

[72] Inventors **Leonard I. Taffel;**
Carl J. Hermach, Chicago, Illinois
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 [73] Assignee **Miehle-Goss-Dexter, Incorporated**
Chicago, Illinois
a corporation of Delaware

3,417,770 12/1968 Denison 137/81.5

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—J. Reed Fisher
Attorney—Wolfe, Hubbard, Leydig, Voit & Osann

[54] **FLUID AMPLIFIER IN INK CONTROL ARRANGEMENT FOR PRINTING PRESSES**
 5 Claims, 8 Drawing Figs.

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 101/365, 101/366; 137/81.5

[51] Int. Cl. **B41f 31/08**

[50] Field of Search 101/335,
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 137/81.5, 36; 118/78; 222/(Inq)

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ABSTRACT: An automatic control system for feeding ink to the ink drum of a printing press in which the ink feed rate is controlled by a fluid-operated device such as a fluid amplifier. Systems utilizing both digital and proportional type amplifiers are disclosed. In the digital type system, the ink feed rate is controlled by supplying pulses of pressurized air to turn on a fluid amplifier which is normally biased off by means of a constant pressure supply of pressurized air. The ink feed rate is controlled by varying the frequency of the air pulses. The frequency may be automatically controlled in accordance with the press speed or some other press variable which affects the ink density of the printed image. In the system utilizing the proportional fluid amplifier, the ink feed rate is automatically controlled by varying the air pressure in the two control nozzles of the amplifier by means of two separate bimetallic strips. The bimetallic strips are deflected toward or away from the open ends of two fluid control elements in accordance with temperature changes effected by light reflected from the printed web in the case of one bimetallic strip, and from the proof sheet in the case of the other bimetallic strip.

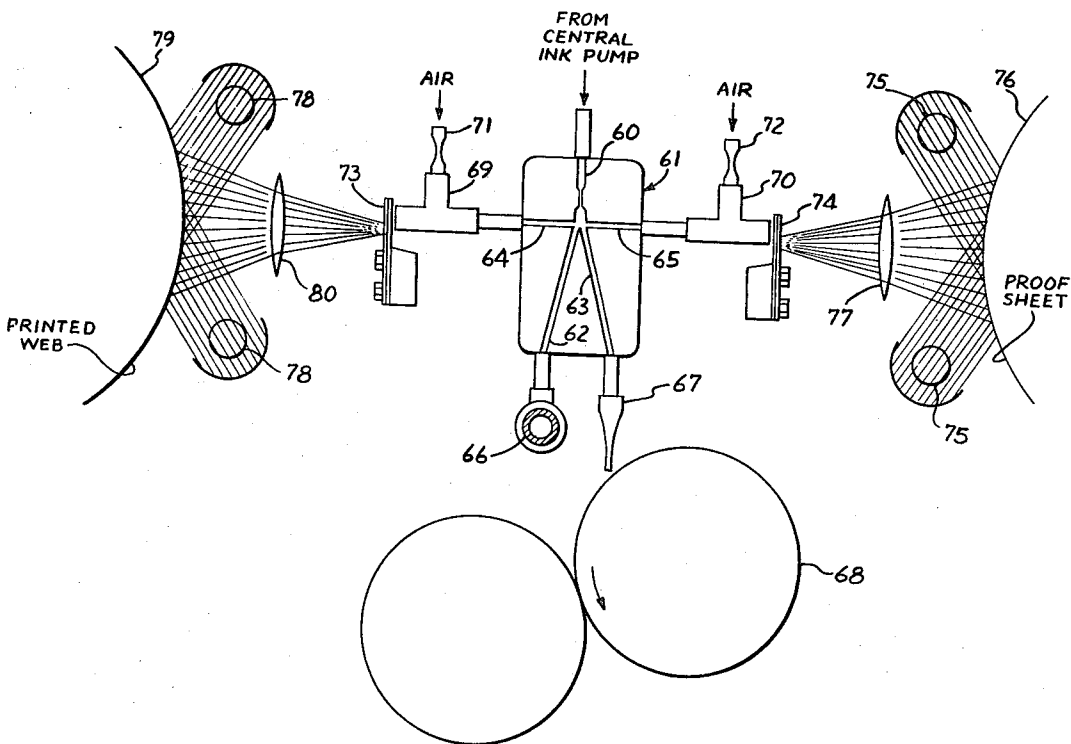


FIG. 1

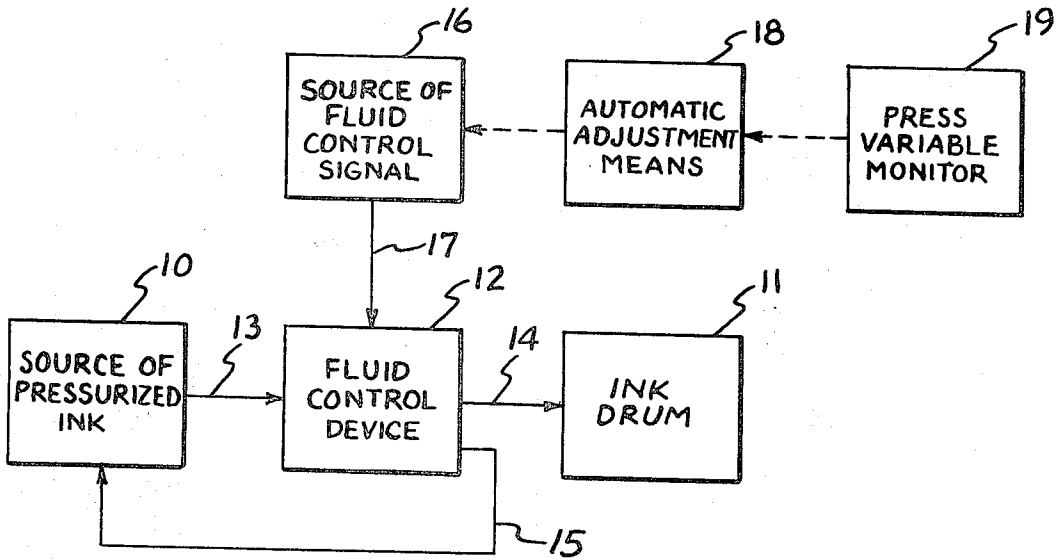
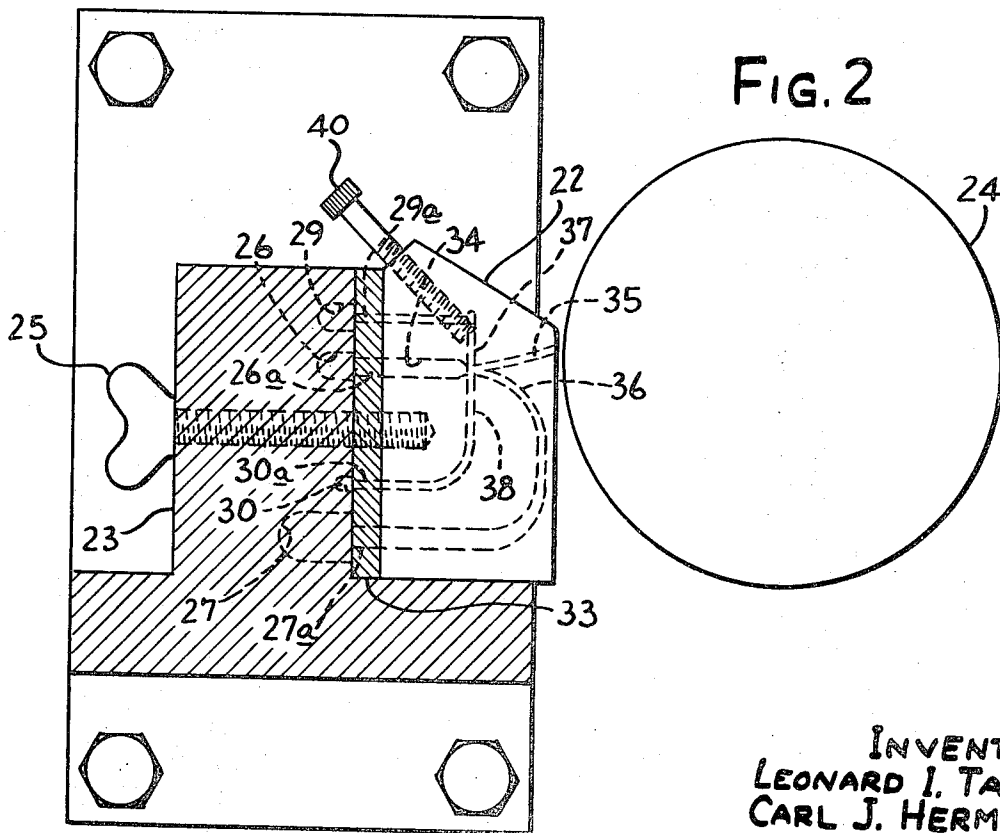


FIG. 2



INVENTORS
LEONARD I. TAFEL
CARL J. HERMACH

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

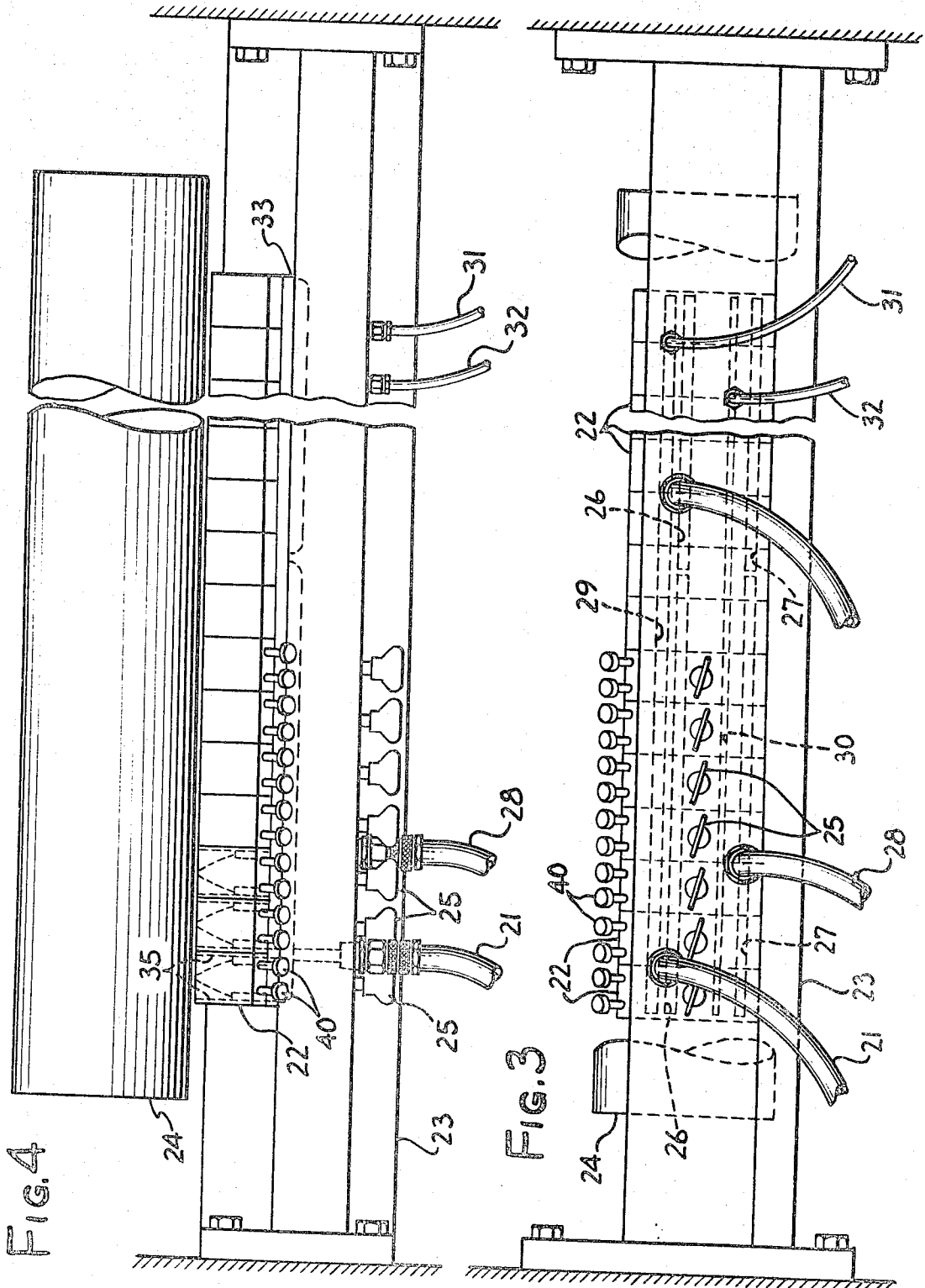


FIG. 4

FIG. 3

INVENTORS
LEONARD I. TAFEL
CARL J. HERMACH

by: *Wolfe, Hubbard, Veit & Osann*
ATTYS.

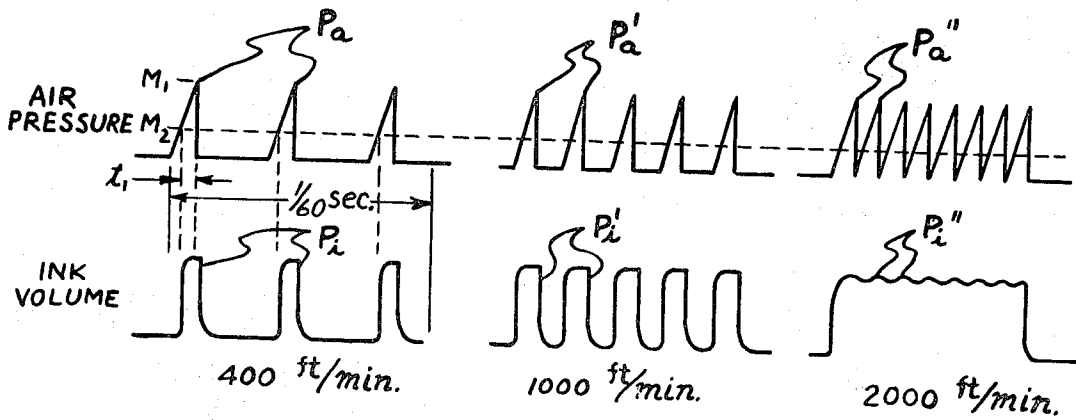


FIG. 5

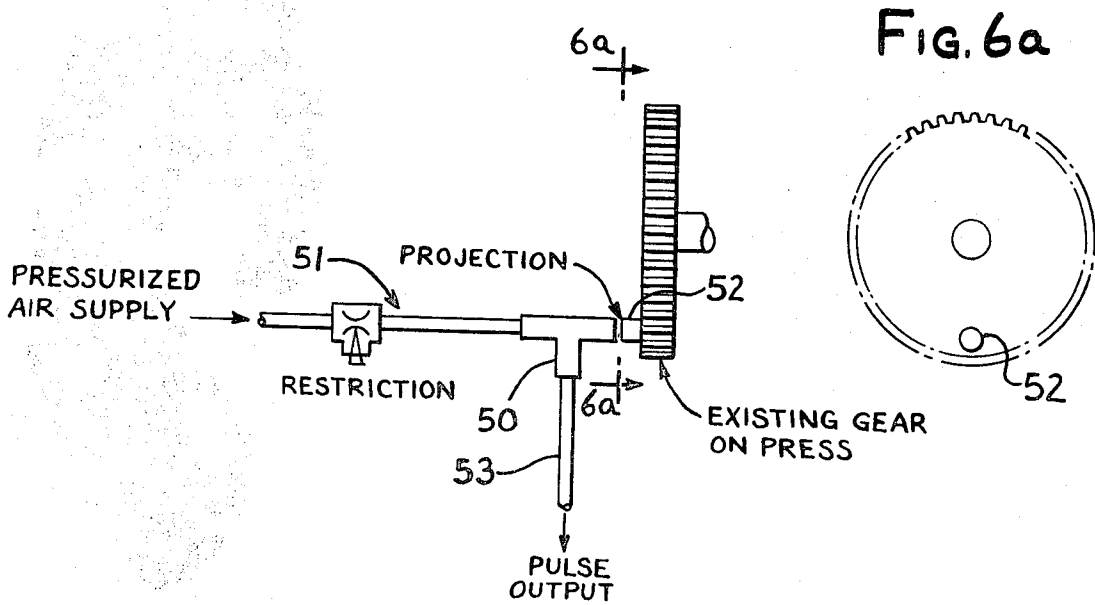


FIG. 6

INVENTORS
LEONARD I. TAFEL
CARL J. HERMACH

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

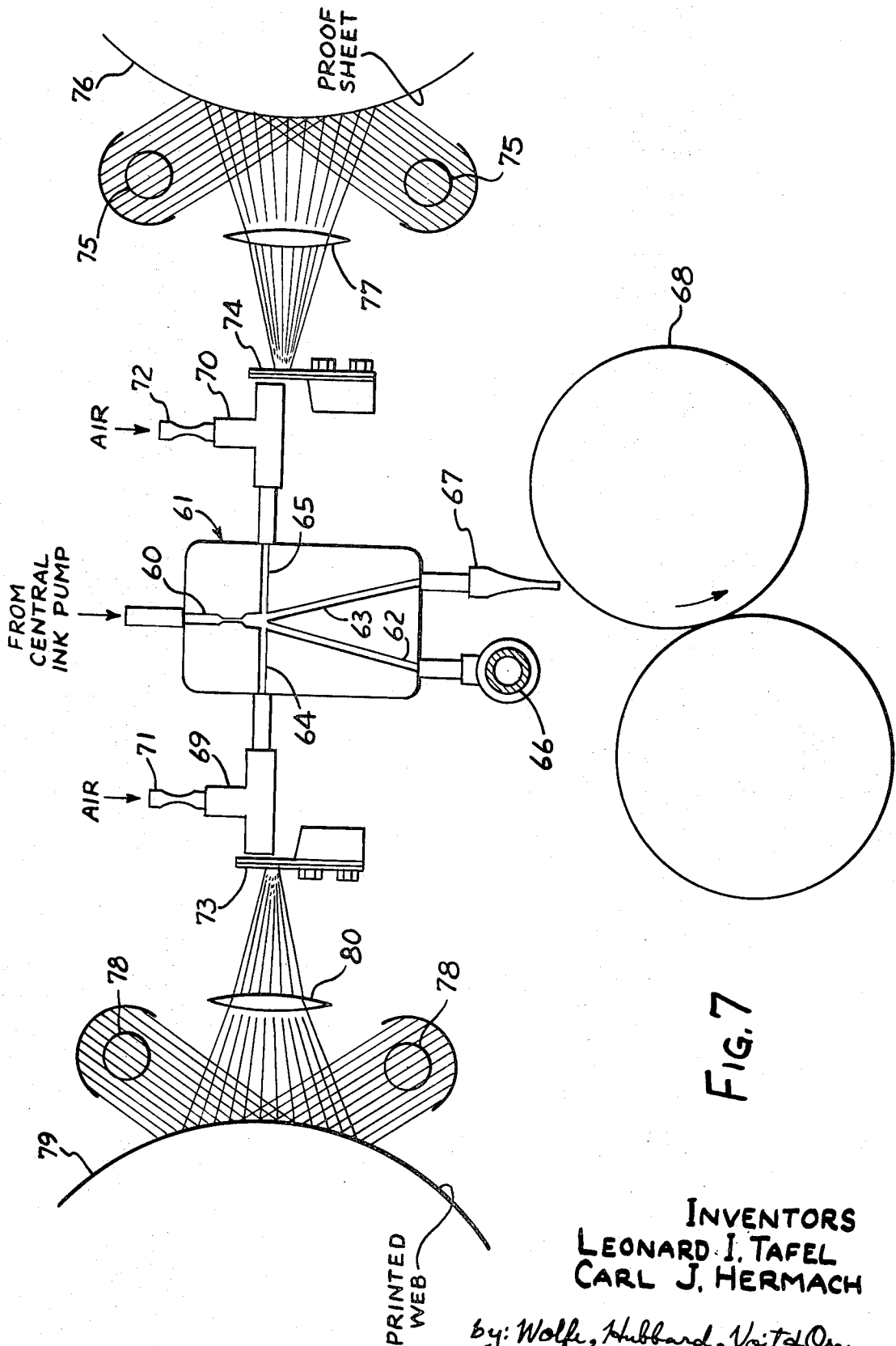


FIG. 7

INVENTORS
LEONARD I. TAFEL
CARL J. HERMACH

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

FLUID AMPLIFIER IN INK CONTROL ARRANGEMENT FOR PRINTING PRESSES

This invention relates generally to systems for controlling the rate at which ink is supplied to the ink drum of a printing press and, more particularly, to an improved fluid-operated ink supply system.

It is a primary object of the present invention to provide an improved ink supply system which is capable of feeding ink to the ink drum of a printing press at a precise rate that is automatically controlled to provide the proper ink density in each column or division of the final printed image. A related object is to provide such a sophisticated supply system which is easy to maintain and can be manufactured at a fraction of the cost of other modern ink supply systems.

A further object of the invention is to provide an improved ink supply system of the foregoing type which facilitates automatic cleanup and color changeover. Thus, it is one objective of this invention to provide such a system that permits practically instantaneous changeover of colors. A related object is to provide such a system that makes color available for any desired page in a multipage printing operation.

It is another object of this invention to provide an improved ink supply system of the type described above which is completely enclosed feeding the ink drum only the amount of ink actually needed by the plates, thereby minimizing contamination by paper dust and other environmental contaminants.

Yet another object of the invention is to provide such an improved ink supply system which permits the use of a relatively short ink train with resultant reductions in the frame height of the press. Thus it is a more particular object of the invention to provide such an ink supply system which makes it possible to design the press with a more convenient height for changing the plates, and easier accessibility to upper fountains and the like.

A still further object of the invention is to provide such an improved ink supply system which permits completely automatic control of the ink feed, with rapid and accurate response to changes in press speed or other press variables that affect the ink density of the printed image, for reliable automatic quality control.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a block diagram of an ink-control system embodying the present invention;

FIG. 2 is an end elevation of an exemplary ink supply system for controlling the supply of ink to an ink drum of a printing press in accordance with the system of FIG. 1;

FIG. 3 is a side elevation of the apparatus shown in FIG. 2;

FIG. 4 is a top plan view of the apparatus shown in FIGS. 2 and 3;

FIG. 5 is a pulse diagram illustrating the operation of the system of FIG. 1 as embodied in the apparatus of FIGS. 2 through 4;

FIG. 6 is a side elevation view of an air pulse generator for use in the system of FIGS. 2-5;

FIG. 6a is a vertical section taken along line 6a-6a in FIG. 6; and

FIG. 7 is a schematic diagram of an alternative ink supply system embodying the present invention.

While the invention will be described in connection with certain preferred embodiments, it will be understood that it is not intended to limit the invention to these particular embodiments. On the contrary, it is intended to cover all alternative, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning now to the drawings, and referring first to FIG. 1, the objective of the illustrative system is to feed ordinary printing ink supplied under pressure from a source 10, to a conventional ink drum 11 at an accurately controlled rate so as to produce a printed image having proper ink density. While the invention will be hereinafter described with particu-

lar reference to a newspaper printing press, it will be understood that the invention is also applicable to any type of press that includes an ink drum or an ink distributing roller. In the larger newspaper printing presses, each plate cylinder supplied by an ink drum is four pages, or 32 columns, wide. Since the ink requirements often vary from column to column, the ink is generally applied to the drum at different rates across the length of the drum, and in many cases 32 or more separate adjustments are provided to permit separate control of the ink feed rate at each column position. The particular ink feed rate selected for each position initially depends primarily on the density of the image to be printed in that column, but adjustments are also often necessary during operation of the press to compensate for errors in plate making, changes in the press speed, changes in the viscosity of the ink, and the like.

In accordance with the present invention, the ink feed rate to the ink drum is controlled by a fluid-operated control device having a power input connected to the source of pressurized ink, and output associated with the ink drum for supplying ink thereto at a controlled rate, and a control input connected to a source of pressured fluid for applying a fluid-control signal thereto for controlling the ink feed rate. Thus, referring to FIG. 1, a fluid-control device 12 such as a digital fluid amplifier has a power input nozzle receiving pressurized ink from the source 10 through a line 13 at a substantially constant pressure of 30 p.s.i., for example. The fluid-control device 12 has two outputs, one of which leads via line 14 to the ink drum to be supplied, and the other of which is connected to a return line 15 for returning unused ink to an ink reservoir associated with the source 10.

For the purpose of controlling the rate at which ink is fed through the output line 14, a source 16 of a pressurized fluid-control signal, such as a series of fluid pulses, is connected to the control input of the fluid-control device 12 via line 17. As will be described in more detail below, the ink output through line 14 is a function of the fluid-control signal applied through line 17, so that the ink feed rate to the ink drum can be accurately controlled by simply adjusting the fluid-control signal. If desired, the control signal can be automatically adjusted by an automatic adjustment means 18 actuated by a press variable monitor 19 which continuously monitors the press speed or some other press variable that affects the ink density of the printed image, of the image itself, and actuates the adjustment means 18 for automatically adjusting the control signal in response to variations in the monitored variable.

Turning now to FIGS. 2 through 5 for a more detailed description of an exemplary embodiment of the system illustrated in FIG. 1, the ink is fed at a substantially constant pressure into a plurality of inlet tubes 21 serving a bank of fluid circuit modules 22 mounted on an inverted T-shaped manifold 23. In the particular embodiment illustrated, a bank of 32 fluid circuit modules are provided so that there is a separate module to serve each of 32 column positions along the ink drum 24. Four ink inlet tubes 21 are provided so that there is one inlet tube for every eight modules, i.e., for each 8-column page. It will be appreciated that the number of modules provided for any given ink drum may vary widely depending on the size of the ink drum, the size of each module, the widths of the columns and pages to be printed, the degree of flexibility and control required, and other factors affecting the press design.

In order to permit any one of the modules 22 to be individually removed for servicing or replacement, each module is individually mounted on a manifold 23 by means of a turn-screw 25 which passes through the upright portion of the manifold 23 and is threaded into the center of the module 22. Thus, to remove a given module, the turn-screw 25 for that module is removed, and the module simply lifted up out of the module bank.

As pressurized ink enters through the various ink inlet tubes 21, the ink is distributed to the modules 22 via a series of longitudinal grooves 26 formed in the mounting surface of the manifold 23. A separate groove 26 is provided for each of the

four groups of modules served by the four inlet tubes 21, and a corresponding series of four longitudinal grooves 27, parallel to the grooves 26, is provided in the same surface of the manifold 23 for returning unused ink from the modules 22 through return tubes 28 to an ink reservoir associated with the pressurized ink source. Finally, an additional pair of continuous longitudinal grooves 29 and 30 are provided in the manifold 23 for distribution of pressurized air supplied from air lines 31 and 32, respectively, for purposes to be described below.

To avoid the necessity for a fluid seal between adjacent fluid circuit modules 22, a continuous elongated mounting plate 33 is secured to the mounting surface of the manifold 23, the plate 33 being provided with appropriate apertures 29a, 26a, 30a, and 27a for providing fluid communication between the manifold grooves 29, 26, 30, and 27, respectively, and the corresponding conduits in the modules 22. The joints between the mounting plates 33 and the manifold 23 on one side, and the modules 22 on the other side, must, of course, be fluid tight, and appropriate sealing gaskets may be provided in these joints if desired. The use of this mounting plate 33 permits the grooves 29, 26, 30, and 27 to be formed continuously along the length of the mounting surface of the manifold, and yet no fluid seal is required between adjacent modules 22 because those portions of the manifold grooves extending between the modules are covered by the mounting plate.

While a number of different fluid-control devices may be utilized in the system of this invention, the particular embodiment illustrated uses a conventional digital fluid amplifier of the wall-attachment type. This particular type of amplifier has two distinct output states which may be characterized as the "on" and "off" states, and a separate output receiver is provided for each of the two states. Thus, referring to FIG. 2, the pressurized ink from the manifold groove 26 is fed into a power input nozzle 34 of the fluid amplifier to form a jet stream which may enter an "on" output receiver 35, or an "off" output receiver 36. (While only one fluid amplifier will be referred to herein, it will be understood that the description is equally applicable to the amplifier in any of the modules 22.) Switching of the power jet back and forth between the "on" and "off" receivers 35, 36 is controlled by pressurized fluid signals applied to a pair of control nozzles 37 and 38 from the two air distribution grooves 29, 30, respectively, in the manifold 23. When the power jet is directed into the first output receiver 35, the ink is directed onto the surface of the rotating ink drum 24; when the power jet is directed into the second output receiver 36, the ink is conducted into one of the manifold grooves 27 and on into one of the return tubes 28 which recycle the unused ink to the ink supply reservoir.

In the particular fluid-control system illustrated, each fluid circuit module 22 forms a pair of fluid amplifiers spaced longitudinally away from each other, and the output receivers 35 of the amplifiers are flared so that they practically converge near the surface of the ink drum 24 (see FIG. 4). As the ink is discharged onto the roller surface, it spreads slightly beyond the peripheries of the output receivers 35 so that ink is applied continuously along the length of the roller 24, when all the amplifiers in the modules 22 are "on". It will be appreciated that this system provides dual control for each column position along the fountain roller 24, since there are two amplifiers in each module, and one module for each column position.

For the purpose of maintaining the fluid amplifier in a normal "off" state, *i.e.*, with the ink output directed into the return receiver 36, a constant biasing signal of predetermined magnitude is applied continuously to the control nozzle 37. Thus, a continuous stream of pressurized air is fed through the air inlet tube 31 and manifold slot 29 into the first control nozzle 37 at a constant pressure, typically 10 p.s.i., so that the power jet of the amplifier is normally deflected into the receiver 36, *i.e.*, biasing the amplifier to the "off" state. To permit adjustment of the biasing pressure, a pair of adjustment screws 40 are threaded downwardly through each module 22 into communication with the control nozzles 37 to provide ad-

justable restrictions therein. If the adjustment screw 40 is retracted, the restriction is opened to increase the biasing pressure and, conversely, if the screw 40 is advanced, the restriction is closed to reduce the biasing pressure.

In order to switch the fluid amplifier to the "on" state for supplying ink through the output receiver 35 to the ink drum 24, a pulse of pressurized air is applied to the second control nozzle 38 so as to deflect the power jet of pressurized ink from receiver 36 into receiver 35 during the interval when the pressure in control nozzle 38 exceeds the pressure in control nozzle 37. As soon as the pulse is terminated, of course, the biasing pressure in control nozzle 37 returns the power jet to the "off" receiver 36. In actual operation of the control system, the switching pulses are applied repetitively as a pulse train at a prescribed frequency so that ink is fed continually through the "on" receiver 35. This operation may be understood more clearly by reference to FIG. 5, which is a series of pulse diagrams illustrating the operation of the exemplary fluid amplifier at different press speeds. Thus, if pulses P_0 of pressurized air are applied to the control nozzle 37 at a pressure M_1 while a constant biasing pressure M_2 is applied to the opposing control nozzle 38, the amplifier will be switched to the "on" state during the interval t_1 when pressure M_1 exceeds pressure M_2 . During each such "on" interval a pulse P_i of ink is discharged through the output receiver 35, thereby producing a series of ink pulses P_i in response to the corresponding air pulses P_a .

To increase the rate at which ink is fed through the output receiver 35 to the ink drum 24, the frequency of the air pulses P_a is increased so that a greater number of ink pulses P_i are produced in any given time interval. Conversely, the ink feed rate may be reduced by reducing the frequency of the air pulses P_a . At relatively high pulse frequencies, the ink flow through the output receiver 35 becomes, in effect, a continuous stream due to the inertia of the fluid and the back pressure of the flared output nozzle on the amplifier (see ink pulses P_i' in FIG. 5). Consequently, any tendency to form pulsating patterns of ink on the roller can be easily eliminated by appropriate design of the output nozzle relative to the pulse frequency and volume.

For fine adjustment of the ink feed rate to the ink drum 24, the biasing pressure M_2 may be raised or lowered by turning the adjustment screw 40. As can be seen from FIG. 5, the magnitude of the biasing pressure M_2 affects the "on" time t_1 of the amplifier, and thus the quantity of ink represented by each pulse P_i . For example, if the biasing pressure M_2 is reduced, the "on" time t_1 of the amplifier during each air pulse P_a is increased, with the corresponding increase in the ink feed rate. Conversely, if the biasing pressure M_2 is increased, the amplifier "on" time t_1 is reduced, with a corresponding reduction in the ink feed rate.

In keeping with the present invention, the frequency of the controlling air pulses P_a is automatically controlled by a press speed monitor which automatically changes the pulse frequency in response to any change in the press speed. Thus, referring to FIG. 6, a T member 50 is connected at one end to a source of pressurized supply air, via line 51, while the other end of the transverse section of the T member cooperates with a rotating valve element 52 to produce repetitive air pulses P_a in an output line 53 connected to the base of the T member. More particularly, the rotating element 52 produces a sharp increase in the back pressure within the T member 50 each time it passes the open end thereof, thereby producing intermittent pulses of pressurized air in the base of the T member, and hence in the output line 53. The rotating valve element 52 is connected directly or by suitable gearing to one of the rotating shafts of the press so that the speed of the rotating valve element, and thus the frequency of the generated air pulses, varies as a direct function of the press speed. Referring to FIG. 5, if the press speed is increased from 400 feet per minute, at which the air pulses P_a are generated at a rate of 180 pulses per second, to a speed of 1,000 feet per minute, the rotary air valve will generate air pulses P_a' at a rate of 300 pulses per second, and corresponding ink pulses P_i' are produced at the

same rate. At a press speed of 2,000 feet per minute, air pulses P_a'' are generated at a rate of 480 pulses per second, thereby producing an essentially continuous stream of ink represented by the waveform P_i'' . In order to permit regulation of the ink feed rate over the entire speed range of a given press, the automatic control system is preferably designed so that the essentially continuous stream of ink represented by P_i'' is produced only at the top design speed, which in this case would be 2,000 feet per minute. Thus, at any lower speed, the ink flow rate supplied by the fluid amplifier can be precisely controlled by regulating the frequency of the air pulses P_a . Consequently, the amplifier functions as a digital control means and permits virtually perfect tracking and instantaneous response to changes in press speed so as to maintain a proper ink density in the various divisions of the printed image over a large number of successive printings thereof.

An alternative form of the fluid-operated control system of this invention utilizing a proportional fluid amplifier is illustrated in FIG. 7. In this system, pressurized ink is fed into the power nozzle 60 of a proportional amplifier 61 of the jet deflection type. In this type of amplifier, the power jet is continuously discharged through both output receivers 62 and 63 at the same time, with the proportion of fluid discharged into each output receiver depending upon the relative pressures of the two control signals applied to the control nozzles 64 and 65. In the particular system illustrated, one of the output receivers 62 is connected to a return line 66 to return unused ink to the main ink supply reservoir, while the other output receiver 63 is connected to a flared nozzle 67 adapted to apply the ink to an ink drum 68.

For the purpose of controlling the proportion of ink discharged into the output receiver 63 for application to the roller 68, pressurized air is supplied at a constant pressure to each of two T-shaped control elements 69 and 70 via restrictors 71 and 72, respectively. The transverse portions of the two elements 69, 70 are connected at one end to the two control nozzles 64, 65, respectively, while the other end is open closely adjacent a flexible bimetallic strip 73 or 74 which controls the back pressure within the control element by adjusting the gap between each strip and the open end of the associated control element.

The positions of the two bimetallic strips 73, 74 are controlled by light reflected from a proof sheet in the case of the strip 74, and from the printed web in the case of the strip 73. Thus, light emitted from a pair of lamps 75 is reflected from a proof sheet 76 and passed through a focusing lens 77 onto one side of the bimetallic strip 74. The reflected light heats the bimetallic strip 74 to cause it to deflect toward or away from the open end of the control element 70, thereby controlling the back pressure within the element 70 as a function of the intensity of the reflected light. For example, an increase in the reflected light causes the bimetallic strip 74 to deflect toward the control element 70, thereby increasing the back pressure within that element, while a reduction in the reflected light reduces the temperature slightly to retract the strip 74 away from the control element and reduce the back pressure.

Deflection of the other bimetallic strip 73 is controlled by light directed from a pair of lamps 78 onto a printed web 79 and reflected through a focusing lens 80 onto one side of the strip 73. As long as the light reflected from the proof sheet 76 and the printed web 79 is essentially the same, the back pressure within the two control elements 70 and 69 is the same, and thus the air pressure applied to the two control nozzles 65 and 64 is also the same. However, if the printed web becomes lighter than the proof sheet, the reflected light focused on the bimetallic strip 73 is increased, thereby increasing the back pressure in the control element 69 with a resultant increase in the control signal applied to control nozzle 64. This causes more of the power jet within the amplifier 61 to flow into the output receiver 63 thereby increasing the rate at which ink is fed through the flaring nozzle 67 to the roller 68. This soon results in an increase in ink density on the printed web 79, so that the proper balance is restored between the two control nozzles 64, 65.

If it is desired to utilize the system of FIG. 7 to control one or more colored inks, the reflected light may be split into its various components and only the desired color derived for application to the bimetallic strips by the use of filters or prisms.

One of the significant advantages of the improved ink-control system provided by this invention is the rapidity of the automatic cleanup or color changeover made possible by the use of the fluid control elements. Thus, changeover of the ink color can be completed in about 30 seconds, which compares with nearly five minutes for the best system available heretofore. Color changeover can be affected practically instantaneously at any given page position, without affecting the ink feed to any of the other page positions. Moreover, the system provided by this invention can be manufactured at a greatly reduced cost and is easy to maintain because of the nearly complete absence of moving parts, with resultant elimination of wearing problems. Furthermore, the short ink train made possible by this invention permits the use of lower press frames, thereby making it possible to provide handier heights for installing plates, easier accessibility to upper ink supply mechanism, more headroom, and the like. Another significant advantage of the system of this invention is that it is completely enclosed, with only that amount of ink actually needed by the printing plate being applied to the ink drum, so that there is little chance for contamination of the ink by paper dust and other environmental contaminants.

We claim:

1. A fluid-operated digital control system for supplying ink to an ink drum in a printing press, said system comprising the combination of a source of pressurized ink; a fluid-operated control device having a power input operatively connected to said source of pressurized ink, a first output operatively connected to said power input and operatively associated with the ink drum for supplying ink thereto at a controlled rate, a second output operatively connected to said power input for receiving unused ink, and control input means operatively associated with said first and second outputs for switching the flow of said pressurized ink from said power input between said first and second outputs; means including a source of pressurized fluid operatively connected to said control input means for applying a digital fluid control signal thereto for controlling the rate at which ink is discharged through said first output of said fluid operated control device, and automatic control means responsive to changes in the ink density of the printed image and operatively connected to said means for applying a digital fluid-control signal to said control input for automatically varying said digital fluid-control signal according to variations in the ink density of the printed image to maintain a preselected ink density in the various divisions of the printed image.

2. A fluid-operated control system for supplying ink to an ink drum in a printing press, said system comprising the combination of a source of pressurized ink; a digital fluid amplifier having a power input nozzle connected to said source of pressurized ink, a pair of output receivers one of which represents an "on" state and is operatively associated with the ink drum for supplying ink thereto, and the other of which represents an "off" state for returning unused ink to said source, said output receivers being operatively connected to said power input for receiving said pressurized ink therefrom, a first control nozzle operatively associated with said power input nozzle and said output receiver and a source of pressurized fluid connected to said first control nozzle for biasing said amplifier to the "off" state, and a second control nozzle; a source of fluid pulses connected to said second control nozzle operatively associated with said power input nozzle and said output receivers for repetitively switching said amplifier to the "on" state at a rate determined by the frequency of the fluid pulses so that the rate at which ink is supplied to said ink drum is dependent on the frequency of the fluid pulses; and means operatively associated with said source of fluid pulses and responsive to the ink density of the printed image for automatically adjusting the frequency of the fluid pulses to maintain a selected density in the various divisions of the printed image.

3. A fluid-operated control system for supplying ink to an ink drum in a printing press, said system comprising the combination of a source of pressurized ink; a digital fluid amplifier having a power input nozzle connected to said source of pressurized ink, a pair of output receivers one of which represents an "on" state and is operatively associated with the ink drum for supplying ink thereto, and the other of which represents an "off" state for returning unused ink to said source, said output receivers being operatively connected to said power input for receiving said pressurized ink therefrom, a first control nozzle operatively associated with said power input nozzle and said output receivers and a source of pressurized fluid connected to said first control nozzle operatively associated with said power input nozzle and said output receivers and a source of fluid pulses connected to said second control nozzle for repetitively switching said amplifier to the "on" state at a rate determined by the frequency of the fluid pulses so that the rate at which ink is supplied to said ink drum is dependent on the frequency of the fluid pulses; and means operatively associated with said source of fluid pulses and responsive to a press variable that affects the ink density of the printed image for automatically adjusting the frequency of the fluid pulses to maintain a selected ink density in the printed image.

4. A fluid-operated control system as defined in claim 3 which includes means for adjusting the bias of said amplifier for fine adjustment of the rate at which ink is supplied to the ink drum.

5. A fluid-operated control system for supplying ink to an ink drum in a printing press, said system comprising the combination of a source of pressurized ink; a digital fluid amplifier having a power input nozzle connected to said source of pressurized ink, a pair of output receivers one of which represents an "on" state and is operatively associated with the ink drum for supplying ink thereto, and the other of which represents an "off" state for returning unused ink to said source, said output receivers being operatively connected to said power input for receiving said pressurized ink therefrom, a first control nozzle operatively associated with said power input nozzle and said output receivers and a source of pressurized fluid connected to said first control nozzle for biasing said amplifier to the "off" state, and a second control nozzle operatively associated with said power input nozzle and said output receivers; a source of fluid pulses connected to said second control nozzle for repetitively switching said amplifier to the "off" state at a rate determined by the frequency of the fluid pulses so that the rate at which ink is supplied to said ink drum is dependent on the frequency of the fluid pulses; and means operatively associated with said sources of fluid pulses and responsive to press speed for automatically increasing the frequency of the fluid pulses in response to an increase in the press speed and automatically decreasing the frequency of the fluid pulses in response to a decrease in the press speed.

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