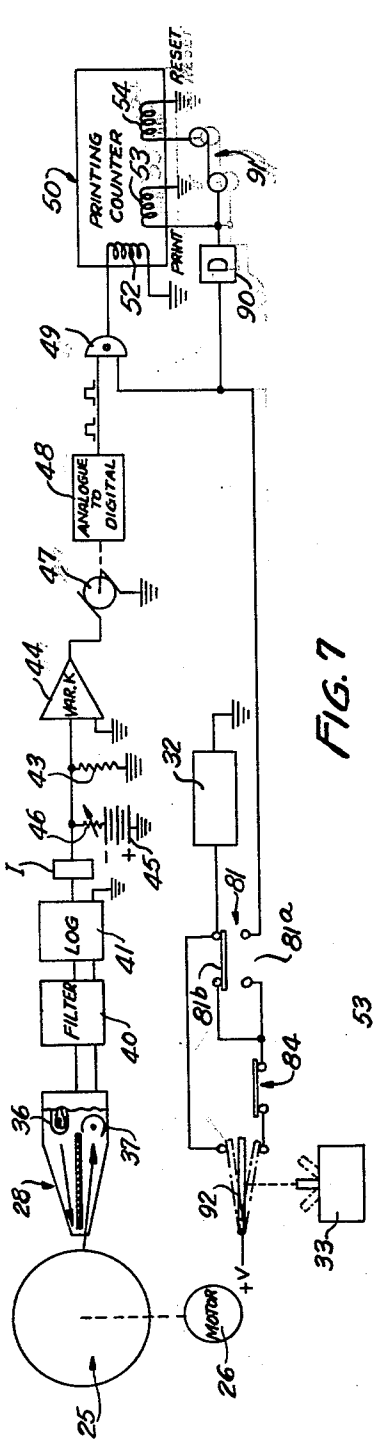


FIG. 7

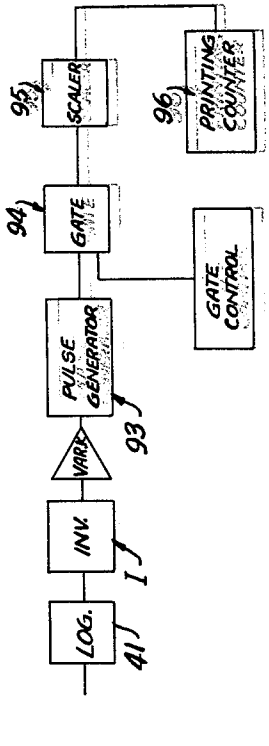


FIG. 9

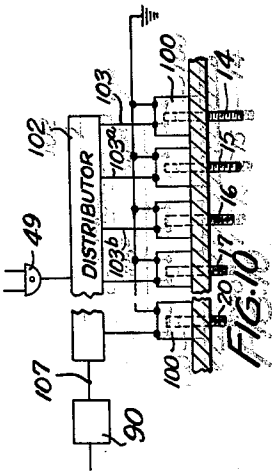


FIG. 10

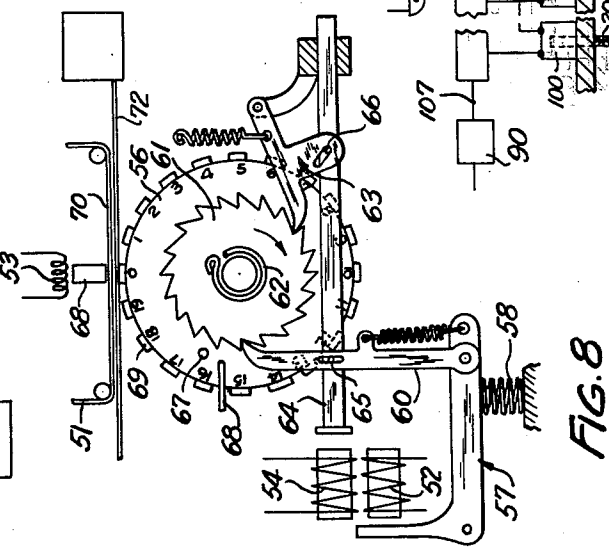


FIG. 8

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United States Patent Office 3,185,088 Patented May 25, 1965

3,185,088

METHOD AND APPARATUS FOR PREDETERMINING SETTINGS FOR INK FOUNTAIN KEYS

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Filed Dec. 1, 1961, Ser. No. 156,393
21 Claims. (Cl. 101—426)

The present invention relates to a method and an apparatus for predetermining settings for keys on the ink fountain of a printing press.

Each ink fountain of a printing press is commonly provided with a plurality of adjustable keys which are spaced along the length of the ink fountain blade and which determine the spacing of the portion of the fountain blade adjacent the key from the fountain roll and thereby regulate the ink flow from the fountain past this portion of the fountain blade. These key settings control the ink density of the printed image and are particularly important if quality prints are to be obtained, especially in multicolor printing presses.

Heretofore, the ink keys have been initially set by guesswork, prints made, the print examined, and then the keys adjusted to correct the spacings of the fountain blade at those portions of the blade which have been supplying too little or too much ink. It can be appreciated that this method of setting the ink keys is extremely time-consuming and also wasteful of paper. In both web and sheet-fed presses large quantities of material might be run through the press before the keys are properly set. In multicolor presses, such as four-, five- and six-color presses, the problem of setting the ink keys is compounded, since the ink fountain for each color must be set and, in many instances, the colors in at least parts of the image overlap each other so that it is difficult to determine which unit is causing the variance in the final print of the printed color from the desired color. The problem is further complicated by the fact that the settings of the ink keys will vary depending upon the tack value and opacity of the ink being used. Inks of the same color, as well as of different colors, will have different tack values and different opacities, i.e., density. In a multicolor printing press the inks in each printing unit have different tack values to prevent the printing units subsequent to the first unit from pulling ink printed by the preceding printing unit or units from the sheet. While it is possible to adjust for variables, such as ink density and tack value, by adjusting the ink flow as a whole from the fountain, this cannot be done until the keys are properly set relatively to each other.

Certain types of mechanisms and methods have been proposed for correcting the settings of ink keys. All of these methods and mechanisms, however, depend upon analyzing the quality of a print made by the unit and then setting the ink fountain keys by guess to correct for variations from the desired ink density on the print. It can be seen that this method does not eliminate the guesswork in the initial setting of the keys and still requires quantities of paper to be used in making the test prints to check the settings of the keys originally made by guess. Moreover, the known systems have not provided information as to the proper settings of the ink fountain keys relative to each other so that the keys can be set and then the ink flow from the fountain varied as a whole, as by adjusting the conventional ducting mechanism commonly associated with the press, to provide more or less ink to adjust for variables effecting the thickness of ink film required to provide the proper color.

It is an important object of the present invention to provide a new and improved method and an apparatus for predetermining the initial setting of an ink key of a printing fountain and to thereby minimize the waste of paper or other material being printed due to running test sheets, as well as to minimize the time necessary to properly set up the press for a run.

Another object of the present invention is to provide a new and improved method and an apparatus for predetermining the relative settings of the ink keys of an ink fountain controlling the ink flow to corresponding zones of a printing cylinder so that the quality of the print can thereafter be controlled by an adjustment which effects the ink flow from each key to the printing cylinder proportionately.

Still another object of the present invention is to provide a new and improved method and means for predetermining the proper settings for the keys of an ink fountain which enable the proper key settings to be determined prior to the making of prints and which can be compensated for variations in characters of the inks being used and which affect the quantity of ink required to provide a given color effect.

Another object is to provide a new and improved apparatus and method in which the ink key settings are obtained by scanning the printing plate for printing the image and wherein the settings are adjusted for the effects of the surface of the printing plate on the readings.

A still further object of the present invention is to provide a new and improved method in which waste printed material and setup time is minimized by determining in advance of the printing operation the relative settings for the keys of the ink fountains of the printing press.

In accordance with the present invention, the image to be printed is divided into zones which basically correspond to the zones in which the ink density would be controlled by a single key. These zones are then scanned to determine the image density of the zones. The measurement of the image density is then used to preset the ink fountain keys so that the keys will be set properly relative to each other and so that further adjustment can be made by adjusting ducting mechanism associated with the fountain or by adjusting other ink flow control devices which affect all zones proportionately. Preferably, however, the scanning apparatus includes means for compensating for variables, such as ink density, tack value, etc.

Further objects and advantages of the present invention will be apparent from the following detailed description thereof with reference to the accompanying drawings, forming a part of the present specification and in which:

FIG. 1 is a schematic showing of a lithographic press embodying the present invention;

FIG. 2 is an enlarged cross section of the ink fountain shown in the press in FIG. 1;

FIG. 3 is a side elevational view of the ink fountain of FIG. 2;

FIG. 4 is a schematic showing of the blanket and impression cylinders of a lithographic press;

FIG. 5 is an illustration of an image to be printed;

FIG. 6 is a perspective view of a scanning apparatus for scanning the image of FIG. 5;

FIG. 7 is a schematic drawing showing the scanning apparatus and associated circuitry for measuring image density of the image being scanned;

FIG. 8 is a diagrammatic showing of a printing counter;

FIG. 9 is a block diagram showing a circuit different from the circuit of FIG. 5 which could be used with the scanning apparatus; and

FIG. 10 is a diagrammatic showing of a system for automatically setting the ink keys of an ink fountain directly from the scanning apparatus.

Referring to the drawings, a sheet-fed lithographic press

of conventional type is shown schematically in FIG. 1 and comprises a plate cylinder **1**, a blanket cylinder **2**, and an impression cylinder **3**. The plate cylinder is inked by a conventional inker **4** comprising an ink fountain **10**, an adjustable ducting mechanism **5** including a duct roll **6**, and a plurality of ink transfer and vibrating rolls **7***a*, **7***b* between the ducting mechanism **5** and the plate cylinder **1**.

The ink fountain **10** includes a fountain roll **11** which rotates in the ink fountain to form an ink film thereon. The duct roll **6** is reciprocated between a position in engagement with the fountain roll **11** and a position in engagement with one of the vibrating rolls **7***b*. During the portion of the cycle that the duct roll **6** is in engagement with the fountain roll **11**, the latter is rotated an angular amount determined by the setting of an adjustable mask **8** of a pawl and ratchet drive **9** for the fountain roll. The extent of rotation of the fountain roll while in engagement with the duct roll determines, for a given film thickness on the fountain roll, the amount of ink transferred from the fountain roll to the duct roll and, in turn, the amount of ink transferred to the plate cylinder. The ducting mechanism and adjustable pawl and ratchet mechanism are well known to those skilled in the art and will not be described in further detail.

The ink fountain **10** is shown in cross section in FIG. 2, and as shown therein comprises the fountain roll **11** which is adapted to rotate in the fountain and a fountain blade **12** which forms the bottom of the ink reservoir and which is adjustable toward and away from the fountain roll **11** to vary the ink flow from the fountain and control the ink film thickness on the fountain roll. The fountain blade **12** extends the length of the fountain roll **11** and a plurality of ink keys in the form of screws **14**, **15**, **16**, **17**, **18**, **19** and **20** are adapted to engage the underside of the fountain blade **12** to determine its spacing from the fountain roll. The screw keys are spaced along the length of the fountain blade and thread through a supporting wall **21** of the fountain to engage their inner ends with the underside of the fountain blade **12**. The blade **12** is resilient and is urged into engagement with the inner ends of the screw keys. The outer ends of the screw keys **14–20** are each provided with a head or knob **22** which is graduated with graduations **22***a* to indicate the angular position of the screw key. In the illustrated ink fountain, one full revolution of a screw key constitutes the normal full range adjustment of the screw key to adjust the key from a position where the screw key urges the fountain blade **12** into engagement with the ink roll **11** to a wide open position.

The ink thickness on various circumferential zones of the fountain roll is determined by the settings of the keys **14–20**. The settings of the ink keys determine the density of the ink in respective circumferential zones on the fountain roll, these zones being designated by the reference numerals **14***a*, **15***a*, **16***a*, etc., and on the image portions of the corresponding circumferential zones on the printing cylinder, the blanket cylinder in the illustrated press, so that if an ink key is varied, the density of the ink on the image portions of a corresponding circumferential zone of the printing cylinder and, in turn, on a corresponding longitudinal zone of the printed image, would be changed. The blanket cylinder is shown as having seven zones, the ink density which is controlled by the seven fountain keys and these zones have been given the reference numerals **14***b*, **15***b*, **16***b*, etc. Moreover, the plate cylinder **1** has corresponding zones and these have been given the reference numbers **14***c*, **15***c*, **16***c*, etc., and the printed images can also be divided into approximate longitudinal ink key zones in which the density of the ink in the zone is determined by the settings of corresponding ones of the ink keys **14–20**.

In accordance with the method of the present invention, an image to be printed by a printing unit embodying the ink fountain **10** is scanned to determine the settings of the ink keys **14–20**. The image scanned may be an original copy, a transparency flat, a printing plate, or similar images corresponding to that to be printed. A printing plate carrying the image to be scanned is illustrated in FIG. 5 and is divided into seven zones **14***d*, **15***d*, **16***d*, etc., and each zone corresponds to that portion of the image whose ink density is controlled by the key in the ink fountain which has the same reference numeral as the zone without the "*d*" applied thereto. To determine the proper setting of the ink key **14**, the zone **14***d* is scanned to determine the image density of the zone by directing light thereon and measuring the average or accumulative intensity of light reflected by the zone. The ink key **14** is then set to a position corresponding to the magnitude of the image density of zone **14***b*. Similarly, the zone **15***d* is scanned to determine the image density by measuring the average or accumulative intensity of the light reflected and the measurement used to set the key **15**, etc. While it has been stated that reflected light is used to determine the settings of the ink keys, it will be appreciated by those skilled in the art that the reflected light is merely an indication of image density and other methods for determining the image density might be used. For example, in multicolor printing, it is common to make color separation negatives preparatory to making the printing plate. Such a color separation negative could be scanned by transmitting light through the image and the average or total amount of light transmitted by the zone of the image corresponding to the ink key determined, and this average used as an indication of image density and the ink key set in accordance therewith.

In the preferred embodiment, the printing plate to be mounted on the plate cylinder is scanned and the image shown in FIG. 5 is on the plate to be used to print the image.

An apparatus for scanning the image to be printed is shown in FIGS. 6 and 7. In the illustrated apparatus, a reading head is adapted to scan, i.e. read, the image corresponding to the image to be printed. The scanning head embodied in the illustrated apparatus is not large enough to scan the entire zone of an image corresponding to an inking zone for a particular ink key with the head and image stationary and, therefore, it is necessary to effect relative movement of the scanning head and the image to enable the scanning head to read the entire image. The apparatus includes a rotatable cylinder **25** on which a sheet or plate carrying the image to be printed is mounted to be scanned. Preferably, the cylinder has conventional clamping means **27** for clamping a printing plate for the image to the cylinder. The cylinder **25** is adapted to be rotated by a motor **26** controlled by a switch **29**. A scanning head **28** is supported adjacent the rotating cylinder **25** and is mounted on a lead screw **30** which extends the length of the cylinder **25** and is driven by a reversible motor **31** to move the scanning head **28** along the cylinder. The lead screw **30** is driven from the motor **31** through an electric clutch **32**, the motor being controlled by a three-position switch **33**.

The scanning head **28** includes a lamp **36** (see FIG. 7) from which light rays are directed onto the image on the cylinder **25** as the latter is rotated and the reflected light rays are picked up by the scanning head **28** and transmitted to a photocell pickup **37** so that the output of the photocell pickup **37**, which is a varying D.C. output, is a function of the light reflected from the image on the rotating cylinder **25**. The scanning head **28** extends approximately the width of a zone controlled by an ink key and the head is moved in a step-wise manner along the cylinder to successively scan the zones **14***d*, **15***d*, **16***d*, etc., in a manner described in more detail hereinafter.

In certain types of scanning units, the output may be A.C. instead of D.C. and it is obvious to those skilled in the art that A.C. can be converted to D.C by merely rectifying the output of such a scanning head.

The light reaching the pickup 37 will vary in accordance with the density of the image being scanned. The variation in light and the output of the photocell will not, however, be a linear function of image density. For practical purposes, the variation in the output of the photocell unit 37 with image density can be considered to be a log function of image density.

The output of the photocell pickup unit 37 is applied to a filtering circuit 40 to average the varying signal from the pickup unit 37. The output from the filtering circuit 40 is, then, a D.C. current having a magnitude which indicates the average image density of the image zone being scanned. The output from the filtering circuit is then applied to a nonlinear circuit 41 which may be a log circuit to convert the input to the circuit to a substantially linear output for variations in image density. The output of the log circuit is inverted by an inverter I and appears across a resistance 43 connected across the output of the inverter and also across the input of a variable gain amplifier 44.

The inverter I is used, since a high intensity of reflected light indicates a low image density and, therefore, a high level output from the photocell unit indicates that a small amount of ink is required, while a low level output indicates a greater image density and that a larger amount of ink is required. When an inverter is used, a low level at the output of the inverter indicates minimum or no image and a high level represents a dense image. Preferably, the output signal from the inverter I is bucked against a biasing potential applied by a source of potential, indicated for the sake of simplicity as a battery 45, which is connected in series with a variable resistor 46 across the resistance 43 in bucking relationship to the signal from the inverter I. The variable voltage obtained by varying resistor 46 provides a zero adjusting or biasing circuit for the variable gain amplifier 44. The circuit including the resistor 46 and the variable gain amplifier 44 constitutes adjustable means for controlling the signal from the inverter I and, in turn, from the scanning head 28.

The output of the amplifier 44 is connected to drive a motor 47 which rotates at a rate determined by the magnitude of the output voltage from the amplifier 44. For a given time period, the total angular rotation of the D.C. motor will be an indication of the magnitude of the ouput signal from the photocell pickup unit 37 and, in turn, an indication of the average image density for the portion of the image being scanned during the given period. The rotation of the D.C. motor is preferably converted to a digital signal by an analogue-to-digital converter 48; although the shaft rotation could be measured by any suitable means. The analogue-to-digital converter 48 may be a chopper wheel which provides a pulse train having a pulse therein for each predetermined increment of movement of the D.C. motor shaft. The pulse train from the converter 48 is applied through a gate 49 to the input of a printing counter 50 adapted to print out the count registered therein onto a tape 51.

FIG. 8 illustrates a specific form of a printing counter which may be used. The printing counter in FIG. 8 comprises a count coil 52 which is pulsed to add a count of one to the counter, a print coil 53 which, when energized, effects a printing out of the number registered in the counter, and a reset coil 54 which is operable to effect a resetting of the counter to zero. In the counter, a printing wheel 56 is stepped one step each time a pulse is applied to the count coil 52. When the count coil 52 is energized, a bellcrank lever 57 is moved in a clockwise direction about its pivot, as the latter is viewed in FIG. 8, against the bias of a spring 58 to cock an indexing pawl 60 adapted to cooperate with an index wheel 61 connected to drive the print wheel 56. When the count coil is deenergized, the spring 58 pushes the pawl and indexes the wheels 61, 56. Each time the count coil 52 is pulsed, the index wheel 61 is stepped one step by the indexing pawl 60 and the printing wheel 56 indexed one position. The indexing pawl 60 indexes the index wheel 61 and the print wheel 56 in a clockwise direction, as viewed in FIG. 8, and moves the wheels against the action of a torsion spring 62 which tends to move the wheels counterclockwise to their zero position. The torsion spring is prevented from moving the wheels by a locking pawl 63 of the conventional type. When the printing wheel 56 is to be reset to zero, the reset solenoid 54 is energized and the energization of the solenoid 54 causes movement of a reset rod 64 having pins 65, 66, respectively received in slots in the indexing pawl 60 and locking pawl 63. When the rod 64 is moved toward the reset coil 54 in response to the energization of the coil, it effects movement of the indexing pawl 60 and the locking pawl 63 away from the indexing wheel 61 to allow the torsion spring to return the printing wheel 56 and the indexing wheel 61 to zero. When the wheel is in its zero position, a stop 67 on the print wheel 56 engages a fixed abutment 68 to limit further movement of the print wheel in a counterclockwise direction. Similarly, the abutment 68 will limit the movement of the wheel in a counting direction to its maximum count, which is 19 in the illustrated counter.

The printing wheel 56 carries printing type 69 on its periphery and in the illustrated embodiment, twenty numbers, 0 to 19, are equally spaced about the circumference of the printing wheel 56. When the printing wheel is at its zero position, the zero type is opposite to a hammer 68 which can be driven toward the type at the position by energizing the print coil 53. The tape 51 and a ribbon 72 are disposed between the hammer and the circumference of the wheel so that when the coil 53 is energized and the hammer moves against the printing type opposite the hammer, the type will print the digit carried thereby onto the tape 51 to indicate the setting of the wheel. As the wheel 56 is stepped, the digits are moved in sequence to the print station so that the number opposite to the hammer is the count registered by the counter and it can be printed onto the tape by energizing the print coil.

Immediately after the hammer operates, the tape 51 is stepped by any suitable indexing means, not shown, to position the tape for the next read-out.

The particular apparatus or method used to total the pulses from the analogue-to-digital converter and to provide a record of the total pulses at a certain time does not, per se, form a part of the present invention, and many commercially available devices can be used. For example, the pulses could be totalized in a counter and the counter read out by a tape punch which punches a tape in accordance with the number set in the counter.

When an image is to be scanned, it is mounted on the cylinder 25 and the motor 26 started so as to rotate the cylinder. The motor 31 is then operated to move the scanning head longitudinally of the cylinder 25 in a stepwise manner. Initially the scanning head is disposed opposite to the zone 14*d* of the image on the cylinder 25. When the motor 31 is started, the head will remain in this position until a switch 81 is operated to effect energization of the electric clutch 32. The switch 81 is actuated by a switch-operating cam 82 driven from the output shaft of the motor 31 through reduction gearing 83. When the scanning head 28 is in its position opposite to the zone 14*d* when the motor is started, the cam 82 must rotate one-half a revolution before it operates the switch 81 and during this time, the cylinder 25 is being rotated past the scanning head and an output signal indicative of image density appears at the output of the filtering circuit 40. Initially the switch actuator for the switch 81 rides on the cam 82 at the start of a high part which extends for an angular distance of 180°. Therefore, the switch 81 is held closed for the initial 180° rotation of the cam and when this is accomplished, the switch 81 rides off the high part of the cam 82 and is operated to its non-actuated condition. In its actuated condition, the switch 81 has contacts 81*a* which are closed to condition the gate 49 to pass pulses from the analogue-to-digital converter. These

contacts 81*a* are opened when the switch actuator rides off the high part of the cam 82 and, in addition, contacts 81*b* of the switch are closed. The contacts 81*b* are in a series circuit for energizing the clutch 32 and when closed, effect engagement of the clutch 32 to rotate the lead screw 30 from the motor 31 and move the scanning head 28 to the following zone. The pitch of the lead screw and the gearing 83 are related so that when the scanning head 28 is disposed in the center of the following zone, the switch 81 will again be actuated to de-energize the clutch 32 and condition the gate 49. This sequence of operation is repeated until the scanning head 28 has stepped the length of the cylinder 25, at which time it operates a limit switch 84. The switch 84 is disposed so that it is actuated by movement of the scanning head from its seventh zone scanning position so that the scanning control for the seventh zone is accurately controlled by the switch 81.

The gate 49 is maintained open to pulses for a predetermined time at each zone since the motor 31 is a constant speed motor. Preferably, the cylinder rotates ten or more times during the scanning period and the faster the rotation, the easier it is to obtain an average signal from the filtering circuit. The motor 47 rotates at a speed dependent upon the output signal from the filtering circuit 40 and this, in turn, determines the number of pulses which are counted by the counter during the time that the gate 49 is conditioned to pass pulses. When the cam 82 is rotated 180°, the gate 49 is closed and the clutch 32 energized to step the scanning head 28 to the next zone. When the switch 81 is operated to open contacts 81*a*, the potential applied to condition the gate 49 goes from its high level to its low level and this negative-going signal is differentiated by a circuit 90 and a pulse derived which is used to energize the print coil 53. The pulse is also applied to the stable stage of a one-shot multivibrator 91 for controlling the energization of the reset coil 54. The output of the differentiating circuit 90 triggers the monostable multivibrator 91 to its monostable state to energize the reset coil 54 and the delay in the return time of the monostable multivibrator 91 is such as to enable the spring 62 to reset the count wheel 56. It will be noted that the triggering time for the monostable multivibrator 91 should be such to assure that the print coil 53 has operated prior to energizing the reset coil 54 and if additional delay is needed, additional delay means may be provided between the differentiating circuit 90 and the multivibrator 91.

Since the printing counter 50 counts the number of pulses in a given time period, it will be appreciated that the count in the counter is a measurement of the frequency of the pulse train from the converter 48.

In the illustrated embodiment, the count wheel 56 has a maximum capacity of nineteen and since the signal from the pickup unit 37 has been inverted, a count of 19 indicates that a large ink fountain opening should be used. The digits on the count wheel 56 in the system can be calibrated so that each count represents 0.001 or 0.0015 of an inch adjustment in the ink fountain. If each count represents .0015 inch adjustment, a count of 18 would indicate that the ink fountain key should be set to provide a spacing of .027" between the fountain blade and the fountain roll at the point controlled by the ink fountain key. Similarly, a count of 1 would inidcate that the spacing between the blade and the fountain roll for the corresponding key should be .0015". The keys 14–20 may be calibrated so that one revolution of the key will effect a change in the opening of the ink fountain blade from 0 to .0285 and, consequently, the graduations on the keys will correspond to the numbers printed out on the tape by the printing wheel 56.

Preferably, the tape 51 is indexed after each printing operation a distance corresponding to the spacing between each adjacent ink key 14–20. With this spacing, after the tape is printed, it can be placed above the keys, as shown in dot-dash lines in FIG. 3, with each digit above the corresponding key so that an operator of the press can readily determine which of the keys to set in accordance with the digits on the tape.

It will be apparent to those skilled in the art that the pulse train from the analogue-to-digital converter in the example given could have two pulses for each thousandths of an inch adjustment, or any other selected number. If two pulses were used, the index wheel 61 would be provided with twice the number of indexing teeth and printing type, and the keys would be calibrated with twice the number of settings or the number value of each of the nineteen settings present shown on the ink keys would be doubled.

In the described system, the resistor 46 for varying the biasing potential for the variable gain amplifier 44 can be adjusted to accommodate the light reflecting characteristics of material on which the image being scanned is formed. For example, for nonimage areas, the output from the scanning head 28 is equivalent to a zero setting for the ink fountain and this output will depend on the surface characteristics of the nonimage areas to adjust for the surface characteristics. The variable resistor 46 is adjusted so that the signal level from the inverter I for nonimage areas of the print being scanned, is bucked out by the reference or biasing potential 45 so that the input to the variable gain amplifier is zero. After the zero setting is adjusted, the variable gain amplifier is adjusted so that the output from the log circuit 41 for the most dense image areas will produce a count which corresponds to the maximum size fountain setting required for the particular ink to produce the image of the maximum density.

Inks used in printing presses have various tack values which are an indication of the flow characteristics and the viscosity of the ink. Moreover, the inks also vary in density so that the amount of ink required will depend in part upon the density of the ink. While the tack values do not actually change the amount of ink required for effecting a given print, inks of different tack values will require different adjustments of the ink fountain to provide a given quantity of ink. For one ink, say, a low tack value or high density ink, the fountain setting required to produce an image of maximum density might be 10, while for a higher tack value ink or a low density ink, the value might be 20. The gain of the variable gain amplifier is adjusted so that for the input from the inverter circuit which corresponds to the maximum image density, the output of the amplifier 44 effects rotation of the motor 47 at the rate necessary to produce 10 counts in the case of the first-mentioned ink and 20 counts in the case of the second-mentioned ink. As is well understood by those skilled in the art, a variable gain amplifier is one whose output is proportional to its input by a proportionality factor *k*, the factor *k* being known in the art as the gain of the amplifier. The *k* of a variable gain amplifier can be varied to adjust the proportionality of the output to the input.

When the image to be scanned by the scanning head 28 is on the plate which is to be used to print the image, the amount of light, and in turn the zero adjustment for the amplifier 44, will depend upon the surface characteristics of the plate surface and the manner in which they reflect the reflectivity of the light. To provide a convenient method for setting the resistor 46 and the variable gain amplifier 44, the image on the cylinder 25 is inked with a black ink and the plate is provided with segments which correspond to image and nonimage areas. These segments are shown in FIG. 5 and are designated by the reference numerals 105, 106, with the segment 105 being the nonimage segment and the segment 105 being a segment of maximum image density. These control segments are the width and height of the image or scanning head 28 and when the plate is mounted on the cylinder 25, the cylinder 25 is rotated and stopped in a position where the nonimage section is disposed opposite to the scanning head and the biasing resistor 46 adjusted to provide zero

input to the variable gain amplifier 44. After the variable gain amplifier 44 has thus been adjusted, the cylinder 25 is rotated to dispose the control segment 106 opposite to the scanning head. The control segment 106 has been inked to represent the maximum density and the level of light therefrom indicates the maximum output signal from the log circuit 41. The variable gain amplifier is now adjusted to provide a reading which corresponds to the fountain opening for producing the maximum density image for the particular ink to be used. This factor may be considered as constant for a particular ink. After the biasing circuit for the amplifier 44 and the gain at the amplifier 44 have been set in the manner described, then the zones 14*d*, 15*d*, etc., are scanned in sequence by the scanning head 28, as described above.

Inasmuch as the gap in the cylinders constitutes nonimage areas and since the scanning head 28 is taking an average of the entire circumferential zone on the cylinder 25 including the gap area, it is necessary to provide some means for compensating the signal for the gap. To this end, the cylinder 25 is preferably provided with a removable sheet 108 of metal which may be set over a gap therein corresponding to a gap of the plate cylinder. The sheet corresponds in surface characteristics to the metal of the plate so that the light reflected from this sheet of metal will correspond to nonimage areas of the plate.

Even if the image being scanned is not on a printing plate, the surface which carries the image will affect the light and adjustment of the variable resistor 46 to provide a zero reading for a nonimage area should be made.

While the present invention may be used to determine the setting of each key, a most important advantage of the invention lies in the fact that the keys will be properly set relative to each other. Once this is true, adjustment for tack value and ink density can be made by adjusting the conventional ink flow adjustment for the press, for example, the ducting mechanism 5, which affects the flow to each image zone proportionately. Consequently, the present invention has considerable value, even though the settings are not compensated for or are not accurately compensated for tack value provided the range of adjustment of the inker is sufficient.

After the image has been scanned, the motor 31 is reversed by operating control switch 33 to return the scanning head. The operation of switch 33 also effects the throwing of a switch device 92 (shown schematically in FIG. 7) which renders the contacts of switch 81 ineffective and completes a circuit to clutch 32. When the scanning head is returned to its position opposite to zone 14*d*, a limit switch, not shown, is actuated to de-energize the motor and clutch 32.

It will be understood by those skilled in the art that the particular type of analogue-to-digital converter which is used to convert the average electrical signal derived from the log circuit 41 to a pulse train does not, per se, form a part of the present invention and that other suitable means can be used. For example, FIG. 9 schematically illustrates a system wherein the output of the amplifier 44 is applied to a pulse generator 93 which generates pulses at a frequency dependent upon the magnitude of the input signal. Such a pulse generator is shown and described in United States Patent No. 2,922,940 to Harry W. Mergler. The output of the pulse generator is applied through a gate 94 to a scaler 95 and then to a printing counter 96, or other mechanism or means for totaling the pulses and providing a read-out. By using the scaler 95, a higher frequency of pulses can be generated in the pulse generator 93 for a given input signal and the pulses then scaled in the scaler 95 to provide the desired number of pulses for a given input voltage to the pulse generator 93. It will be understood, of course, that the scaler 95 need not be used and that if the pulse generator issues one pulse for an input voltage indicating a thousandths inch adjustment, by way of example, the pulse could be applied directly to the printing counter 96. The gate 94 is controlled in the same manner as the gate 49 of the first-described embodiment by suitable gate control circuitry.

In the described embodiment, the scanning head is moved along the cylinder 25 in a stepwise manner. It will be appreciated by those skilled in the art that the scanning head could be moved continuously along the cylinder 25 and the signal received from the scanning head integrated to provide an indication of the image density of the zone. In this case, the counter would accumulate counts as the scanning head moves across the zone and the count would be read out when the scanning head reached the end of the zone and prior to its moving across the following zone. It will be recognized by those skilled in the art that the total count is a function of the average image density of the zone and could be used in the same manner as the average light signal evolved from rotating the cylinder 25 past the scanning head 28 while it is in a stationary position.

In the invention as thus far described, the press operator manually sets the ink keys. As illustrated in FIG. 10, each ink key can be provided with an individual stepping mechanism indicated by the reference numeral 100. The stepping mechanism 100 can be substantially the same as that shown in FIG. 7 without the printing wheel, and the screw key may be slidably keyed to the index wheel to provide for axial movement of the key. The output of the gate 49 when the scanning head is scanning the zone 14*d*, can be applied directly to the stepping mechanism 100 for the screw key 14 through a distributor 102. The distributor 102 is adapted to distribute the pulse trains to the proper key and such distributors are well known in the art. For example, the pulse train from the gate 49 may be stepped from an output 103 to an output 103*a* and then to an output 103*b*, etc., by applying stepping pulses to a connection 107 to the distributor 102. The signal on the connection 107 may be derived from the differentiating network 90, inasmuch as the stepping mechanisms for the key do not require a printing coil, and the signal used in the first embodiment to effect a printing of the number is now used to effect a stepping of the distributor, so that the pulse train applied to the distributor 102 is stepped from one output connection to the other. It is understood that each of the output connections is connected to a corresponding stepping mechanism for a respective one of the ink keys.

It can now be seen that the present invention provides a method wherein the settings for the ink control devices, e.g., ink keys, of a printing machine are determined before printing actually is started by measuring the over-all image density in the zone of the image whose ink density in the printed image will be controlled by the particular ink control device and setting the ink control device in accordance with this measurement before starting press operation. The ink control devices are provided with linear graduations and while the image is scanned photoelectrically to provide a signal which varies nonlinearly with respect to the image density, the signal is converted to vary linearly therewith so that the average ink density reading is provided which can be made to correspond to the settings on the control devices so that the operator need not make an interpolation of the reading from the scanning mechanism in order to be able to set the ink control devices. Moreover, in its more refined form, the present invention provides a mechanism which can be used to set the ink control devices without the intervention of an operator. By using the present invention, setup time for a printing press can be minimized and the running of waste test prints also held to a minimum or substantially eliminated to thereby save the cost of the materials upon which the prints are made, as well as the time consumed in running the prints.

While embodiments of the present invention have been described in considerable detail, it is hereby my intention to cover all constructions, modifications, and arrangements which fall within the ability of those skilled

in the art and within the spirit and scope of the present invention.

Having described my invention, what I claim is:

1. The method of presetting a plurality of ink control devices for controlling the flow of ink to respective circumferential zones on a printing cylinder of a printing press to control the density of ink in corresponding image zones on an image to be printed comprising the steps of optically scanning an image corresponding to the image to be printed by zones which correspond to said image zones to provide an electrical signal corresponding to each zone of the image to be printed by one of said cylinder zones with the magnitude of the signals being a function of the image density of the corresponding image zone, and adjusting each of the ink control devices to control the ink flow to the zone of the printing cylinder controlled thereby in accordance with the magnitude of the electrical signal for the corresponding image zone.

2. The method as defined in claim 1 and further comprising the step of compensating said signals for the track value of the ink to be used.

3. The method as defined in claim 1 wherein the signal for each zone is derived by rapidly moving an optical scanning head and the image zone relative to each other.

4. The method of setting a plurality of ink control devices for controlling the amount of ink applied to respective circumferential zones of a printing cylinder for printing an image which comprises the steps of photoelectrically obtaining for each zone a measurement of the image density throughout the length of the zone by optically scanning the corresponding zone of an image corresponding to the image to be printed to determine the image density in the zone, and pre-adjusting the ink control devices to provide an ink flow in accordance with the magnitude of the image density for the corresponding zone.

5. The method of predetermining the settings of a plurality of ink control devices which control the amount of ink applied to respective circumferential zones of a printing cylinder for printing an image which comprises the steps of providing an image corresponding to the image to be printed and photoelectrically scanning zones of the image which correspond to the circumferential zones in which the image density is controlled by respective ones of said ink control devices and establishing respective electrical signals for each zone, each of which signals has a magnitude that is a function of the ink density for the zone, analyzing the magnitudes of said signals and preparing a record of the magnitudes of the said signals reading directly in settings for said control devices.

6. The method as defined in claim 5 wherein said electrical signals are compensated for the tack value of the ink to be applied by the cylinder by increasing or decreasing the magnitude of the signals for a given image density.

7. The method as defined in claim 5 wherein the magnitude of said signals is increased or decreased to compensate for the effect which the material on which the scanned image is formed has on the zero or nonimage area readings.

8. The method of pre-adjusting an ink control device for controlling the amount of ink applied to a respective circumferential zone of a printing cylinder which comprises the steps of disposing an image corresponding to the image to be printed by the zone in a light beam and measuring light received from the image to provide an electrical signal indicative of the ink density of the image, relatively moving the image with respect to the light beam to scan the length of the image in the zone thereof corresponding to the circumferential zone of the printing cylinder and providing an electrical signal which varies with the image density of the zone being scanned, averaging the electrical signal to provide an output signal having a magnitude which is a function of the ink density of the zone, determining the magnitude of the output signal and preparing a permanent record of said settings in terms of the settings of said control device for producing the corresponding image density and setting the ink control device in accordance therewith.

9. The method as defined in claim 8 wherein the output signal is increased or decreased to compensate for the tack value of the ink.

10. The method as defined in claim 8 wherein said output electrical signal is converted to a pulse train and the frequency of the pulse train measured to determine the magnitude of the electrical signal.

11. The method as defined in claim 8 wherein the magnitude of said signals is increased or decreased to compensate for the effect which the material on which the scanned image is formed has on the zero or nonimage area readings.

12. In an apparatus for determining the setting for an ink control device for controlling the ink applied by a printing cylinder, means for measuring the average light absorbing characteristics of an image to be printed which comprises means for subjecting an image corresponding to the image to be printed to light and photoelectric means for measuring light received from said image and a scanning head limiting the area of the image to which said photoelectric means is responsive and means for relatively moving the image and head to repeatedly scan the length of at least a portion of the image, said photoelectric means having an output which varies nonlinearly with the light absorbing characteristics of the image being scanned, circuit means for summing the variations in the output of said photoelectric means and providing an electrical signal having a magnitude which is a function of the average light absorbing characteristics of said image, said circuit means including nonlinear circuit means for rendering said electrical signal substantially linear relative to the variation in the density of said image in response to said nonlinear variation of said photoelectric means, means for adjusting the proportionality of said signal to the output of said photoelectric means for compensating for the tack value of the ink to be used, and means for indicating the magnitude of said electrical signal.

13. The method of determining the settings for printing press ink control devices for controlling ink flow to corresponding zones of the printed image, comprising the steps of providing a member carrying an image corresponding to the image to be printed and including a nonimage portion on the member, optically scanning the nonimage portion to determine the light affecting characteristics of the member and to provide a zero signal level for nonimage portions, scanning the image by zones corresponding to the zones of the printed image wherein the ink density is controlled by respective ones of said ink control devices and deriving signals having magnitudes related to said zero signal according to the image densities of the zones, and setting each of said ink control devices in accordance with the magnitude of the signal from the corresponding zone.

14. The method of determining the settings for printing press ink control devices for controlling ink flow to corresponding zones of the printed image comprising the steps of providing a member carrying an image corresponding to the image to be printed and including a nonimage portion, optically scanning the nonimage portion to determine the light affecting characteristics of the member and to provide a zero signal level for nonimage portions, scanning the image by zones corresponding to the zones of the printed image wherein the ink density is controlled by respective ones of said ink control devices and deriving signals having magnitudes related to said zero signal according to the image densities of the zones, increasing or decreasing said signals to adjust for flow and density characteristics of the ink to be used, and setting each of said ink control devices in accordance with the adjusted signal for each zone.

15. The method as defined in claim 13 wherein said member is provided with an image portion of maximum image density and this portion is scanned and the magni-

tude of the signal therefrom adjusted to correspond to a constant for the ink to be used which is determined by the flow and density characteristics of the ink and adjusting the level of the signals from said zones proportionately.

16. The method of predetermining the settings of ink fountain keys of a printing press which comprises providing a printing plate having the image to be printed thereon, inking the plate, relatively moving the plate and an optical scanning head to scan the image by zones corresponding to the zones of the image in which the ink is controlled by a respective one of said keys, and deriving a signal for each zone indicative of image density in the zone, and setting said keys in accordance with said signals.

17. The method as defined in claim 16 wherein the printing plate during scanning is mounted on a cylinder with a gap between the trailing and leading edges thereof corresponding to the gap in the plate cylinder of the press and a sheet of material having the light reflecting qualities of the plate for nonimage portions is disposed in the gap.

18. The method as defined in claim 16 wherein a nonimage portion of the plate is scanned to provide a "zero" signal level corresponding to zero output and an image portion of maximum density is scanned to provide a signal for maximum image density, and the signal derived by scanning is multiplied by a factor which is variable to provide an output of a predetermined level in response to the signal for maximum image density.

19. The method of determining the settings of a plurality of control devices of a printing press, each of which determines the amount of ink applied to a corresponding zone of the image, by optically scanning an image to provide an electrical signal whose magnitude is a function of the image density of the scanned area, preparing a printing plate with the image to be printed thereon and including control segments representing nonimage areas and areas of maximum image density, inking the printing plate, optically scanning the nonimage control segment to provide an electrical signal having a magnitude representing nonimage areas, to determine the magnitude of the zero signal representing nonimage areas, optically scanning the control segment for the most dense image portions to obtain a second signal, applying the signals to an amplifier and adjusting the amplifier for zero output for the first signal and for a predetermined output representing the maximum setting for the ink control device for the ink to be used for the second signal, optically scanning the zones of the image and applying the signals derived from scanning to said amplifier, and setting each of the ink control devices in accordance with the magnitude of the output from the amplifier for the corresponding zone.

20. An apparatus for scanning an image carried by a printing plate including first and second portions corresponding respectively to image and nonimage portions of the plate, means for scanning individual portions of said plate and providing an electrical signal which is a function of the average image density of the scanned portion comprising means for measuring the light-absorbing characteristics of the scanned portions and operable to measure the light-absorbing characteristics of said first and second portions individually and to derive an electrical signal which is a function of the image density thereof, adjustable means responsive to the signal from said means for scanning for providing an output signal which is proportional to said electrical signal and including means for varying the factor of proportionality between said electrical signal and said output signal, said adjustable means including means for varying the magnitude of said output to zero for a given image density.

21. An apparatus as defined in claim 20 wherein said adjustable means is a variable gain amplifier.

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