

March 5, 1935.

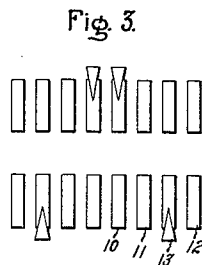
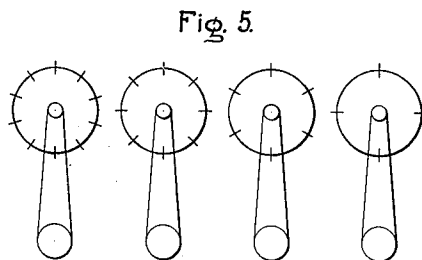
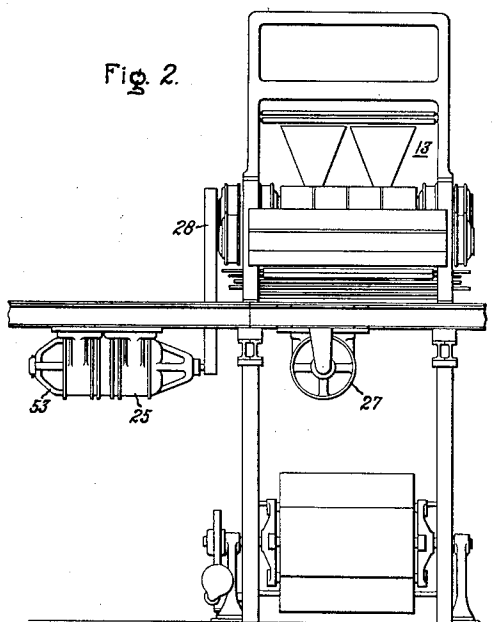
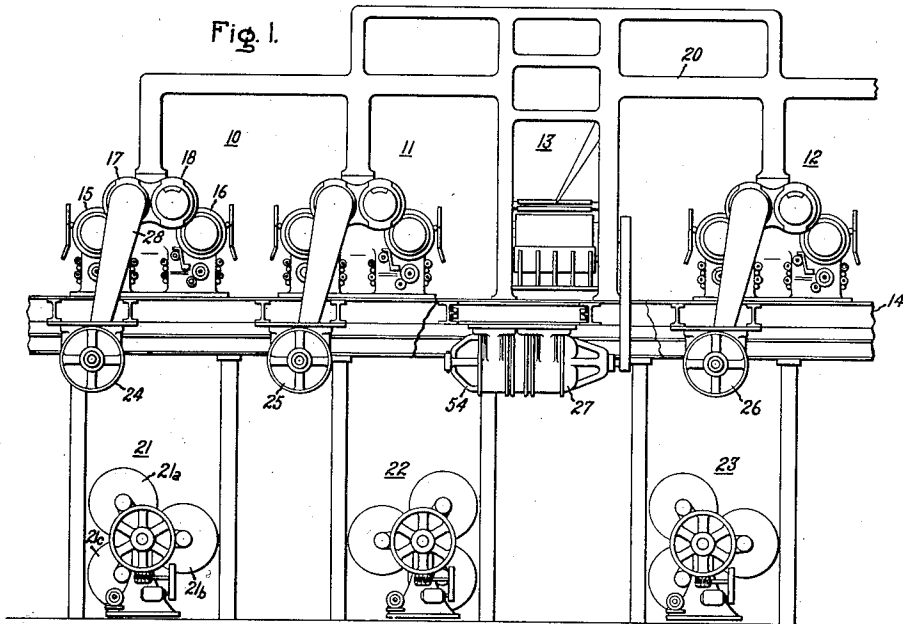
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1,993,579

SYNCHRONIZING SYSTEM FOR UNIT TYPE PRINTING PRESSES

Filed Dec. 2, 1932

3 Sheets-Sheet 1



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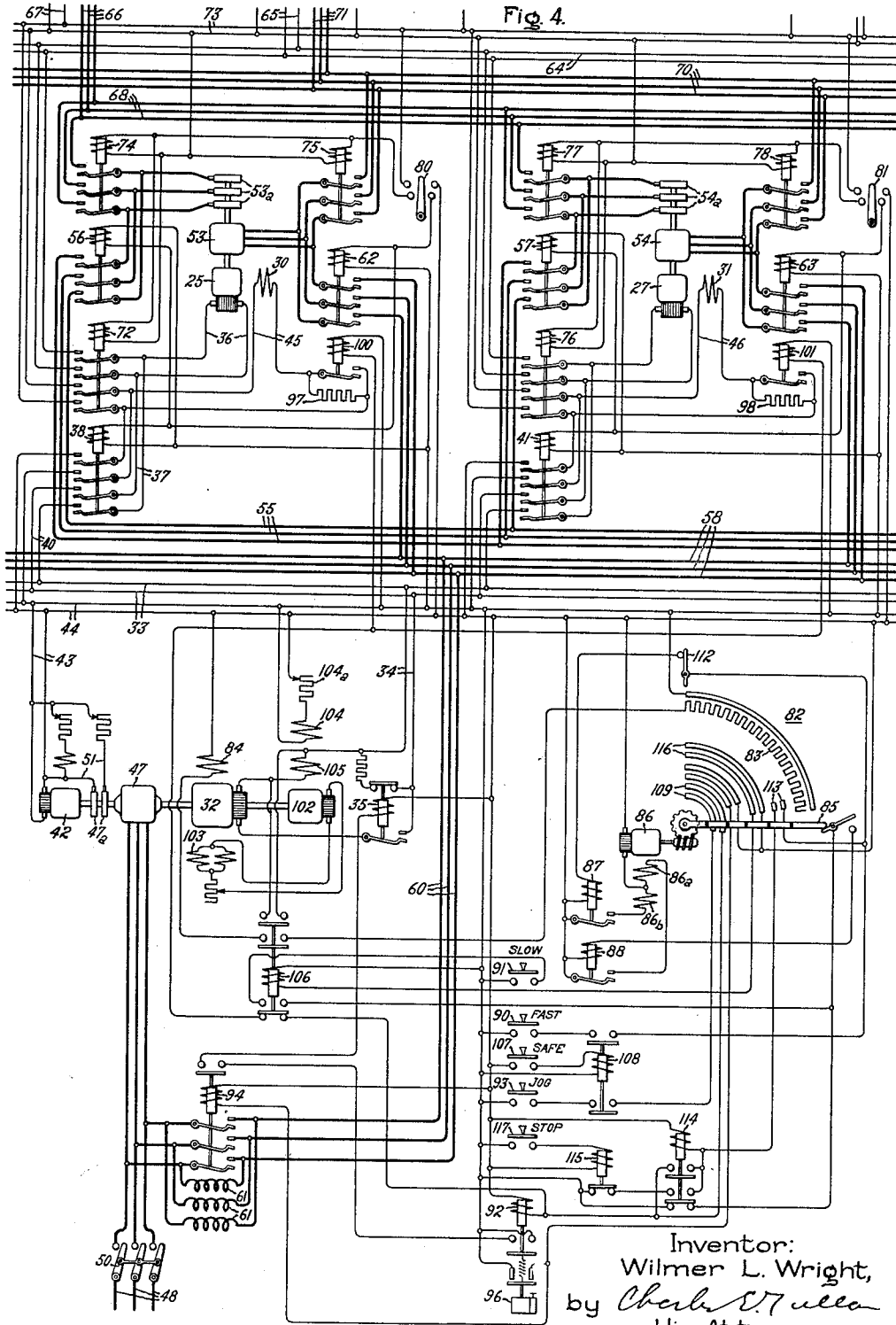
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SYNCHRONIZING SYSTEM FOR UNIT TYPE PRINTING PRESSES

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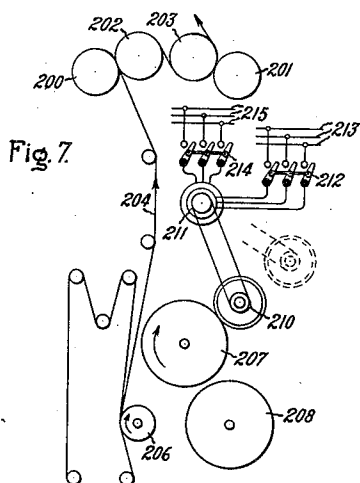
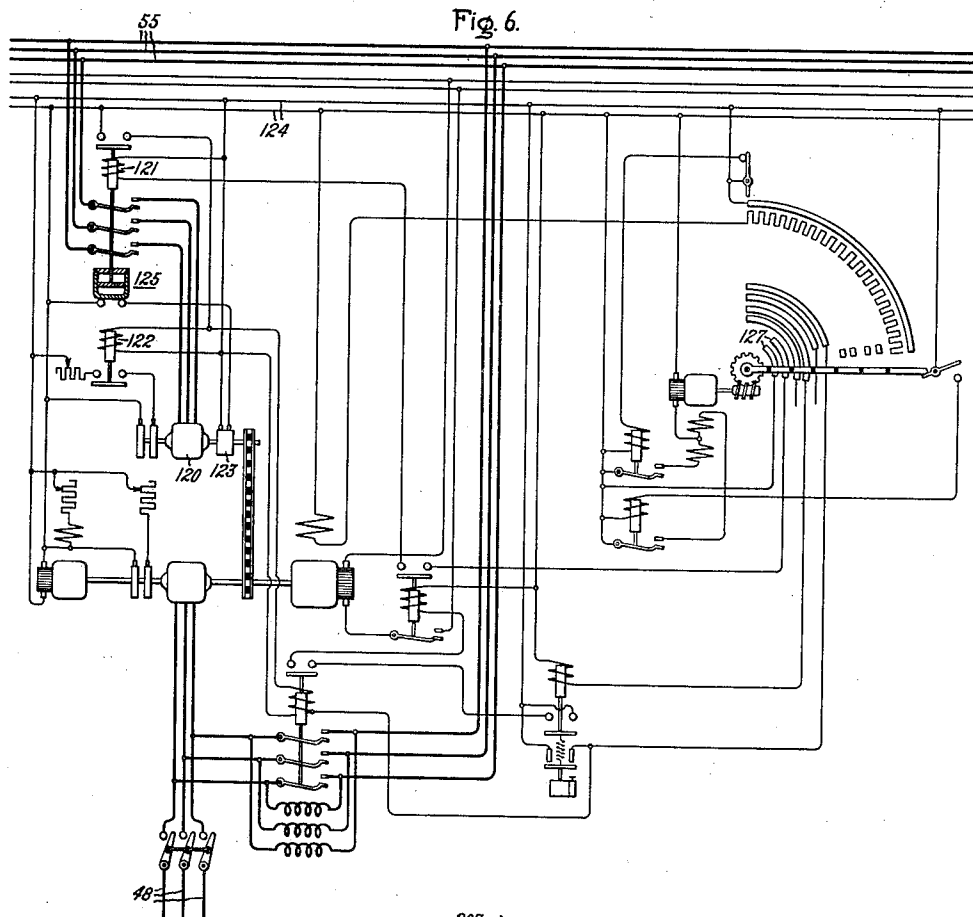
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SYNCHRONIZING SYSTEM FOR UNIT TYPE PRINTING PRESSES

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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SYNCHRONIZING SYSTEM FOR UNIT-TYPE PRINTING PRESSES

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Application December 2, 1932, Serial No. 645,430

21 Claims. (Cl. 101—220)

This invention relates to printing presses, more particularly to rotary web printing presses consisting of a plurality of separately driven printing units and folding units, and it has for an object the provision of a simple, reliable and improved means for maintaining the several printing units and folding units in exact synchronism with each other at all speeds from standstill to full speed while at the same time entirely eliminating undesirable mechanical shafting or other mechanical interconnections between the press units.

The provision of satisfactory operation of this type of press at low threading speed is extremely difficult due to wide variations in the torque requirement, and a further object of this invention is the provision of improved means insuring uniform low threading speed operation of the several units irrespectively of changes in the torque requirements of the press.

In carrying the invention into effect in one form thereof, the several units of a printing press are each driven by an individual driving means, for example an electric motor, supplied from a suitable source and these units are synchronized with each other by means of a plurality of alternating current motors each connected to one of the press units and having secondary windings connected together, and means are provided for insuring the connection of the primary winding of these alternating current synchronizing motors to a source of alternating voltage prior to the energization of the driving means and also to insure deenergization of the driving means prior to disconnection of the synchronizing motors from the alternating current source.

Uniform synchronous operation of the several press units at low threading speed irrespectively of changes in the torque requirements of the press is accomplished by means of a variable voltage generator for supplying the unit driving motors together with an exciter having its armature connected to a field winding of the generator and provided with a series field winding traversed by the current exchanged between the generator and the driving motors.

In a modified form uniform synchronous low threading speed of the several units is assured by means of an auxiliary generator connected to the secondary windings of the synchronizing motors, the frequency of the generated voltage of which auxiliary generator differs from the frequency of the primary supply source by an amount proportional to the desired low threading speed.

The rapid synchronization of the impression cylinders of the several units in exact registry with each other and with the cutting element of the folding mechanism is made possible and greatly facilitated by the provision of mechanical connections between the synchronizing motors and their respectively associated press units having ratios such that when markings on the cylinders register with markings on the frame of the press, the same polar relationship always obtains between the primary and secondary windings of all of the synchronizing motors.

For a better and more complete understanding of this invention, reference should now be had to the following specification and to the accompanying drawings in which Fig. 1 is a front elevation, partly broken away, of several units of a modern unit type rotary web printing press; Fig. 2 is an end elevation of the press of Fig. 1; Fig. 3 is a diagrammatical representation of two groups of press units in a press room; Fig. 4 is a diagrammatical representation of a system embodying the electrical synchronizing means for the press units and the control therefor together with an embodiment of means providing synchronous and uniform operation of the several press units at low threading speed; Fig. 5 is a diagrammatical representation of proper ratios of driving connections between the synchronizing means and the press units serving to illustrate a feature of this invention; Fig. 6 is a simple, diagrammatical representation of a modification of the system of Fig. 4; and Fig. 7 is a simple diagrammatical representation of a feature of the synchronizing system providing operation of the mechanism for speeding up an incoming roll in synchronism with the printing and folding units of the press so that the peripheral speed of the incoming roll is equalized with the speed of the web of an expiring roll of paper.

Referring now to the drawings a plurality of printing units 10, 11 and 12, a folding mechanism unit 13 of a unit-type rotary web printing press are mounted on and securely fastened to a steel deck 14 in alignment with each other as illustrated in Fig. 1. It will, of course, be understood that a modern unit-type printing press may and usually does comprise more than four units and this number of units is chosen merely for the purpose of simplifying the drawings while adequately illustrating the invention. A typical and satisfactory arrangement of printing press units in a press room is illustrated in Fig. 3 in which sixteen separate units, eight on either side of an aisle are provided. In this figure the printing units

are conventionally represented by a plain oblong whilst the folding mechanism units are conventionally represented by oblongs provided with superposed triangles. Thus, for example, the four units at the right hand side of the lower row may be taken to represent the units 10, 11 and 12 and the folding unit 13 of Fig. 1.

The printing unit comprises a pair of plate cylinders and a pair of impression cylinders; for example, the two outside cylinders 15, 16 of unit 10 are plate cylinders and the two inside cylinders 17 and 18 are impression cylinders. The printing units 11, 12, etc. are in all respects similar to the printing unit 10.

The folding unit 13 consists of the usual folding mechanism and is also provided with a cutter or knife for severing the webs into individual newspapers. Printed webs are delivered from each of the printing units 10, 11 and 12 and led over rollers or angle bars (not shown) mounted on the press super-structure 20 to the folding mechanism 13. It is clear that the folder 13 may receive webs delivered in both directions from the press units arranged on either side of the folder.

On the floor of the basement beneath the press decks are located the reel mechanisms 21, 22 and 23 associated with the printing units 10, 11 and 12 respectively. As shown, each of these reel mechanisms is fully loaded with three full reels of news-print; the mechanism 21, for example, being provided with reels 21a, 21b and 21c. The web is led from one of the full reels, for example, the reel 21c up through an opening in the press deck 14 to the printing unit 10 passing between the cylinders 15 and 17 to be printed on one side and then between the cylinders 16 and 18 to be printed on the reverse side and from thence to the folding mechanism 13.

The several units of the press are separately driven by suitable driving means such for example as those represented by the electric motors 24, 25, 26 and 27 to the drive shafts of which the units 10, 11, 12 and 13 are respectively connected by suitable driving connections such as represented by the drive chain 28. As illustrated in Figs. 1 and 2, these driving motors are secured to the lower side of the press deck 14. It will be observed that a single element of the printing unit, for example the impression cylinder 17 is driven by the chain 28 and that the remaining elements of the unit are mechanically geared together as illustrated.

In Fig. 4, the driving motors 25 and 27 for the printing unit 11 and the folding unit 13 respectively are illustrated as direct current motors respectively provided with separately excited field windings 30 and 31. Only the motors 25 and 27 are shown in this figure because a showing of the remaining unit drive motors together with the necessary control circuits would render the drawings entirely too complicated. The armature members of the motors 25 and 27 are supplied with direct current from any suitable source such for example as that represented in the drawings by the direct current generator 32 to the armature member of which the direct current supply buses 33 are connected as by means of conductors 34 and line contactor 35 and to which supply buses 33 the armature members of the driving motors 25, 27 are connected by suitable electrical connections. For example, the armature member of motor 25 is connected to the supply source buses 33 by means of conductors 36, 37, lower pair of contacts of electromagnetic switching device 38 and conductors 40. The armature member of the driv-

ing motor 27 is connected to the supply buses by similar connections and by a similar electromagnetic switching device 41. The exciting current is supplied to the field windings 30 and 31 of the unit driving motors from a suitable source of direct current such for example as that represented by the exciter 42, the armature member of which is connected by means of conductors 43 to the excitation buses 44 to which in turn the field windings 30 and 31 are respectively connected by connections 45 and 46 and by upper pairs of contacts of contactors 38 and 41.

As shown, the supply generator 32 is driven by suitable driving means illustrated as an alternating current motor 47 which in turn is supplied with electrical energy from any suitable source such for example as that represented by the three supply lines 48 to which the terminals of the motor 47 are arranged to be connected by closing the switch 50. Preferably, the generator 32 is driven at a speed which is substantially constant and for this reason the alternating current motor 47 is illustrated as a synchronous motor; its direct current field winding being supplied with direct current from the exciter 42 to the terminals of which the direct current field winding (not shown) is connected by means of slip rings 47a and conductors 51.

In order that the printed pages on the web delivered from the printing units 10, 11 and 12 shall be in proper register with each other and severed in proper register with respect to the top and bottom margins thereof by the knife of the folding mechanism 13, it is essential that the units 10, 11, 12, and 13 shall be arranged in proper initial register and subsequently maintained in exact synchronism with each other at all speeds from standstill to full running speed. For the purpose of maintaining these units in exact synchronism and at the same time eliminating all mechanical shafting or other mechanical interconnections between the several press units electrical synchronizing means are provided for electrically interconnecting the several units. Synchronizing means are illustrated as comprising a plurality of asynchronous alternating current motors 53, 54, etc. each having its rotor member connected to the drive shaft of one of the unit driving motors 25, 27, etc. As shown in Figs. 1 and 2 of the drawings, the driving motor and the synchronizing motor for each press unit is itself constructed as a unitary structure. For example, the driving motor 25 and the synchronizing motor 53 both have their rotor members mounted on the same shaft and their stator windings are mounted on the same structural base. The secondary windings (not shown) of the synchronizing motors 53, 54, etc., are connected to synchronizing buses represented by the three conductors 55. The terminals of the secondary windings of the synchronizing motors 53, 54 are brought out to slip rings 53a and 54a respectively which in turn are connected to the synchronizing buses 55 by means of suitable electromagnetic switching devices 56 and 57 when the latter are operated to their closed position. Each of the remaining press units of the lower group of units of Fig. 3 is similarly provided with a synchronizing motor mechanically connected to the shaft of its drive motor and electromagnetic switching devices similar to 56 and 57 are likewise provided for connecting their secondary windings to the synchronizing buses 55. Alternating voltage of any suitable commercial frequency is supplied to the primary windings of the synchronizing motors 53, 75

54 which in turn are connected by means of conductors 60 and reactance devices 61 to the source of alternating voltage 48. Suitable electromagnetic switching devices 62 and 63 serve when operated to the closed position to connect the primary windings of the synchronizing motors 53, 54 to the supply buses 58 so that the direction of rotation of the rotating magnetic field of the primary windings of these motors is opposite to the direction of rotation in which the rotor members are driven by the driving motors 25, 27.

Synchronization of the several press units at all speeds from standstill to full running speed is produced as follows:

When the primary windings of the respective synchronizing motors 53, 54, etc. are simultaneously energized from a common source of polyphase alternating current, the rotor members of these synchronizing motors will assume a position in which the circulating current in the secondary windings and in the synchronizing buses 55 is a minimum and the synchronizing motors are said to be in step or "inphase". These rotor members of the synchronizing motor will maintain their co-synchronous relation as long as their primary windings remain energized and their secondary windings remain connected to the synchronizing buses and will develop a differential torque of rotation approximately equivalent to the "break-down" or "pull-out" torque of a normal induction motor. The synchronizing motors of such a system do not thus develop a driving torque and will, therefore, remain at standstill unless driven by some external means. When so driven, however, all elements will be rotated in synchronism. Such a system, therefore, when applied to individual press units provides a synchronous tie-in medium at standstill and due to the fact that the primary windings are energized so that the rotating magnetic fields rotate in a direction opposite to the mechanical rotation of the rotors thereby producing increasing frequency of the voltage induced in the secondary windings with increasing speed of rotation of the rotors, a synchronous tie-in is provided at all running speeds. Any unbalancing in the power requirement for the different press units is equalized by the induction generator and motor action of the tie-in elements themselves and is evidenced by a flow of energy to or from the secondary windings of the tie-in motors.

The several units of the upper group of printing press units of Fig. 3 are likewise separately driven by a plurality of driving motors similar to the driving motors 25, 27 etc. for the units of the lower group. These driving motors for the upper group of units are connected to suitable supply buses 64 which in turn are connected by means of conductors 65 to a suitable separate generator (not shown) similar to the generator 32. The separate generator for supplying the driving motors of the upper group of units is for the purpose of providing maximum flexibility of control. Thus, the speed of one group of units may be increased or decreased without in the least affecting the operation of the others. The upper groups of press units of Fig. 3 are also provided with synchronizing motors in all respects similar to the synchronizing motors 53, 54. The secondary windings of these synchronizing motors are respectively connected by means of connections 66 to synchronizing buses 68 and their primary windings are supplied with alternating voltage from supply buses 70 supplied from a suitable source and to which the primary wind-

ings are connected by means of conductors 71. It will thus be seen that synchronizing buses 68 for the upper group of units correspond to the synchronizing buses 55 for the lower group and that similarly the primary supply buses 70 for the upper group of units correspond to the supply buses 58 for the lower group, whilst the supply buses 64 for the driving motors of the upper group of units correspond to the driving motor supply buses 33 for the lower group.

In order to increase the flexibility of operation and to provide operation of one of the lower group of units of Fig. 3 with the upper group of units or vice versa, suitable switching devices are provided for connecting the driving motors 25, 27, etc. and the primary and secondary windings of the synchronizing motors 53, 54, etc. with the buses 64, 71, and 68 respectively of the upper group of units. To this end a suitable electromagnetic switching device 72 serves to connect the armature members and field windings of driving motor 25 to the armature supply buses 64 and the excitation buses 73 whilst electromagnetic switching devices 74 and 75 serve when operated to their closed position to connect the secondary windings of the synchronizing motor 53 to the synchronizing buses 68 and the primary windings of the synchronizing motor 53 to the supply buses 70. Similarly the electromagnetic switching device 76 serves to connect the armature terminals and field windings of the driving motor 27 to the buses 64 and 73 respectively whilst electromagnetic switching devices 77 and 78 serve to connect the secondary and primary windings of the synchronizing motor 54 to the buses 68 and 70 respectively. Similar switching devices are provided for connecting the driving and synchronizing motors of each of the remaining units of the lower group of press units of Fig. 3 to the group of electrical buses associated with the upper group of units. Selector switches 80 and 81 serve when operated to their right hand position to energize the switching devices 38, 62, and 56 and 41, 57 and 63, to connect the driving motors 25, 27 etc. and their synchronizing motors 53, 54, etc. to the lower group of buses and these same synchronizing switches 80 and 81 when operated to their left hand position serve to energize the switching devices 72, 74 and 75 and 76, 77 and 78 to connect the driving and synchronizing motors to the upper group of buses. In the central or neutral position in which these selector switches are illustrated in the drawings the operating coils of all of the electromagnetic switches controlled thereby are deenergized and all of the electromagnetic switching devices are in the open positions in which they are illustrated.

The primary and second windings of the synchronizing motors may be wound for any desired number of pairs of poles. As diagrammatically illustrated in Fig. 5 these motors may be wound for five, four, three, or two pairs of poles. It will be clear that if corresponding type cylinders of adjoining press units are to be synchronized in proper registry with each other it is necessary that the same polar relationship obtain between the primary and secondary windings of all the synchronizing motors when markings on the type cylinders are in registry with registration markings on the frame of the press. If odd, or fractional mechanical connection ratios are employed between the synchronizing motors and the press units to which they are respectively connected, it is very difficult to obtain this coincidence of polarity relationship of the primary and

secondary windings and the synchronizing motors when the cylinder markings are in proper register, and may require that the press cylinders and the driving and synchronizing motors be turned over by hand a great number of times before the proper relationship is obtained. In order to facilitate the selection and registration of printing press units involving the use of polar wound synchronizing motors for maintaining the co-synchronous relationship of the printing cylinders, a drive ratio between the synchronizing motors and their respectively connected press units is selected such that the same polar relationship obtains between the primary and secondary windings of all the synchronizing motors when the markings on the printing cylinders register with registration markings on the press frame. This relation is established when the mechanical ratio of connections is a whole number, or a fraction such that the denominator thereof is equal to the number of pairs of poles of the synchronizing motors. For example, in a typical installation, the synchronizing motors may be wound for ten poles as indicated at the left hand of Fig. 5. In this case the driving connections may have any integral ratio such as 1, 2, 3, etc. or any fractional ratio such as $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{5}$, $\frac{6}{5}$ etc. in which the denominator is 5, i. e., the number of pairs of poles. Similarly, if the synchronizing motors are wound for four poles as indicated at the right hand of Fig. 5 the driving connections may have any integral ratio or fractional ratio in which the denominator is equal to the number of pairs of poles such as $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$, etc.

For the purpose of controlling the operating speed of the press driving motors suitable speed controlling means 82 is provided for controlling the voltage supplied to the driving motors by the generator 32. This rheostat comprises a resistance element 83 connected in circuit with the field winding 84 of the supply generator, together with a movable contact arm 85 for varying the amount of the resistance 83 in circuit. This movable contact arm 85 is driven by a pilot motor 86 provided with a split field winding 86_a and 86_b for controlling the direction of rotation of the motor 86. A suitable electromagnetic switching device 87, when operated to its closed position, serves to energize the split field winding 86_b and to effect rotation of the motor 86 in a direction such that the arm 85 is moved to decrease the amount of the resistance 83 in circuit with the field winding of the generator, whilst a similar electromagnetic switching device 88, when operated to its closed position, serves to energize the split field winding 86_a and to effect rotation of the motor 86 in a direction to decrease the amount of the resistance 83 in circuit.

Suitable manually operated switches 90 and 91 indicated by the legends "fast" and "slow" respectively control the operation of the electromagnetic switching devices 87 and 88 respectively. Although these manually operated switching devices 90 and 91 may be any suitable type, they are preferably of the push-button type.

Operation of the press units at low threading speeds is effected by means of an electromagnetic switching device 92 under the control of a manually operable push-button switch 93. The relay device 92 when operated to its closed position controls the operation of the contactor 94 by means of which the reactance devices 61 are short-circuited and full synchronizing voltage applied to the primary windings of the synchronizing motors.

The line switch 35 serves to connect the armature

member of the generator 32 to the press driving motors and means in the form of an interlock on the contactor 94 in circuit with the operating coil of line switch 35 insures the energization of the synchronizing motors prior to the energization of the driving motors whilst means illustrated in the form of a time delay device 96 controlling the operating winding of the contactor 94 serves to insure deenergization of the driving motor prior to deenergization of the synchronizing means.

In order to provide the necessary starting torque for the driving motors, resistances 97 and 98 normally in circuit with the field windings 30 and 31 of the driving motors are short-circuited by means 100 and 101 from the movable contact arm 85 of the speed controlling rheostat 82 is in the low speed position. This exclusion of the resistances 98 and 97 from the field circuits of the driving motors increases the excitation of the motors and correspondingly increases the torque which they develop.

Uniform operation of the several press units despite variations in the torque requirements of the press is provided in the form of an auxiliary regulating dynamo electric machine 102 having its armature member connected in circuit with an auxiliary or regulating field winding 103 of the supply generator 32. The auxiliary exciter 102 is provided with a separately excited field winding 104 supplied from the excitation buses 44 with an adjustable resistance 104_a included in circuit and is further provided with a series field winding 105 connected in series relationship between the armature of the generator 32 and the driving motors so as to be traversed by the current exchanged between the generator and the driving motors. It is well known that when a printing press is operating at low threading speed, the torque requirements vary widely from instant to instant and these variations in the torque tend to effect abrupt changes in the speed of the press often resulting in breaking the web. The variation in the threading speed of the driving motor in response to variations in the torque requirements of the press are prevented by the auxiliary dynamo-electric machine in the following manner:

If the torque requirement of the press tends to increase, the speed of the driving motors tends to decrease and thus to cause a greater amount of current to flow in the armatures of the driving motors. This increased armature current flowing through the series field winding 105 of the exciter 102 increases the voltage of the exciter and correspondingly increases the amount of current flowing in the auxiliary field winding 103 of the generator 32. The field winding 103 is wound to act cumulatively with the main field winding 84 so that the increase in the exciter voltage effects an increase in the generated voltage of the generator 32, thereby increasing the speed of the driving motors to the former value. In a similar fashion if the torque requirement of the press decreases, the speed of the driving motors tends to increase and thus to reduce the amount of current flowing in the armatures of the driving motors. This reduction in the current taken by the driving motor effects a corresponding reduction in the excitation due to the series field winding 105 of the exciter 102 and consequently effects a corresponding reduction in the excitation and generated voltage of the generator 32, as a result of which the speeds of the driving motors are decreased to their former values. Thus it will be seen that the auxiliary exciter 102 acts as

a regulating machine to maintain uniform operation of the press units at low threading speed. Suitable switching device 106 under the control of the movable contact 85 of the rheostat 82 serves to short-circuit the field winding 105 of the auxiliary machine 102 and thereby to render the latter ineffective when the arm 85 is moved from its low speed position to a high speed position.

With the above understanding of the apparatus and connections, the operation of the system will readily be understood from the detailed description which follows:

The cylinders of press units 10, 11, 12, etc. are first barred over until registration marks on these cylinders coincide with registration marks on the frame. The operation of the selector switches 80, 81, etc. to the right hand position serves to connect the primary windings of synchronizing motors 53, 54, to supply buses 58, the secondary windings of these synchronizing motors to each other through the synchronizing buses 55 and also to connect the armatures of driving motors 25 and 27 to supply buses 33 and their respective field windings to the excitation buses 44, and are next synchronized with each other by closing the switch 50 to apply polyphase power from the source 48 through the reactance devices 61 to the synchronizing motor supply buses 58. The synchronizing motors lock in step and thus the press units are synchronized with each other at stand-still. This also results in connecting the generator driving motor 47 to the supply source 48 causing the motor 47 to drive the generator 32 and the exciter 42. It will, of course, be understood that any suitable starting device (not shown) is employed to bring the motor 47 up to speed.

Assuming that it is desired to operate the press at low threading speed for the "plating up" operation, the "safe" button 107 is depressed thereby energizing the operating coil of the "safe" relay 108 and causing it to close its upper and lower contacts. Depression of the jog button 93 completes a circuit for the operating coil of the jog relay 92 that is traced from one side of the supply line 44 to the other side thereof through interlocks 109 of the rheostat 82, in response to which the jog relay 92 closes its contacts to complete an energizing circuit for the operating coil of the synchronizing switch 94 that is readily traced from the positive to the negative side of the supply buses 44 through the lower contacts of the relay 92. Contactor 94 closes in response to its energization and short-circuits the current limiting reactances 61 thereby increasing the voltage applied to the primary windings of the synchronizing motors. In the closed position of this contactor, its upper auxiliary contacts complete an energizing circuit for the line switch 35 from the positive to the negative side of supply line 44 through the upper contacts of jog relay 92 as a result of which the line switch 35 closes its main contact to connect the armature of generator 32 to the supply buses 33 to which the armature members of the unit driving motors 25, 27, etc. have previously been connected. Due to the fact that the rheostat contact arm 85 is in its low speed position, the main field 84 of the generator 32 is open-circuited. However, an initial open circuit voltage of generator 32 is established by means of exciter 102 by virtue of its auxiliary shunt field 104 made adjustable by rheostat 104a. This initial voltage is approximately equivalent to the counter E. M. F. of the driving motors at threading speed. The auxiliary regulating dynamo

electric machine 102 functions in the previously described manner to compensate for irregularities in the torque requirements of the press thereby to maintain uniform low threading speed. It will also be clear that when the operating coil of the jog relay 92 is energized the operating coils of contactors 100, 101, etc. are connected through the lower auxiliary contacts of relay 106 in parallel with the operating coil of the jog relay 92 so that the contactors 100, 101 are energized and operated to the closed position to short-circuit resistance 97, 98 thereby to supply abnormal excitation to the driving motors to provide the necessary starting torque.

As long as the jog button 93 is maintained depressed the press continues to operate at slow threading speed and when this button is released the jog relay 92 is deenergized and its upper contact opens the energizing circuit of line contactor 35 thereby causing the latter to descend and disconnect the generator 32 from the unit driving motors. After an interval of time determined by the setting of the time delay device 96, the lower contact of jog relay 92 opens the energizing circuit of contactor 94 causing the latter to open and interrupt the power supply to the synchronizing motors except for the small amount of power that is transmitted through the reactance devices 61. The time setting of time delay device 96 is adjusted so that the power supply to the synchronizing motors is not interrupted until after the unit driving motors have decelerated to rest.

To operate the press at high speed the "fast" button 90 is depressed to complete an energizing circuit for the operating coil of the fast relay 87 that is traced from the lower side of the supply line 44 through the contactor coil, limit switch 112, and contacts of "fast" button 90 to the upper side of supply line 44. The "fast" contactor is operated to its closed position to connect the armature of rheostat motor 86 across the supply line 44 in series relationship with split-field winding 86b as a result of which the motor is energized to rotate the contact arm 85 in a counter-clockwise direction. As the contact arm moves from the low speed position in which it is shown it bridges interlocking contacts 113 to complete an energizing circuit for the run relay 114 from the positive side of the supply line 44 through "fast" button 90, interlocking contacts 113, coil of run relay 114 and thence to the lower supply line 44. The run relay 114 closes in response to the energization of the operating coil and its lower contact short-circuits the interlocking contact 113 to establish a holding circuit that is traced from the positive side of the supply line 44 through the contacts of stop relay 115, lower contacts of run relay 114 (in the closed position thereof) and thence through the coil 114 to the negative side of the supply line 44. The upper contacts of relay 114 in closing establish an energizing circuit for the jog relay 92 traced from the positive side of supply line 44 through contacts of relay 115, lower and upper contacts of relay 114 and thence through the coil of jog relay 92 to the negative side of supply line 44. As before jog relay 92 in closing also effects the closing of contactor 94 to short the reactance device 61, the closing of line contactor 35 from the supply generator 32 to the unit driving motors and the closing of contactors 100, 101 to provide the necessary starting torque for the unit driving motors. Simultaneously the contact arm 85 bridges the interlocking contacts 116 completing a circuit from the positive side of

supply source 44 through the operating coil of exciter relay 106 and thence through contact 116 to the lower side of supply source 44. Exciter relay 106 closes its upper pair of contacts to short-
 5 circuit the series field winding 105 of the regulating machine 102 thereby to render the latter ineffective simultaneously closing its intermediate contacts to complete a circuit for the main field winding 84 across the supply lines 44 with the resistance 83 in circuit. The lower contact of relay 106 in moving to the upper position interrupts the energizing circuit for contactors 100, 101 causing the latter to open and remove the short circuit from about resistances 97 and 98 thereby reducing the torque developed by the driving motors.

As long as the "fast" button 90 is maintained depressed, the rheostat operating motor 86 will continue to rotate the contact arm 85 thereby decreasing the resistance in the generator field circuit and increasing the speed of the unit driving motors until when the arm 85 has reached the top speed position, it opens the limit switch 112 thereby deenergizing the "fast" contactor 87 and interrupting the circuit of the rheostat motor 86. The "fast" button may now be released and the press will continue to operate at top speed. Any tendency of the unit driving motors to depart from synchronism is prevented by the synchronizing torques developed by the synchronizing motors from the power drawn from the source 48 when one of the synchronizing motors tends to move out of step with any of the others.

To stop the press it is only necessary to depress the stop button 117 to complete an energizing circuit across the supply line 44 for the operating coil of the stop relay 115. Stop relay 115 in responding to the energization of its operating coil opens its contact thereby interrupting the holding circuit for the operating coil of the run relay 114 previously traced through these contacts and likewise interrupting the circuit for the operating coil of jog relay 92 as a result of which both the run relay 114 and the jog relay 92 descend to their lower or open position. The deenergization of the jog relay 92 results in disconnecting the unit driving motors from the generator 32 and the reinserting of the current limiting reactances 61 in circuit with the primary windings of the synchronizing motors; the latter operation being separated from the former by a time interval determined by the setting of the dash-pot 96. The run relay 114 in descending to its lower position establishes an energizing circuit for the slow contactor 88 extending from the positive side of the supply line 44 through lower contacts of relay 114, limit switch 85 (in the closed position), coil or slow contactor 88 to the negative side of the supply line 44 as a result of which the rheostat operating motor 86 is connected across the supply line 44 with a split field 86a in circuit thereby causing the motor 86 to rotate the movable contact arm 85 in a clockwise direction until it reaches the position in which it is illustrated to open the limit switch 85 and deenergize the slow contactor 88 and the operating motor 86. When the arm 85 moves out of engagement with the contact 116 it interrupts the energizing circuit of the exciter relay 106 causing the latter to descend to its lower position thereby removing the short-circuit from about series field winding 105 of the regulating exciter 102 and simultaneously interrupting the circuit of the main field winding 84 of supply generator 32.

The system of Fig. 6 is in all respects similar

to that of Fig. 4 with the exception of the means for producing uniform low threading speed of the unit driving motors. In this modification, the auxiliary regulating machine 102 of Fig. 4 is replaced by a small alternating current generator 120 chain driven from the drive shaft of the main supply generator. The ratio of the chain driving connections are such that the frequency of the voltage generated by the auxiliary generator 120 is increased above the frequency of the supply net 48 by an amount proportional to the desired low threading speed, e. g. the frequency of the voltage of generator 120 may be sixty-two and one-half cycles. An electromagnetic switch device 121 the circuit for the operating coil of which is completed by the upper auxiliary contactor of the line switch at the instant that the latter connects the supply generator to the unit driving motors serves to connect the auxiliary generator to the synchronizing buses 55 and secondary windings of the synchronizing motors. The contactor 121 is provided with an upper auxiliary contact which is closed when the contactor 121 is moved to its upper position. In its closed position this auxiliary contact establishes an energizing circuit for the operating coil of contactor 122 which when energized and closed connects the direct current field winding (not shown) of the auxiliary generator 120 to the excitation buses 124.

In order to prevent a severe shock to the generator 120 at the instant of synchronization of the synchronizing motors an electromagnetically operated slip clutch 123 is interposed in the connection between the drive chain and the generator shaft. This clutch is normally energized and engaged; the energizing circuit being traced from the positive side of the excitation buses 124, the operating coil of the clutch, contacts of time delay device 125 and thence to the negative side of the excitation buses 124. At the instant that the contactor 121 is closed to synchronize the auxiliary generator 120 with the synchronizing motors the contacts of a time delay device 125 interrupts the energizing circuit of the slip clutch 123 thereby interrupting the driving connection and allowing the generator 120 to fall into step with the synchronizing motors. After a time interval the length of which is determined by the constants of the time delay device 125, the latter descends to its lower closed position to reestablish the energizing circuit of the slip clutch 123, resulting in the reengagement of the clutch and the reestablishment of the driving connections for the auxiliary generator. The frequency of the voltage generated by the generator 120 is equal to the frequency of the voltage induced in the secondary windings of the synchronizing motors when operating at threading speed. Thus the auxiliary generator imposes a fixed frequency on the synchronizing buses of the synchronizing motors thereby pulling the synchronizing motors into step as the press drives tend to accelerate after breaking from rest. The auxiliary generator thus causes the set to operate at a fixed speed independently of any variations in the torque requirements of the press. The capacity of the alternator is such as to balance the difference in power that is required by the press at threading speed and that which the driving motors produce by virtue of their inherent regulation. Preferably their driving motors are connected to the main generator with an initial open-circuit voltage that will start the press from rest under maximum load conditions. This initial voltage is normally in excess of that required to operate the press at

slow threading speed. However, since the auxiliary generator automatically locks the synchronizing motors at the proper threading speed, it is obvious that there will be flow of energy through the auxiliary generator because the tendency of the driving motors is to drive the press faster than the synchronous speed for which the auxiliary generator is geared. When the movable contact arm of the generator rheostat is moved from the low speed to the high speed position, it becomes disengaged from the contact 127 thereby interrupting the energizing circuit of the contactor 121 as a result of which the latter descends to its open position and disconnects the auxiliary generator 120 from the secondary buses of the synchronizing motors thereby permitting the speed of the press to be increased from the threading speed to any desired operating speed.

The apparatus shown in Fig. 7 is a sub-combination of the system of Figs. 4 and 6 and it serves to synchronize the peripheral speed of an incoming roll of news print with the speed of the web delivered to the printing units from an expiring roll. In this figure the plate cylinders 200 and 201 as well as the impression cylinders 202 and 203 are illustrated conventionally. A web 204 of news print is being supplied from a nearly exhausted roll 206. This nearly exhausted roll 206 and two full rolls 207 and 208 are mounted upon a reel mechanism such for example as illustrated in Fig. 1 of the drawings beneath the press unit. The rolls 207 and 208, however, are at rest and in order to attach the web from roll 207 to the web 204 without shutting down the press, usually described as making a "flying paster" it is necessary to synchronize the peripheral speed of the roll 207 with that of the web 204. For this purpose a friction wheel 210 normally occupying the position illustrated in dotted lines is mechanically driven by an alternating current induction motor 211. A suitable switching device 212 when operated to its closed position serves to connect the primary windings of the motor 211 to a suitable source of alternating voltage such for example as that represented in the drawings by the three supply lines 213 which may be and preferably are the same source as that represented by the three supply lines 48 in Fig. 4. Similarly a suitable switching device 214 when operated to its closed position serves to connect the secondary windings of the motor 211 to the synchronizing buses represented by the three supply lines 215 which are the same synchronizing buses as those represented by the three lines 55 in Fig. 4. The connections between the primary windings and the source 213 are chosen so that the direction of rotation of the rotating magnetic field is opposite to the direction of rotation of the rotor members. As long as the rotor member of motor 211 is in step with the rotor members of the synchronizing motors, very little current flows in the secondary windings of the motor. However, if the rotor tends to lag behind the rotors of the synchronizing motors, a large current is drawn from the synchronizing buses 215 and thus the motor 211 is caused to operate in synchronism with the synchronizing motors.

To synchronize the full incoming roll 207 with the web 204 it is necessary only to close the switching devices 212 and 214 and then to move the friction roll 210 from its normal position (shown in dotted lines) into engagement with the periphery of the full roll 207 thereby increasing the speed of the roll 207 to a speed proportional to the speed of the press itself and equal

to the speed of the web 204. The reel mechanism is then operated to force the roll 207 against the web 204 and a splice is made by means of paste previously applied at the extremity of the roll 207. Simultaneously the web from the nearly exhausted roll 206 is severed between the roll 206 and the point at which the paster is made.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete form, it will be understood that the apparatus and connections shown are merely illustrative and the invention itself is not limited thereto since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of this invention or the scope of the annexed claims.

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

1. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units and having their primary windings connected to a source of alternating voltage of predetermined frequency and having their secondary windings connected together, and means for supplying an alternating voltage having a frequency different from said predetermined frequency to said secondary windings to provide uniform low threading speed irrespectively of changes in the press torque.

2. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and their primary windings connected to a source of alternating voltage so that the direction of rotation of the rotating magnetic fields is opposite to the direction of rotation of said units, and means providing uniform low threading speed of said driving motors irrespectively of changes in the press torque comprising an alternating current generator connected to said secondary windings and having a frequency different from the frequency of said source by an amount proportional to the desired low threading speed.

3. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and their primary windings connected to a source of alternating voltage of predetermined frequency, and means insuring uniform low threading speed operation of said units comprising an auxiliary generator for supplying an alternating voltage having a frequency different from said predetermined frequency, mechanical driving connections between said auxiliary generator and a source of driving power, means for establishing electrical connections from said auxiliary generator to said secondary windings, and means for interrupting said mechanical driving connections during the establishment of said electrical connections.

4. In combination, a plurality of printing press

units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and their primary windings connected to a source of alternating voltage of predetermined frequency, and means insuring uniform low threading speed operation of said units comprising an auxiliary generator for supplying an alternating voltage having a frequency different from said predetermined frequency, driving connections including a clutch between said auxiliary generator and a source of driving power, a switching device for establishing electrical connections between said auxiliary generator and said secondary windings, and interlocking electrical connections controlled by said switching device for operating said clutch to interrupt said driving connections during the establishment of said electrical connections between said auxiliary generator and said secondary windings.

5. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and their primary windings connected to a source of alternating voltage of predetermined frequency, and means insuring uniform low threading speed operation of said units comprising an auxiliary generator for supplying an alternating voltage having a frequency different from said predetermined frequency, driving connections including a clutch between said auxiliary generator and a source of driving power, a switching device for establishing electrical connections between said auxiliary generator and said secondary windings, electrical connections controlled by said switching device for operating said clutch to interrupt said driving connections upon establishment of said connections from said auxiliary generator to said secondary windings, and a time delay device controlled by said switching device for operating said clutch to reestablish said driving connections a predetermined interval of time after the interruption thereof.

6. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and having their primary windings supplied from a source of alternating voltage, speed control means for said driving motors provided with a member operable to a low threading speed position and to a running speed position, means insuring uniform low threading speed operation of said units irrespective of changes in torque comprising an auxiliary generator for supplying an alternating voltage of a frequency different from that of said source, and means controlled by said member in said low speed threading position for connecting said auxiliary generator to said secondary windings and responsive to operation of said member to said running position to disconnect said auxiliary generator from said secondary windings.

7. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units, said alternating current motors having their secondary windings connected together and their primary windings supplied from a source of alternating voltage of predetermined frequency, a generator for supplying said driving motors, a switching device for connecting said generator to said driving motors, speed control means for said driving motors having a member operable to a low threading speed position and to a running speed position, means insuring uniform low threading speed operation of said press units comprising an auxiliary generator for supplying a voltage of a frequency different from said predetermined frequency, and a switching device controlled by said member in said threading speed position and by said first mentioned switching device for connecting said auxiliary generator to said secondary windings and responsive to operation of said member to said running position for disconnecting said auxiliary generator from said secondary windings.

8. In combination, a plurality of units of a printing press, driving means for each of said units, means for maintaining said units in synchronism comprising a plurality of multi-pole alternating current motors, having their primary windings supplied with power and having their secondary windings connected to each other, and means for insuring the correct polar relationship of the primary and secondary windings of each of said motors when said printing units are in register comprising mechanical connections between each of the said motors and said units having a ratio that is a whole number or a fraction whose denominator is a multiple of the number of pairs of poles of said motors.

9. In combination, with a plurality of units of a printing press, means for effecting a synchronous relationship between said units comprising a plurality of multi-pole alternating current motors each individualized to one of said units, the secondary windings of said motors being connected together and the primary windings being connected to a supply source so that the direction of rotation of the rotating magnetic fields of said motors is opposite to the direction of rotation of said units, and mechanical connections between said synchronizing motors and said units insuring polar registration between the primary and secondary windings of all of said motors when printing units are in registration.

10. In combination with a printing press unit supplied with a web of paper, an alternating current motor connected to said unit and having its primary winding connected to a source of alternating voltage, and means for increasing the peripheral speed of an incoming roll of paper and synchronizing the speed thereof with that of said web comprising an alternating current motor having its secondary winding connected to the secondary winding of said first mentioned motor and having its primary winding connected to said source.

11. In combination with a printing press unit supplied with a web of paper, driving means for said unit, an alternating current motor having its rotor connected to said unit and having its primary winding connected to a source of alternating voltage so that the direction of rotation

of its rotating magnetic field is opposite to the direction of rotation of said rotor and means for speeding up an incoming roll and synchronizing the peripheral speed of the web from a spent roll comprising a friction wheel or belt arranged to engage said incoming roll, an alternating current motor having its rotor connected to drive said friction wheel, means for connecting the secondary winding of said last mentioned motor to the secondary winding of said first mentioned motor, and means for connecting the primary winding of said last mentioned motor to said source so that the direction of rotation of its rotating magnetic field is opposite to the direction of rotation of said rotor.

12. In combination with a plurality of printing press units and means for supplying paper webs to said units, driving means for said units comprising a plurality of motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units and having their secondary windings connected together and their primary windings connected to a source of alternating voltage, and means for speeding up an incoming roll of paper and synchronizing the peripheral speed thereof with the speed of said web comprising a friction wheel arranged for engagement with said incoming roll and an alternating current motor having its rotor connected to drive said friction wheel and having its secondary winding connected to the secondary windings of said synchronizing motors and its primary winding connected to said source.

13. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, means for synchronizing said units comprising a plurality of alternating current motors each connected to one of said units, means for supplying power to said driving motors, means for supplying power to said synchronizing motors and means insuring the establishment of power connections to said synchronizing motors prior to the energization of said driving motors.

14. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, synchronizing means for said units comprising a plurality of alternating current motors each provided with a primary winding and a secondary winding and each connected to one of said units, said secondary windings being connected to each other, means comprising a variable voltage generator for supplying power to said driving motors, a switching device for controlling the energization of said motors, a switching device for establishing power connections from a source of alternating current to said synchronizing motors and interlocking control connections insuring the operation of said last named switching devices to establish connections to said synchronizing motors prior to energization of said driving motors.

15. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, synchronizing means comprising a plurality of asynchronous alternating current motors having their secondary windings connected together, a generator for supplying power to said driving motors, a switching device for establishing and interrupting connections from said generator to said driving motors, a switching device for establishing power connections from a source of alternating current to said synchronizing motors, and interlocking

control connections insuring the operation of said switching devices to establish said connections to said synchronizing motors prior to energization of said driving motors and the deenergization of said driving motors prior to interruption of said synchronizing connections.

16. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, synchronizing means for said units comprising a plurality of alternating current motors having their secondary windings connected together and each connected to one of said units, means for establishing and interrupting connections from a supply source to said motors, means for establishing and interrupting connections from a source of alternating current to said synchronizing motors, interlocking control connections insuring the establishment of said connections to said synchronizing motors prior to the establishment of said connections to said driving motors, and a time delay device insuring the interruption of said connections in the reverse order.

17. In combination, a plurality of printing press units, driving means for said units comprising a plurality of electric motors each connected to one of said units, synchronizing means for said units comprising a plurality of alternating current motors each connected to one of said units and having their secondary windings connected together, a switching device for establishing and interrupting connections from a source of supply to said driving motors, a source of alternating current, a current limiting device connected between said alternating current source and the primary windings of said synchronizing motors, a switching device for short-circuiting said current limiting device, interlocking control connections insuring the operation of said last mentioned switching device to short-circuit said current limiting device prior to operation of said first mentioned switching device to establish connections to said driving motors, and a time delay device insuring opening operation of said first mentioned switching device prior to opening of said last mentioned switching device.

18. In combination, a plurality of printing press units, a direct current motor individualized and connected to drive each of said units, means for supplying said motors comprising a variable voltage generator provided with main and auxiliary field windings, means for controlling the speed of said motors comprising a rheostat connected in circuit with said main field winding, said rheostat being provided with a contact arm movable to a slow threading speed position and to a running speed position, an exciter provided with a field winding connected to be traversed by the current exchanged between said generator and said motors for maintaining a uniformly low threading speed independently of changes in the press torque, and means comprising a contactor energized in the running speed position of said rheostat arm for rendering said exciter ineffective.

19. In combination, a plurality of units of a printing press, an electric motor individualized to each of said units, means for supplying said motors comprising a variable voltage generator provided with main and auxiliary field windings, speed control means for said motors comprising a rheostat connected in circuit with said main field winding, means for maintaining a uniform-

ly low threading speed independently of changes of press torque comprising an exciter provided with a series field winding connected to be traversed by the current exchanged between said generator and said motors, and means for rendering said exciter ineffective at speeds of said motors above said low threading speed.

20. In combination, a plurality of printing press units, a plurality of electric motors each connected to drive one of said units, means for increasing the excitation of said motors to provide increased starting torque, supply means for said motors comprising a generator provided with main and auxiliary field windings, means for providing uniform low threading speed of said motors comprising an exciter having its armature connected to said auxiliary field winding and provided with a series field winding traversed by the current exchanged between said generator and said motors, a motor speed control device provided with a member operable to low and high speed positions, and means operable in said low speed position for rendering said motor excitation increasing means and exciter effective and operable in said high speed position for ren-

dering said excitation increasing means and said exciter ineffective.

21. In combination, a plurality of printing press units, a plurality of electric motors each provided with a field winding and each connected to drive one of said units, a resistance device connected in circuit with said field windings for limiting the excitation of said motors to a predetermined value, supply means for said motors comprising a generator provided with main and auxiliary field windings, means insuring uniform low threading speed of said motors comprising an exciter having its armature connected to said auxiliary field winding and provided with a series field winding traversed by the current exchanged between said generator and said motors, a motor speed control device provided with a member operable to a low speed and to a high speed position, and means operable in said low speed position for short-circuiting said resistance device to increase the excitation of said motors and operable in said high speed position for rendering said resistance devices effective and said exciter ineffective.

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