United States Patent

[11] 3,557,692

[72] Inventor **William H. Lee**
Lakewood, Ohio

[21] Appl. No. **758,327**
[22] Filed **Sept. 9, 1968**
[45] Patented **Jan. 26, 1971**
[73] Assignee **Harris-Intertype Corporation**
Cleveland, Ohio
a corporation of Delaware

[54] **PLURAL INDEPENDENTLY OPERABLE MOTOR DRIVE ARRANGEMENT IN PRINTING PRESS**
14 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **101/177,** 101/183, 318/43, 318/85
[51] **Int. Cl.** **B41f 5/16**
[50] **Field of Search** 318/78, 85, 52, 45, 43; 321/4; 101/177, 183

[56] **References Cited**

UNITED STATES PATENTS

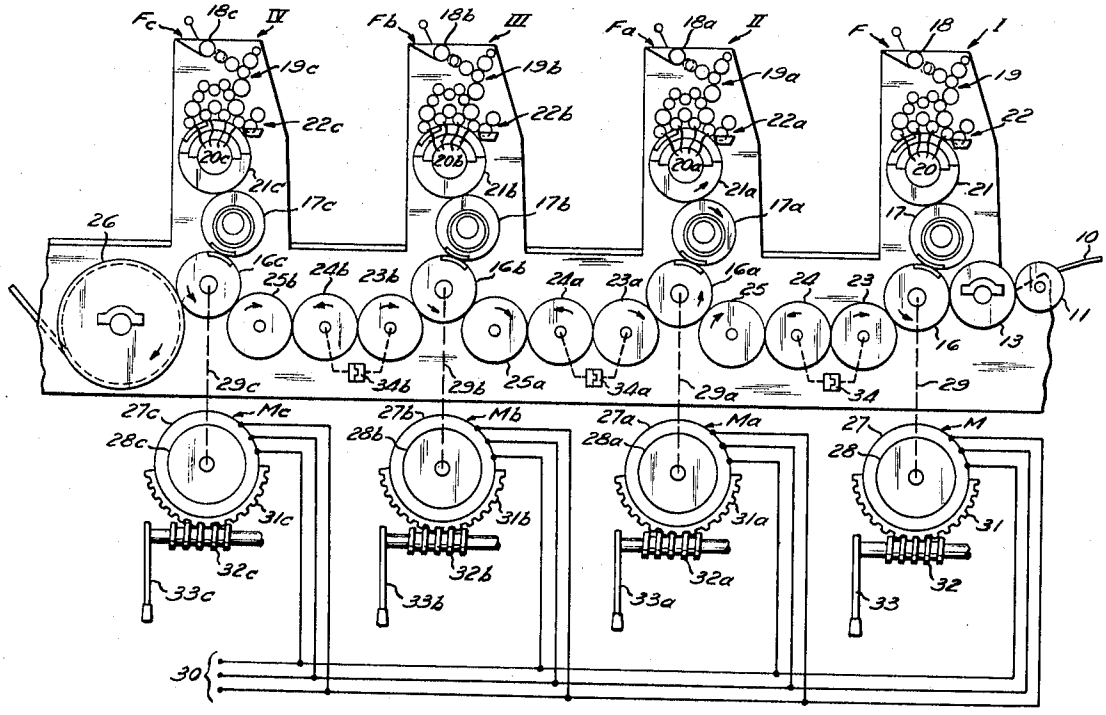
1,450,339	4/1923	Smith	318/78
1,465,087	8/1923	Merril	318/43
2,077,768	4/1937	Perry	318/78
3,109,976	11/1963	Sichling	321/4
3,273,041	9/1966	Strohmeier	321/4
3,447,050	5/1969	Geis	321/27

FOREIGN PATENTS

130,104	10/1959	U.S.S.R.	321/7

Primary Examiner—Oris L. Rader
Assistant Examiner—Alfred G. Collins
Attorney—Yount, Flynn & Tarolli

ABSTRACT: A multicolor printing press having each rotary printing unit driven by an individual synchronous motor. The rotational position of the rotor of each motor may be adjusted individually, either by turning its stator or by changing the frequency of the AC energization of its stator. This enables the printing units to be brought into registration initially or after an out-of-register condition has occurred. A given adjustment of the motor in electrical degrees produces a much smaller rotational adjustment in mechanical degrees of the corresponding printing unit. Any other cyclically-operated mechanism associated with the press may be driven by an individual synchronous motor having a similar speed adjustment.



PATENTED JAN 26 1971

3,557,692

SHEET 1 OF 2

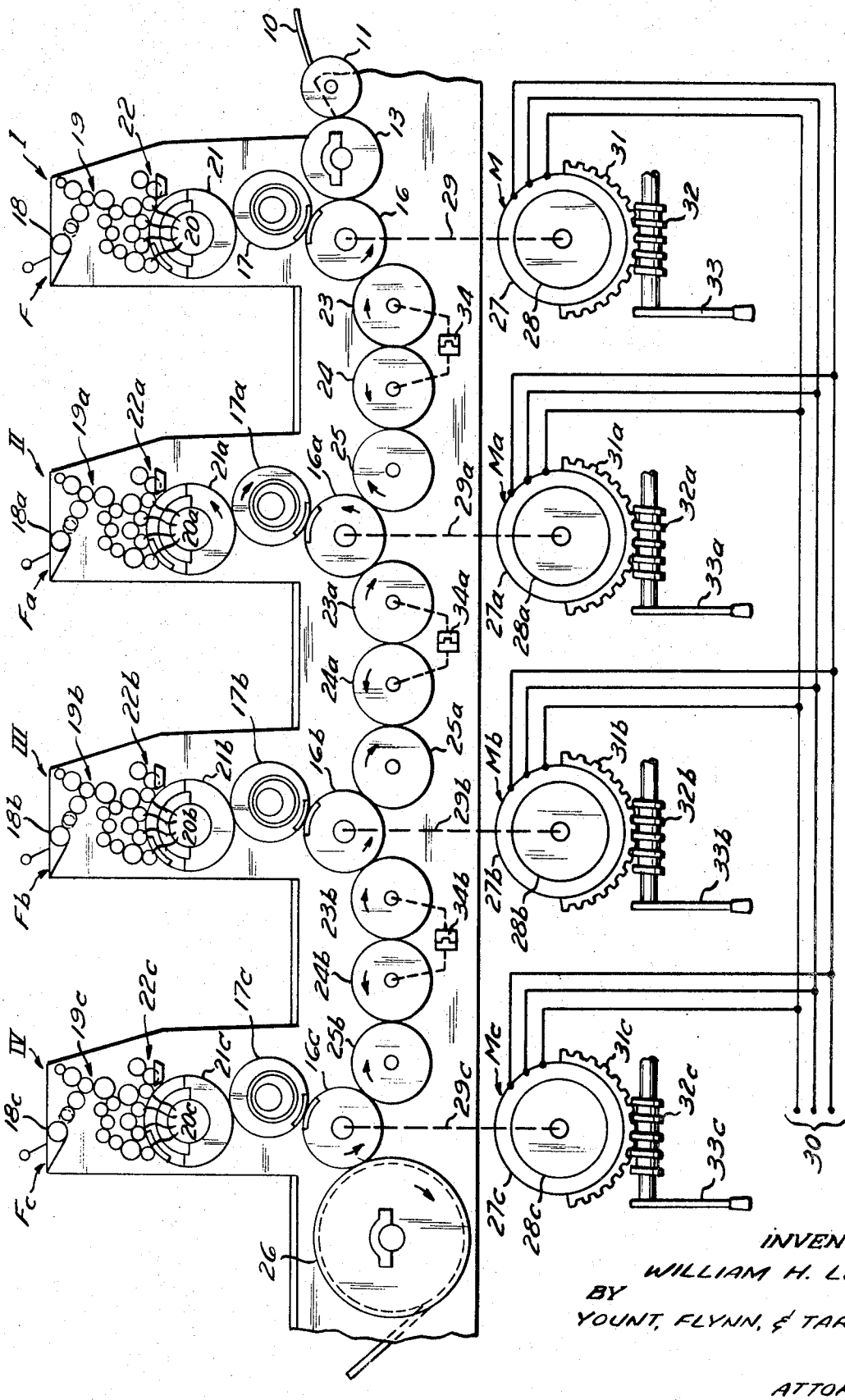


Fig. 1

INVENTOR
WILLIAM H. LEE
BY
YOUNT, FLYNN, & TAROLLI
ATTORNEYS

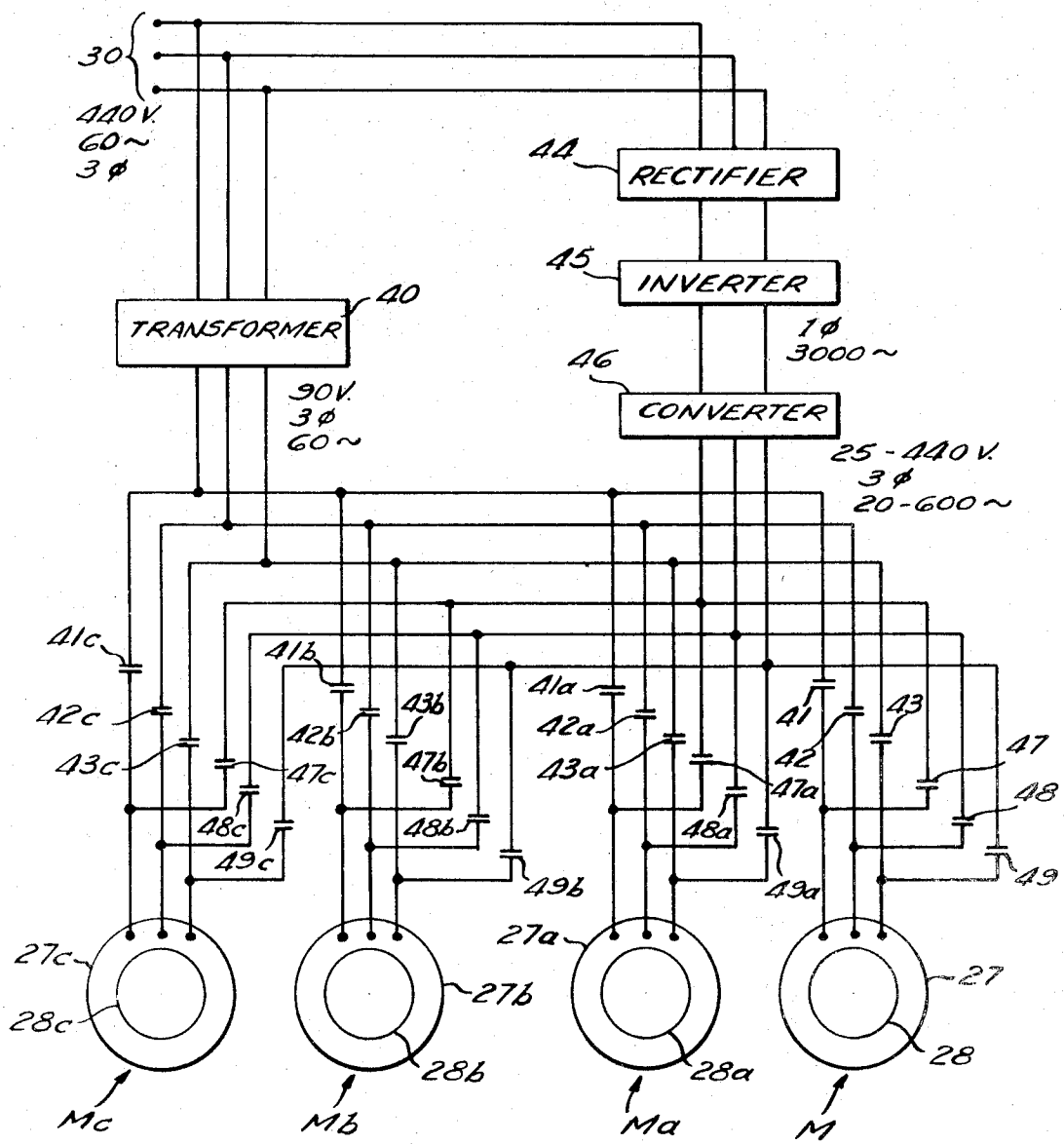


Fig. 2

INVENTOR.
WILLIAM H. LEE

BY
YOUNT, FLYNN, & TAROLLI

ATTORNEYS

PLURAL INDEPENDENTLY OPERABLE MOTOR DRIVE ARRANGEMENT IN PRINTING PRESS

This invention relates to a plural motor drive arrangement in a printing press.

Multicolor printing presses include a plurality of printing units which receive in succession the sheets or the web to be printed upon. One of the important objectives in the use of such presses is to obtain precise lengthwise registration of the different color images which are printed by the successive printing units. Conventionally, this has been attempted by the provision of gears which mechanically interconnect the different printing units so that they should run in synchronism with each other. However, due to mechanical inertia, play in the gearing and other factors, such arrangements have not been entirely satisfactory.

In addition, the usual geared interconnection of the plural printing units can be disadvantageous during "make ready" of the press in preparation for a press run. During "make ready" several different workers may be adjusting the respective different printing units of the press at the same time, in which case the geared interconnection between the printing units would tend to cause the "make ready" procedure to proceed at the pace of the slowest worker.

The present invention is directed to a novel and improved drive for a press which overcomes these and other difficulties and disadvantages associated with the prior press drive arrangements. In accordance with the present invention, each printing unit in a multicolor press is driven by an individual synchronous motor. With the several printing units disconnected mechanically from each other, the "make ready" procedure may be performed on each printing unit independent of the others. The initial synchronization of the printing units at the beginning of a press run is facilitated by the adjustability provided by the present drive arrangement, enabling each printing unit to be adjusted with respect to the others while the press is running by temporarily speeding up or slowing down the circumferentially revolving magnetic field produced by the stator of its drive motor. This may be done mechanically by turning the stator about the axis of the rotor, or it may be done electrically by changing the frequency of the AC energization of the stator. After the out-of-register printing unit has been brought back into registration with the others, the temporary speed adjustment of its drive motor may be discontinued and the synchronous operation of the motors will be relied upon to maintain registration or synchronism of the printing units.

The present drive arrangement also may be used to control the timing of any other cyclically-operated device on a press, such as a cutter, perforator, folder former or the like, whose operation should be precisely controlled with the longitudinal position of the printed image of or images on the sheet or web.

It is a principal object of this invention to provide a novel and improved drive arrangement in a multicolor press which has an individual synchronous driving motor for each printing unit in the press and, if desired, for any other cyclically-operated mechanism associated with the press, with each motor being operable individually to facilitate the "make ready" of the press or to establish or restore correct registration of the different color images printed by the respective printing units.

Another object of this invention is to provide such a drive arrangement in a multicolor press in which the instantaneous rotational position of the rotor of each motor with respect to the rotor of each motor may be selectively adjusted to provide the desired registration.

Another object of this invention is to provide such a drive arrangement in a multicolor press in which the rotor adjustment is accomplished by temporarily increasing or decreasing the velocity of the circumferentially-revolving magnetic fields produced by the stator of that motor.

Another object of this invention is to provide such a drive arrangement in a multicolor press in which the adjustment of a motor may be accomplished by turning its stator about the axis of its rotor.

Another object of this invention is to provide such a drive arrangement in a multicolor press in which the adjustment of a motor may be accomplished by changing the frequency of the AC energization of the stator.

Further objects and advantages of this invention will be apparent from the following detailed description of two presently-preferred embodiments thereof, which are illustrated schematically in the accompanying drawings.

In the drawings:

FIG. 1 shows schematically in elevation a multicolor printing press having a synchronous drive motor for each rotary printing unit in the press, with the stator of each motor being physically adjustable circumferentially of its rotor in accordance with a first embodiment of the present invention; and

FIG. 2 is a block diagram of an electrical control circuit for the drive motors which enables the corresponding printing units to be brought into circumferential registration in accordance with a second embodiment of the present invention.

Referring first to FIG. 1, the press is shown for convenience of illustration as a four-color lithographic press of known design having four similar printing units in succession, designated in their entireties by the reference numerals I, II, III and IV, respectively. While a four-color press is shown for convenience of illustration, it is to be understood that the present drive arrangement may be used in a multicolor press having any number of printing units disposed to print on one or both sides of the paper by either the letterpress or the lithographic process.

The sheet of paper or the like which is to be printed upon is fed from right to left down an inclined feed table **10** by conventional drive tapes (not shown). The sheet is front and side registered while resting on the feed table and then is advanced to a feed cylinder **11**, and from there to an advance cylinder **13**. The sheet is transferred from the advance cylinder **13** to the impression cylinder **16** of the first printing unit I.

In the first printing unit I, the sheet on the impression cylinder **16** is printed on by a blanket cylinder **17** having an image on a conventional rubber blanket. The first printing unit also comprises an inker including an ink reservoir or fountain F containing ink of the first color, a fountain roller **18** for withdrawing ink from the fountain, a series of additional rollers **19**, and finally a plurality of form rollers **20** which transfer a thin film of the ink onto a plate cylinder **21** which carries the lithographic plate for the image of this first color. The ink image is transferred from this plate onto the blanket cylinder **17** and from there onto the sheet.

The first printing unit also includes a dampener **22** for transferring water, or a mixture of water and alcohol, from a reservoir onto the plate on the plate cylinder **21**. This dampener provides a constant feed rate of the dampening liquid, which the operator of the press may adjust so as to provided the minimum feed rate which will permit a clean printing action.

After the first color is printed on the sheet in the first printing unit I, the sheet passes from the impression cylinder **16** in the first printing unit I over a series of three transfer cylinders **23, 24, 25** which transfer the sheet from the impression cylinder **16** of the first printing unit I over to the impression cylinder **16*a*** of the second printing unit II where the second color is printed on it.

The first transfer cylinder **23** is geared to the impression cylinder **16** of the first printing unit I. The second and third transfer cylinders **24** and **25** are both geared to the impression cylinder **16*a*** of the second printing unit II, but not to the first transfer cylinder **23**. Preferably, the transfer cylinders **23, 24** and **25** are so-called skeleton cylinders, which are constructed in a conventional manner so that there is no interference between the cylinder **23** and the sheet grippers thereon, on the one hand, and the cylinder **24** and the sheet grippers thereon, on the other hand, in any relative rotational position of the two cylinders. Since this construction of the transfer cylinders is known per se, it is considered to be unnecessary to describe it in further detail.

The second printing unit II preferably is essentially similar to the first printing unit I, with corresponding elements of the second unit having the same reference numerals as those in the first printing unit, with an *a* suffix added.

The sheet then passes successively through the third and fourth printing units III and IV, which preferably are essentially similar to the first printing unit I and the elements of which are given the same reference numerals, with *b* suffixes added to the reference numerals in the third printing unit III and *c* suffixes added to the reference numerals in the fourth printing unit IV.

Finally, the sheet emerging from the fourth printing unit IV is received by a conventional delivery mechanism including a delivery cylinder **26**.

In the operation of this press, the image of the first color is printed on the sheet in the first printing unit I, as described, and following this the second, third and fourth color images are printed on the sheet in succession in the second, third and fourth printing units II, iII and IV, respectively. The longitudinal registration between these successively printed images depends upon maintaining the correct circumferential registration between the impression cylinders **16**, **16***a*, **16***b* and **16***c* of the respective printing units.

In accordance with the present invention, the printing units are separately driven by individual synchronous AC motors M, M*a*, M*b* and M*c* of known design. Except during their initial synchronization, as described hereinafter, the printing units are not mechanically interconnected, such as through a common geared drive. Motor M has a stator or armature **27** and a rotor **28**, which is mechanically coupled to the impression cylinder **16** of the first printing unit, as indicated schematically by the dashed line **29**, either by a direct connection or through a gear reduction. The corresponding parts of motors M*a*, M*b* and M*c* for for second, third and fourth printing units, respectively, have the same reference numerals, with suffixes *a*, *b* or *c* added.

The stator of each motor has windings which are energized from a three-phase power supply **30** through suitable switches or contactors (not shown) which enable each motor to be energized independent of the others for forward or reverse rotation or to be "inched" or "jogged" by small increments in the usual manner under the control of the operator. The energization of each stator produces magnetic fields which revolve circumferentially around the respective rotor to cause the latter to rotate at a speed determined by the frequency of the AC power supply **30** and the number of poles in the motor. The power supply **30** may be adjustable to enable a corresponding adjustment of the running speed of all the printing units in the press simultaneously.

All of the drive motors are identical to each other and all have their stators energized from the same power supply, so that the respective impression cylinders **16**, **16***a*, **16***b* and **16***c* in the successive printing units will rotate at exactly the same speed so that the images which they print on the paper may register longitudinally with each other. In order to facilitate the initial registration or to restore registration in case an out-of-register condition occurs during a press run the embodiment of the present invention which is illustrated in FIG. **1** has provision for selectively turning the stator of any of these motors with respect to its rotor, thereby temporarily increasing or decreasing the speed of that motor, until the out-of-register printing unit is in circumferential registration with the other printing units. This adjustment can be made while the press is running.

Referring to the first drive motor M, the stator **27** carries an external ring gear segment **31** extending about the rotational axis of the rotor **28** as a center. This gear is engaged by a worm **32**, which may be turned manually by means of a handle **33** so as to turn the entire stator **27** about the axis of the rotor. When the stator **27** is turned, the revolving magnetic fields which the stator produces as a result of its AC energization from the power supply **30** are displaced circumferentially of the rotor. That is, the physical turning of the stator introduces a circumferential velocity component which either adds to or subtracts from the effective velocity at which these magnetic fields are caused to revolve circumferentially due to the AC energization of the stator. Stated another way, such turning of the stator either advances or retards the revolving magnetic fields produced by the AC energization of the stator windings. Whether these revolving fields are advanced or retarded depends, of course, upon the direction of rotation of the rotor **28** and the circumferential direction in which the stator **27** is turned physically by the press operator.

The same adjustability is provided for each of the other drive motors M*a*, M*b*, M*c* individually, with corresponding elements of the stator-turning mechanism having the same reference numerals and a suffix *a*, *b* or *c*.

With this arrangement, while the press is running, the press operator may bring the printing units into circumferential registration, so as to provide precise longitudinal registration of the respective printed images, simply by turning the appropriate motor stator until registration is achieved. After this has been done, the continuing synchronous operation of the drive motors will maintain the printing units in substantial registration.

This drive arrangement also facilitates the "make ready" procedure for each printing unit I, II, III and IV independent of the others. Since each printing unit has its own individual drive motor M, M*a*, M*b* or M*c*, the worker who is performing the "make ready" procedure on that printing unit may inch or jog the impression cylinder in that printing unit without regard to the others since there is no gearing permanently interconnecting them mechanically.

At the completion of the "make ready" procedure for all of the printing units, each drive motor may be energized to inch the cylinders in that printing unit until a register mark on one of these cylinders is lined up with a reference point, which may be marked on the frame of the press, for example. This will cause each of the impression cylinders to have predetermined rotational position in the press such that the respective images which they print should be close to longitudinal registration with one another.

Following this, the several printing units may be mechanically interconnected temporarily, such as by engaging a clutch or inserting a geared connection between the previously-disconnected transfer cylinders **23** and **24**, **23***a*, and **24***a*, and **23***b* and **24***b* which act between the successive printing units I and II, II and III, and III and IV. This temporary mechanical interconnection is indicated schematically by respective clutches **34**, **34***a* and **34***b* and the corresponding dashed-line connections in FIG. **1**. After this temporary mechanical interconnection has been made, all of the drive motors are energized from the same power supply, and the temporary mechanical interconnection between the several printing units insures that their respective impression cylinders rotate in substantial synchronism with each other.

After the press has reached the desired running speed, the clutches or geared connections between successive printing units are disconnected, so that each printing unit now is driven by its individual drive motor with no mechanical interconnection between the several printing units. Any misregistration between the different color impressions on the printed sheets coming out of the press may be corrected by turning the stator of the drive motor for an out-of-register printing unit until the objectionable misregistration has been eliminated in the manner already described for the running register adjustment.

In accordance with the present invention, the drive arrangement for each printing unit preferably is such that a given electrical displacement in the drive motor produces a much smaller mechanical displacement of the impression cylinder which it drives. This enables a precise registration between the circumferential positions of the different impression cylinders to be achieved in response to a much larger electrical adjustment of the drive motor whose impression cylinder was determined to be out of register with the others. For example, each drive motor in FIG. **1** may have a large number of electrical

poles, so that the electrical degrees of the motor are much smaller than its mechanical degrees. Thus, if the motor is a 240-pole motor energized by a 360 cycles per second, three-phase power supply, a 1° shift in electrical position would cause a mechanical shift of only one-half minute of arc on the impression cylinder, or approximately 0.001 inch on the circumference of a 16 inch diameter cylinder. Alternatively, equivalent results could be achieved by using a 40-pole motor energized from a 360 c.p.s. power supply and driving the impression cylinder through a 6-to-1 gear reduction, in which case the combination of the number of poles in the motor and the mechanical gear reduction between the motor rotor and the impression cylinder will provide the desired reduction between the electrical displacement in the motor and the circumferential displacement of the impression cylinder.

FIG. 2 shows a second embodiment of the present invention in which the adjustment of any of the drive motors M, M*a*, M*b* and M*c* may be accomplished by changing the frequency of the AC energization of the motor stator.

In the particular example shown in FIG. 2, a 440 volt, three-phase, 60 c.p.s. power supply **30** is connected to the primary of a stepdown transformer **40**. The secondary of this transformer delivers 90 volt, three-phase power of the same frequency to each of the drive motors M, M*a*, M*b* and M*c* through respective individual sets of contactors or switches **41**, **42** and **43**, which are closed during normal operation of the motors.

The three-phase power supply **30** is also connected to a rectifier **44**, which delivers a DC output voltage whose magnitude may be selectively adjusted by changing the bias on the rectifier. This DC voltage is applied to an inverter **45**, which converts it to single-phase AC voltage of a predetermined frequency, such as 3,000 c.p.s., and of an amplitude corresponding to the magnitude of the DC voltage output from rectifier **44**.

The output of the inverter **45** is connected to the input of a converter **46**, which changes both its frequency and number of phases. This converter may be a conventional motor-generator set or it may be an electronic circuit operating in an equivalent fashion. The converter **46** is adjustable both as to the frequency and the amplitude of its output voltage. For example, it may deliver a three-phase output voltage whose frequency is within the range from 20 to 600 c.p.s. and whose amplitude is within the range from 25 to 440 volts.

The output voltage from the converter **46** may be applied to any of the drive motors through respective sets of contactors or switches **47**, **48** and **49**, which are normally open. The set of contactors **47—49** for any particular motor may be closed and at the same time the normally-closed set of contactors **41—43** for that same motor may be opened by a conventional manually-operated control arrangement (not shown). In this fashion the press operator may disconnect the stator of any selected motor from its normal power supply input from the transformer **40** and connect it to the output of the converter **46**. The press operator will have adjusted the converter **46** to deliver an output voltage whose frequency is either above or below the normal (60 c.p.s.) power supply from transformer **40**, so as to either speed up or slow down the corresponding drive motor to eliminate the misregistration.

In the embodiment of FIG. 2, the circumferential displacement of the impression cylinder (in mechanical degrees) will be much smaller than the corresponding electrical displacement in the motor (in electrical degrees), either by providing a sufficiently large number of poles in the motor or by the combined effect of the number of motor poles and a gear reduction between the motor and the impression cylinder.

In the use of the FIG. 2 system, each drive motor may be inched independent of the others during the "make ready" period by connecting it to the transformer **40**.

After the several printing units have been initially adjusted with respect to the reference points and the disconnectable mechanical interconnections have been engaged between all of the printing units, as described with reference to FIG. 1, then all of the drive motors are connected to the transformer **40** to be energized by the 60 c.p.s. voltage. After the press has come up to full speed, the mechanical interconnections between the several printing units are disconnected, so that each printing unit now is driven individually by its drive motor.

Any misregistration between the different color printed impressions may be corrected by disconnecting the motor for the out-of-register printing unit from the transformer **40** and connecting it to the converter **46**, and then adjusting the frequency of the converter **46** until registration is achieved, after which this motor is again connected to the transformer **40**.

While two presently-preferred embodiments of the present drive arrangement have been disclosed with reference to the registration of different printing units in a multicolor press, it is to be understood that various adaptions and modifications which depart from the disclosed embodiments may be adopted without departing from the spirit and scope of this invention. For example, any other cyclically-operated mechanism associated with the press, such as a cutter, perforator, folder former or the like, may be driven by a corresponding synchronous motor energized from the same power supply as the drive motor for a printing unit in the press, with each motor being adjustable in the manner described to enable the corresponding mechanisms to be brought into proper synchronism with each other.

I claim:

1. In a printing press having a plurality of successive cyclically-operated mechanisms:

a plurality of drive arrangements connected individually to the respective cyclically-operated mechanisms and each including a synchronous drive motor having a stator and a rotor and means coupling the rotor to the corresponding cyclically-operated mechanism for driving the latter, each motor stator having windings inductively coupled to the rotor and arranged to produce magnetic fields which revolve circumferentially about the rotor to cause the latter to rotate synchronously in response to AC energization of the stator windings;

means for temporarily mechanically coupling said mechanisms so that they are synchronously driven as said motors are brought up to speed; and

a like plurality of rotational positioning means, each individual to one of said drive motors and operable independently of said other rotational positioning means, once said temporary means are decoupled, for selectively changing the rotational position of its rotor with respect to the rotor of each other drive motor.

2. Apparatus according to claim **1**, wherein said last-mentioned means comprises means for selectively increasing or decreasing temporarily the speed at which the magnetic fields produced by its stator revolve circumferentially of its rotor.

3. Apparatus according to claim **2**, wherein said last-mentioned means comprises means for turning the stator about the axis of the rotor.

4. Apparatus according to claim **2**, wherein said last-mentioned means comprises means for varying the frequency of the AC energization of the stator windings.

5. Apparatus according to claim **4**, wherein said means for varying the frequency of the AC energization comprises:

rectifier means having a variable bias for converting AC power to an adjustable DC voltage;

an inverter connected to the output of said rectifier means for converting the latter's DC output voltage to a single phase AC voltage of a predetermined frequency;

a converter connected to the output of said inverter and operable to change the latter's single phase AC output voltage to a polyphase AC voltage, said converter including means for selectively changing the frequency of said polyphase AC voltage; and

means for selectively applying the output of said converter to the stator windings of the corresponding drive motor.

6. Apparatus according to claim 2, wherein said drive arrangement is operable, in response to a given electrical displacement in electrical degrees between its rotor and the revolving magnetic fields produced by its stator windings, to produce a rotational displacement in mechanical degrees of the corresponding cyclically-operated mechanism which is only a small fraction of said electrical displacement.

7. In a multicolor printing press having a plurality of successive rotary printing units:

a plurality of drive arrangements connected individually to the printing units and each including a synchronous drive motor having a stator and a rotor and means coupling the rotor to the corresponding printing unit for driving the latter, each motor stator having windings inductively coupled to the rotor and arranged to produce magnetic fields which revolve circumferentially with respect to the rotor to cause the latter to rotate synchronously in response to AC energization of the stator windings;

clutch means for temporarily coupling said units as said drive means are brought up to speed; and

means individual to each drive motor for, after said motor is brought up to speed, selectively increasing or decreasing temporarily the speed at which the magnetic fields produced by its stator revolve circumferentially of its rotor to thereby change the instantaneous rotational position of its rotor with respect to the rotor of each other motor.

8. Apparatus according to claim 7, wherein said last-mentioned means comprises means for turning the stator about the axis of the rotor.

9. Apparatus according to claim 7, wherein said last-mentioned means comprises means for varying the frequency of the AC energization of the stator windings.

10. Apparatus according to claim 9, wherein said means for varying the frequency of the AC energization comprises:

rectifier means having a variable bias for converting AC power to an adjustable DC voltage;

an inverter connected to the output of said rectifier means for converting the latter's DC output voltage to a single phase AC voltage of a predetermined frequency;

a converter connected to the output of said inverter and operable to change the latter's single phase AC output voltage to a polyphase AC voltage, said converter including means for selectively changing the frequency of said polyphase AC voltage; and

means for selectively applying the output of said converter to the stator windings of the corresponding drive motor.

11. Apparatus according to claim 7, wherein each drive arrangement is operable, in response to a given electrical displacement in electrical degrees between its rotor and the revolving magnetic fields produced by its stator windings, to produce a rotational displacement in mechanical degrees of the corresponding cyclically-operated mechanism which is only a small fraction of said electrical displacement.

12. Apparatus according to claim 11, wherein said last-mentioned means comprises means for turning the stator about the axis of the rotor.

13. Apparatus according to claim 11, wherein said last-mentioned means comprises means for varying the frequency of the AC energization of the stator windings.

14. Apparatus according to claim 13, wherein said means for varying the frequency of the AC energization comprises;

rectifier means having a variable bias for converting AC power to an adjustable DC voltage;

an inverter connected to the output of said rectifier means for converting the latter's DC output voltage to a single phase AC voltage of a predetermined frequency;

a converter connected to the output of said inverter and operable to change the latter's single phase AC output voltage to a polyphase AC voltage, said converter including means for selectively changing the frequency of said polyphase AC voltage; and

means for selectively applying the output of said converter to the stator windings of the corresponding drive motor.