METHOD AND APPARATUS FOR DRIVING OPEN-END SPINNING FRAME

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ABSTRACT

Method and apparatus for driving open-end spinning frame by a first electric source which actuates the spinning frame at a predetermined higher speed for carrying out the normal spinning operation and by a second electric source which actuates a spinning unit of yarn break at a predetermined lower speed during the yarn piecing operation. These electric sources are variable frequency electric sources for driving at least each individual variable speed motor which is directly connected to a spinning rotor of each spinning unit at predetermined variable speed.

15 Claims, 11 Drawing Figures
Fig. 2A

1. M VS
2. M VS
3. M VS
4. M VS
5. M VS
6. M VS
7. M VS
8. M VS
9. M VS
10. M VS
11. M VS
12. M VS
13. M VS
14. M VS
15. M VS
16. M VS
17. M VS
18. M VS
19. M VS
20. M VS
21. M VS
22. M VS
23. M VS
24. M VS
25. M VS
26. M VS
27. M VS
28. M VS

STATIC VARIABLE FREQUENCY ELECTRIC SOURCE
STATIC VARIABLE FREQUENCY ELECTRIC SOURCE
STATIC VARIABLE FREQUENCY ELECTRIC SOURCE
Fig. 2B

Input Trans

AC Electric Source

Rectifier

Chopper

Inverter

Output

Fig. 2C

Voltage Stabilizer

Reference Potential

38 or 39

38 or 39
METHOD AND APPARATUS FOR DRIVING OPEN-END SPINNING FRAME

BRIEF SUMMARY OF THE INVENTION

The present invention relates to an improved method and apparatus for driving in open-end spinning frame, more particularly, to a method and apparatus capable of controlling the driving speed of the open-end spinning frame utilizing a plurality of spinning units such having a rotor provided with a centrifugal rotary spinning cavity into which opened fibers are continuously introduced to spin them into yarn which is continuously delivered from the cavity, and selectively controlling the driving speed of one spinning unit for carrying out the yarn piecing operation.

Various types of open-end spinning frames have been introduced recently so as to eliminate inherent drawbacks of other spinning frames, for example, upper limitation of the productivity due to the winding and twisting mechanism of the conventional ring spinning frame. It is well-known that the most practical open-end spinning method comprises opening a bundle of fibers, supplied from a supply mechanism, into individual fibers while passing through an opening mechanism; introducing the fibers into a centrifugal rotary spinning cavity of a rotor which is considered as a twisting mechanism, so that introduced fibers are collected upon an inside peripheral wall of the cavity; continuously taking off the collected fibers from the inside peripheral wall of the cavity in a rebundled condition while providing twist to the rebundled fibers by a taking-off mechanism; and delivering the twisted rebundled fibers outside of the rotor; then winding the twisted rebundled fibers by a winding mechanism so that a yarn package such as a cheese is produced.

By utilizing the above-mentioned open-end spinning method, the production efficiency of yarn in the spinning room can be remarkably increased so that the reduction of the production cost in of the spinning factory can be attained. However, it is desired to further increase the production efficiency of the spinning frame together with an improvement of yarn quality.

In the fiber supply mechanism and the winding mechanism are driven at comparatively slow speeds in comparison with the spinning rotor and therefore, there is no difficulty in speeding up the driving of these two mechanisms. However, as the spinning rotor is driven at very high speed, in comparison with the spindle of the conventional ring spinning frame, it is fairly difficult to further increase the driving speed of the spinning rotor. The main reasons for the above-mentioned difficulty are hereinafter illustrated. In conventional open-end spinning, rotatable members are mainly driven by means of a belt driving system. In particular, the spinning rotor is normally driven in this manner. Therefore, if, in the case of applying the belt driving system it is intended that, the rotating speed of the spinning rotor be increased considerably, it is inevitable that the power consumption for driving the opened spinning frame with be considerably increased and the driving power will be transmitted in an unstable condition and further, noise created by the driving mechanism and vibration of rotatable members become excessive. Further, the yarn piecing operation in the event of yarn-breakage becomes more difficult with speeding up of the spinning operation. This is because, in the yarn piecing operation of the above-mentioned open-end spinning process, when a spinning yarn is broken, an end of the yarn from a package, upon the winding mechanism, is introduced into the spinning rotor and next, the yarn take-up mechanism is actuated to start simultaneously when opened fibers are introduced into the inside collecting wall of the spinning rotor. If the above-mentioned yarn piecing operation is carried out with very high speed rotation of the spinning rotor the available time to actuate the rotatable members of the spinning unit becomes shorter in accordance with the speeding up of rotation of these members.

Therefore, the rotation speed of all rotors of the spinning frame may be temporarily lowered to carry out the above-mentioned yarn piecing operation and to solve the above-mentioned drawback. However, if the rotation speed of all spinning rotors is lowered, the productivity of the spinning frame is consequently reduced.

The principal object of the present invention is to provide the most preferable method and apparatus for driving the open-end spinning frame utilizing the above-mentioned spinning rotor system wherein, each rotor is directly driven by a driving motor connected thereto instead of applying the well-known belt driving mechanism, and each driving motor is connected to a variable frequency electric source.

Another object of the present invention is to provide a practical method and apparatus for driving the above-mentioned open-end spinning frame, wherein each rotatable member or at least each spinning rotor, is directly connected to a shaft of a motor which is connected to a variable frequency electric source comprising a first electric source for driving at a higher speed and a second electric source for driving at a lower speed. Further, each spinning unit can be connected to the second electric source instead of the first electric source independently to other spinning units when it is required to carry out the yarn piecing operation, and the unit can be again connected to the first electric source after completion of the yarn piecing operation.

According to the present invention, in the open-end spinning frame wherein opened fibers are fed into the fiber collecting surface of the spinning rotor and the collected fibers are continuously taken from the fiber collecting surface so as to form a rebundled strand of fibers while providing twists to the rebundled strand of fibers, generally, each rotor is directly driven by a motor which can be connected to the above-mentioned variable frequency electric sources. Consequently, the spinning rotor can be driven at very high speeds, and the fiber supplying mechanism and fiber opening mechanism and take-up mechanism can be driven at higher speeds corresponding to that of the spinning rotor so that any yarn having a desired count and twist can be practically produced. Further, when a spun yarn of a certain spinning unit is broken, the electrical connection of the motor for driving this spinning unit is only changed from the connection with the first electric source to the second electric source so as to drive the rotor at a lower speed during the yarn piecing operation after completion of the above-mentioned yarn piecing operation, the electrical connection of the motor is returned to the first electric source so that the spinning operation of the unit can be carried out in a normal high speed condition. During the above-mentioned changing operation, the remaining spinning
units are maintained in the normal condition of connection to the higher frequency source.

In a practical driving method according to the present invention, the spinning rotor of each spinning unit is directly connected to a motor which is alternatively connected to one of the variable frequency electric sources, that is the first normal electric source for driving each unit at higher speed and the second electric source for driving each unit individually at lower speed while the yarn piecing operation is carried out by alternatively changing the connection of the driving motor with one of the above-mentioned electric sources. Consequently, the production capacity of the opened spinning frame can be remarkably increased. Further, as the effect of the centrifugal force upon the opened fibers is enhanced, the hooked fibers are readily straightened so that the yarn quality can be improved very much, while the rotating speed of the rotor can be individually lowered during the yarn piecing-up operation so that the yarn piecing-up operation can be successfully and easily carried out.

Further features and advantages of the present invention will be apparent from the ensuing description with reference to the accompanying drawings to which, however, the scope of the invention is in no way limited.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a somewhat diagrammatic view of the driving apparatus of an open-end spinning unit according to the present invention,

FIG. 2A is a similar view, to FIG. 1, of a modified driving apparatus of an open-end spinning unit,

FIGS. 2B and 2C are diagrams of an electric circuit applied to the embodiment shown in FIG. 2A,

FIG. 3 is an embodiment of the electric circuit for driving the open-end spinning frame according to the present invention,

FIG. 4 is an embodiment of the electric circuit for selectively connecting a spinning unit to a second electric source,

FIGS. 5, 6, 7 are other embodiments of the electric circuit for driving the open-end spinning frame according to the present invention,

FIG. 8 is one practical embodiment of the electric circuit for driving the open-end spinning frame according to the present invention, utilizing static variable frequency electric sources, and

FIG. 9 is a diagram showing an illustrative electric connection of a selecting device applied to the embodiment shown in FIG. 7.

DETAILED DESCRIPTION

In an apparatus for driving an open-end spinning frame according to the present invention, each spinning rotor is directly connected to an individual motor which is connected to the variable frequency electric source as mentioned above. Two types of variable frequency electric sources, that is, a generator which is driven by a variable speed electric motor and a static variable frequency electric source, such as a thyristor, are suitably utilized for the present invention.

For convenience of illustration of the present invention, firstly, a basic embodiment of the present invention is hereinafter illustrated.

In the embodiment of FIG. 1, which shows a spinning unit utilizing a generator driven by a variable speed electric motor, a pair of feed rollers 1, 2, for delivering a bundle of fibers; an opening roller 3, which is considered as a mechanism for opening the bundle of fibers into separated fibers; a spinning rotor 4, which corresponds to a twisting mechanism; a pair of draw-off rollers 5, 6 for delivering a yarn 7 from the rotor 4; and a take-up roller 8, which is a winding mechanism for forming a package 9, are capable of being driven by individual motors 10, 11, 12, 13, respectively and these motors, except 11, are connected to generators 14, 15, 16, respectively, while the motor 11 is connected to a generator 17 which is driven by a variable speed electric motor 20. These generators 14, 15 and 16 are driven by a variable speed electric motor 18. That is, the motor 18 directly drives a shaft of the generator 15 which is a high frequency electric source of the motor 12 for driving the spinning rotor 4 at very high speed. The motor 18 also drives a gear box 19 for driving shafts of the generators 14, 16 at the respective reduced speeds so as to apply corresponding electric power to the motor 10 and 13, respectively. The other variable speed motor 20 is connected to the motor 11 directly so that the motor 11 for the opening roller 3 is driven at a corresponding speed to the electric power generated by the generator 17. As mentioned above, the rotor 4 can be easily driven at very high speed, for example, at around 60,000 R.P.M. which is almost double that of the conventional belt driving system. Consequently, the centrifugal force of fibers effected upon the collecting surface of the spinning rotor 4 is remarkably enhanced so that fibers tend to be taken from the collecting surface in a more straightened condition and these fibers are taken from the collecting surface so as to form a rebundled fiber strand with twists, that is, a yarn 7, the quality of yarn can be improved considerably. As the production rate per unit time is determined by the take-up speed of yarn 7 from the spinning rotor 4, and the required number of twists to be imparted upon the yarn 7 taken up from the spinning rotor 4 is defined by the number of revolutions of the rotor 4 per a unit time, and the take-up speed of yarn 7 from the rotor 4, the possibility of increasing the rotation speed of the rotor 4 means the raising of the productivity of the open-end spinning frame. In other words, the productivity of the open-end spinning frame can be remarkably enhanced by increasing the rotational speed of the feed rollers 1, 2, draw-off rollers 5, 6, take-up roller 8, together with considerable speeding up of the spinning rotor's rotation.

However, if the spun yarn 7 is broken during the high speed spinning operation such as the high speed rotation of the spinning rotor 4 at around 60,000 R.P.M., it is difficult to carry out the yarn piecing operation which comprises the step of yarn end insertion from a package 9 into the spinning rotor 4 and restarting the rotation of the feed rollers 1, 2 together with the draw-off rollers 5, 6, which is immediately after the above-mentioned step, because only a very short timing is allowable for carrying out the operation. From our experiment, we found that if the rotation speed of the spinning rotor 4 exceeds 40,000 R.P.M., as the centrifugal force of fibers urged upon the collecting surface of the rotor 4 becomes large and the yarn take-up speed from the rotor 4 is also increased, the time for piecing the above-mentioned yarn end inserted into the rotor 4 with the collected fibers upon the collecting surface be-
comes very short so that the yarn piecing operation can not be carried out perfectly.

To overcome the above-mentioned difficulty, in the method of the present invention, when a spun yarn 7 is broken and the above-mentioned yarn break is detected by a detecting means, the rotation speed of the motor 18 is changed from its normal condition to a predetermined condition of reduced rotational speed in accordance with a control signal due to the above-mentioned detection of the yarn break. Consequently, the rotation speeds of the generators 14, 16 and 15 are lowered so that the frequency of their outputs are lowered. Therefore, the rotation speeds of these members are lowered to their predetermined rotation speeds, respectively. For example, the rotation speed of the rotor 4 is lowered to approximately 30,000 R.P.M. These members are stopped by braking means (not shown) immediately after lowering their rotation speed, so as to insert an end of yarn from the package 9 into the spinning rotor 4. Then these members commence their rotation at their lowered speeds, respectively, immediately after insertion of the yarn end. After completion of yarn piecing operation, the rotation speeds of these members are gradually increased by gradually speeding up the rotation of the variable speed motor 18 by a control signal, and when the rotation speed of these members are elevated to their normal operating conditions, the motor 18 then commences to drive at its normal speed. The above-mentioned changing operation of the rotation speeds of these members, the feed rollers 1, 2, draw-off rollers 5, 6, take-up roller 8 and the spinning rotor 4, is carried out at their synchronized conditions relating to each other. However, as it has been confirmed that the rotation speed of the opening roller 3 does not exert any influence upon the yarn piecing operation, the rotation speed of the opening roller 3 may be constantly maintained. In the above-mentioned yarn piecing operation, these members commence their rotation at their predetermined lowered condition after completion of the yarn piecing operation.

Referring to FIG. 2A wherein static variable frequency electric sources are applied instead of generators driven by the respective variable speed motors, the feed rollers 1, opening roller 3 and spinning rotor 4 are directly driven by the variable speed motors 10, 11 and 12, respectively, and the draw-off rollers 5, 6 and take-up roller 8, which is utilized for making the package 9, are driven by the respective shafts connected to a gear box 21 at a predetermined driving ratio, and the gear box 21 is driven by the individual motor 13. These motors are connected to respective static variable frequency electric sources 25, 26, 27 and 28, respectively as shown in FIG. 2A so that these motors can be driven at the corresponding variable speeds while maintaining the speed ratio therebetween at a predetermined value in accordance with their output frequencies.

FIG. 2B shows one example of the static variable frequency electric source using semi-conductor elements such as thyristors. Referring to FIG. 2B, an A.C. electric source 31 is connected via an input transformer 32 to a rectifier circuit 33, so that the output of the rectifier circuit 33 is applied to an inverter 35 via a chopper 34. On the other hand, the output of the input transformer 32 is applied via a conductor 37 to a control circuit 36. The outputs of the control circuit 36 are respectively applied via conductors 38 and 39 to the chopper circuit 34 and the inverter 35, and a variable frequency output is created on an output terminal 40. In the above-mentioned circuit, the rectifier circuit 33 transforms the A.C. voltage from the A.C. electric source to a D.C. voltage, the chopper 34 connects the output D.C. voltage of the rectifier circuit 33 to a variable D.C. voltage which is controlled by an output (via conductor 38) of the control circuit 36. The chopper 34 is composed of a circuit utilizing the semi-conductor elements such as thyristors. The inverter 35 is also composed of thyristors and is provided for converting the output variable D.C. voltage of the chopper 34 to an A.C. voltage having a desired frequency which is controlled by an output (via conductor 39) of the control circuit 36. One example of the control circuit 36 is composed of, as shown in FIG. 2C, a voltage stabilizer 41, an upper value setting potentiometer 42, a lower value setting potentiometer 44 and a variable value setting potentiometer 43. The conductor 37 is connected to the voltage stabilizer 41 so that the upper and lower value setting potentiometers 42 and 44 are connected to the output of the voltage stabilizer 41. Upper values of the voltage or the frequency of the output is determined by a setting value of the potentiometer 42, low values of the voltage or the frequency of the output is determined by a setting value of the potentiometer 44. The variable value setting potentiometer 43 is connected to two variable points of the potentiometer 42 and 44 and is controlled by a motor drive or manually. As a result of this, an output having a desired frequency is obtained on the output terminal 40.

Several preferable embodiments of the present invention which are practically applicable for the open-end spinning frame utilizing a plurality of the above-mentioned spinning units are hereinafter illustrated in detail.

For the convenience of illustrations hereinafter, elements having the similar functions as the corresponding one shown in FIG. 1, are represented by the same reference or the same graphical symbol as shown in FIG. 1. Further, to simplify the illustration, the feed rollers, draw-off rollers are represented by 1A, 5A, respectively.

In the embodiment shown in FIG. 3, the opening roller 3 and the spinning rotor 4 of each spinning unit are directly driven by the respective individual motors, 11, 12 and these motors 11 and 12 are connected to the respective variable frequency electric sources. The variable frequency electric source connected to the motor 12 comprises a normal electric source for driving the spinning roller at a predetermined higher rotational speed (hereinafter referred to as a first variable frequency electric source or first electric source) and an additional electric source for driving the spinning roller 4 at a predetermined lower rotation speed (hereinafter referred to as a second variable frequency electric source or second electric source), and the motor 12 of each spinning unit is capable of changing the connection with the first electric source to the second electric source independently at the time of the yarn piecing operation, and after completion of the yarn piecing operation the connection of the motor 12 with the electric source again returns to the first electric source. In this embodiment, the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit (S) are driven by a motor 10A by way of a gear box 45, and each motor 10A of each spinning unit (S) is connected to an A.C. generator 46 of the first electric source (E1).
and is driven by way of a switch 49A. Therefore, these members of each spinning unit (S) are driven by the output power of the generator 46 during the normal spinning operation. The normal electric source (E2) comprises a variable speed motor 48, a generator 46 which is driven at a comparatively lower speed by way of a reduction gear box 19A connecting the motor 48 with the generator 46 so as to generate a comparatively lower frequency output power, and a generator 47 which is directly connected to a shaft of the motor 48. The output power of the generator 47 is applied to the high speed motor 12 for driving the spinning rotor 4 of each spinning unit (S) by way of a respective switch 50A. The opening roller 3 of each spinning unit (S) is driven by the motor 11 which is driven by a common generator 17A by way of a switch 51A. The common generator 17A is directly connected to a motor 20A. Therefore, the opening roller 3 of each spinning unit (S) is driven by a third electric source (E3) comprising the motor 20A and the generator 17A. (E3) designates the second electric source for driving the spinning units, except for their common rollers, at the time of the yarn piecing operation. The second electric source (E3) comprises a variable speed motor 52 and an A.C. generator 53 which is directly connected to the motor 52 so as to generate lower variable output frequencies, and a generator 54 for generating the output power of lower frequency by way of a gear box 19B. The output power of the generator 54 is applied to the motor 10A for driving the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit (S) by way of the corresponding switch 49B, while the output power of the generator 53 is applied to the motor 12 for driving the spinning rotor 4 of each spinning unit (S). (D,E) designates a D.C. electric source from which a D.C. current is applied to the motors 11, 12 of each spinning unit by way of the corresponding switch 51B, 50C at the time of stopping the spinning unit (S). In other words, the motors 11 and 12 can be instantly stopped by applying the D.C. current from the D.C. electric source (D,E) so that dynamic braking is applied to these motors. (B) designates braking means of the respective motors.

When the spinning units (S) of the open-end spinning frame are started simultaneously, the first electric source (E1) and the third electric source (E3) are applied so as to drive the motors 10A, 11 and 12 of each spinning unit (S), respectively. However, as it is required to piece an end of the prepared yarn with fibers introduced into each spinning rotor 4 just after supplying a bundle of fibers from the feed rollers 1A and the opening roller 3, the generators 46, 47 are driven at a comparatively low speed by lowering the rotational speed of the variable speed motor 48 of the first electric source (E1) so as to generate the output powers in their condition of lower frequencies. Therefore, the motors 10A and 12 of each spinning unit (S) are driven at a lower speed so that piecing operation can be satisfactorily completed. After completion of the yarn piecing operation, the condition of the first electric source (E1) is returned to its normal driving condition so that the motors 10A and 12 are driven at their higher speeds which are maintained on a constant related condition. Consequently, the rotation speeds of the feed rollers 1A, draw-off rollers 5A, take-up roller 8 and the spinning rotor 4 are mutually accelerated while maintaining their comparative speed ratios.

It is to be noted that the second electric source (E2) is actuated at the same time as the starting of the first electric source (E1) and the third electric source (E3). However, the output power of the second electric source (E2) is generated at a lower frequency than that of the normal electric source (E2) for the normal spinning condition.

If a spun yarn of a spinning unit is broken during the normal spinning operation, an output signal from means for detecting the yarn break (not shown) is applied to the corresponding spinning unit (S) so that the switches 49A and 50A are opened and the brake circuit of this spinning unit (S) is actuated to stop the driving and then the switches 49B and 50B are closed by applying a signal of the detecting means after a predetermined time which is controlled by a timer. Therefore, the motors 10A and motor 12 of the corresponding spinning unit (S) are connected to the second electric source (E2) which is set at a predetermined condition of a lower frequency and these motors are driven at a predetermined lower speed so that the yarn piecing operation can be carried out easily.

After completion of the yarn piecing operation, the rotation speed of the motor 52 of the second electric source (E2) is gradually increased so that the frequency of the output power of the generator 54 can be elevated, and when the above-mentioned frequency of the output power of the generator 54 reaches that of the first electric source (E1), a control signal is applied to the switches 49B, and 50B, 49A and 50A so as to open the switches 49B and 50B and close the switches 49A and 50A. Consequently, the spinning unit (S) in which the yarn piecing operation has been completed, is driven at the normal driving speed. After the above-mentioned changing of the connection from the second electric source (E2) to the first electric source (E1), the second electric source (E2) is returned to its normal condition of low frequency, which is a set condition. In the above-mentioned embodiment, the feed rollers 1A draw-off rollers 5A, and take-up roller 8 of each spinning unit (S) are driven by the corresponding individual motor 10A. However, when it is required to change the driving ratio of these rollers in accordance with the desired count, number of twist of yarn, changing the driving ratio between these rollers in the gear box 45 of each spinning unit (S) is unavoidable, so that the operation for changing the driving ratio is troublesome and a fairly large number of change gears must be stocked.

The above-mentioned selective connection of a spinning unit (S), wherein a spinning yarn is broken and the yarn breakage is detected by a feeder (not shown), to the second electric source is hereinafter illustrated in detail. An embodiment of the selecting means is shown in FIG. 4, that is a selecting circuit for carrying out the above-mentioned connection utilized for the spinning frame provided with a plurality of open-end spinning units (S1), (S2), (S3) — is shown.

The following example illustrates how the above-mentioned selective connection is carried out.

Now we will explain the case where a yarn break occurred in the third spinning unit (S3). When a feeder is actuated to close a switch 60C by the yarn break, a relay 61C is excited and a relay contact 61C' of the relay 61C closes whereby a relay 62C becomes excited and a contact point 62C' of the relay 62C is closed. As a relay contact 67' is closed initially, a pulse oscillator
3,780,513

63 becomes energized and generates a pulse signal whereby a semi-conductor element such as thyristor 64C is actuated into an on condition so that a relay 65C also is energized. When relay 65C becomes energized, since then feeler of the spinning unit 51 is not in a working condition, then 61A is maintained in a deenergized state. That is, the spinning unit 51 is not connected to the second electric source because there has been no yarn break in this unit. Next a pulse signal is generated and the thyristor 64C and a relay 65C become energized to close contacts 65C’, and at the same time, the relay 61A is maintained in a deenergized state as mentioned above and a relay 66C becomes energized. By closing a relay contact 66C’ (and 50B in FIG. 3) of the relay 66C, (and by opening of relay contact 50A in FIG. 3), a power source is commutated from the first electric source to a second electric power source and also a relay 67 is excited to release contact 67’. The function of the pulse oscillator 63 is stopped by relay contact 67’ of the relay 67, and at the same time, the yarn piecing control circuit of the third spinning unit (53) becomes actuated.

When the yarn piecing of the third spinning unit is completed, the position of this spinning unit is memorized in the pulse oscillator 63.

When a feeler of the eighth spinning unit (58) (not shown) is actuated after the yarn piecing of the third spinning unit is completed, the relay 62H becomes energized, as mentioned above, and pulse oscillator 63 generates a pulse signal, the corresponding thyristor 64D and a relay 65D become energized and at the same time, relay 65C is de-energized.

Next pulse signal actuated thyristor 64E and relay 65E and releases an excited state of the relay 65D.

In such a manner, an excited state of the relay 65G is released, the relay 65H is activated, and a relay 66H is excited then the power source is commutated to the second electric source by the relay 66H.

Further, the relay 67 is excited, and the pulse oscillator 63 ceases its operation, and at the same time, the yarn piecing control circuit becomes its working condition.

When feelers of the first and third spinning units (51), (53) are actuated simultaneously during the yarn piecing by the action of the relay 65H, at the first time the yarn piecing by the first feeler is carried out by an operation of the thyristor 64A and the relay 65A, and next the yarn piecing by the third feeler is carried out by an operation of the thyristor 64C and the relay 65C.

It will be understood by the above-mentioned explanation that during the yarn piecing by the action of the relay 65H, even if the third feeler is actuated before the actuation of the first feeler, the operation of the yarn piecing is carried out by the order of the first feeler and then the third feeler. That is, the pulses applied to the above-mentioned spinning units are supplied from the first spinning unit in order with a predetermined time interval.

In the above-mentioned illustration, subindex or suffix, A, B, C, D, - G, H represent the elements belongs the first, second, third, fourth, - seventh and eighth spinning units (51), (52), (53), (54) - (57), (58), respectively for the convenience of illustration. The order of these spinning units is also called for convenience, in order from a gear end side of the spinning frame.

To solve the above-mentioned difficulty, in an embodiment shown in FIG. 5, motors 70, 71, 72 are directly connected to the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit (S), respectively, and the rotation ratios between these rollers are defined by the ratio of frequencies of the output generated by the respective generators of the electric source. That is, the first electric source (E1) and the second electric source (E2) are provided with generators 75A, 76A, 77A and 78A, and 75B, 76B, 77B and 78B, respectively. The motors 70, 71, 72 and 73 are capable of being connected to the generators 75A, 76A, 77A and 78A, respectively, or generators 75B, 76B, 77B and 78B, respectively. The individual variable speed motor 48 drives the generators 75A, 76A, 77A by way of a reduction gear box 80A and drives the generator 78A directly, while another individual variable speed motor 52 drives the generators 75B, 76B, 77B by way of a reduction gear box 80B and drives the generator 78B directly. Consequently, when it is required to change the rotation ratios between the rollers 1A, 5A and 8, it is possible to change the above-mentioned driving ratio of all spinning units (S) by only changing the gear ratios of the gear boxes 80A, 80B, simultaneously. However, this embodiment it is also considered as a drawback due to the condition of each rotation member with the respective generators. In the embodiment shown in FIG. 6, the draw-off rollers 5A and the take-up roller 8 of each spinning unit (S) are driven by a motor 13 to which an output power generated by an individual generator 16A is applied, while the feed roller 1A of each spinning unit (S) is driven by a motor 10 to which an output power generated by an individual generator 11A is applied. The speed ratio of the rollers 5A to roller 8 is defined by a gear box 82.

In the above-mentioned embodiment, the connection of the spinning unit (S) with the first electric source or the second electric source is selectively changed by the electrical changing means. However, in the modified embodiment shown in FIG. 7, the above-mentioned changing is carried out mechanically. That is, a shaft 85A for driving the feed rollers 1A, a shaft 86A for driving the draw-off rollers 5A, a shaft 87A for driving the take-up rollers 8 of each spinning unit (S) are extended from the first electric source (E1) through all the spinning units (S), while a shaft 85B, a shaft 86B and shaft 87B are extended from the second electric source (E2) through all the spinning units (S). The feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit (S) can be engaged to the above-mentioned shafts 85A, 86A and 87A, respectively, by means of the engageable and disengageable clutches 88A, 89A and 90A, respectively, so as to drive these rollers at their predetermined high speeds, and can be disengaged from the above-mentioned shafts when it is required. These rollers can also be engaged or disengaged to shafts 85B, 86B and 87B by means of mechanical engageable and disengageable clutches 88B, 89B and 90B. These shafts 85A, 86A and 87A are driven by the variable speed motor 18A of the first electric source (E1) in a relatively reduced condition by the gear box 19A, while these shafts 85B, 86B and 87B are driven by the variable speed motor 18B of the additional electric source (E2) in a relatively reduced condition by the gear box 19B. The combing roller 3 of each spinning unit (S) is driven by the motor 11 which receives the output of the generator 17 directly con-
The generators 14A, 14B are driven at the respective variable speeds when the spinning units (S) commence to drive or the yarn piecing operation of some spinning unit (S) is carried out, by means of changing the rotation speed of the respective motors 18A, 18B. In the above-mentioned construction of the driving apparatus when whole spinning units (S) simultaneously commence to drive, the feed rollers 1A, draw-off rollers 5A, take-up rollers 8, of all the spinning units (S) are driven by engaging these rollers with the respective shafts by way of the respective clutches 88A, 89A, 90A, respectively, so that the rotation speed of these rollers are controlled in accordance with the rotation speed of the motor 18A, respectively. The rotor 4 is also driven in a similar manner to the above-mentioned driving method. The opening rotor 3 is driven by the motor 11 which is controlled by the common generator 17 directly connected to the motor 20. In the above-mentioned starting of the spinning operation, the variable speed motor 18A is driven at a lower speed so as to drive the feed rollers 1A, draw-off rollers 5A, take-up roller 8 and rotor 4 of each spinning unit at the corresponding low speed so that the yarn piecing operation at the time of starting can be perfectly carried out. After the completion of the above-mentioned yarn piecing operation, the first electric source is driven at its normal spinning condition so that driving speeds of rotatable members of each spinning unit are gradually increased to their normal operating conditions.

The second electric source commences to simultaneously drive at the time of starting the first electric source (E1). As already illustrated, the driving speeds of the shafts 85B, 86B and 87B, and the output frequency of the generator 14B are predetermined at a lower value than those of the first electric source (E1).

During the normal spinning operation, when in a certain spinning unit (S), a spinning yarn is broken, an output signal of a detector for detecting the yarn break (not shown) is applied to the corresponding spinning unit (S), the switch 91A is opened and the switch 91B is closed, and the clutches 88A, 89A, 90A are simultaneously disengaged from the respective shafts while the clutches 88B, 89B, 90B are simultaneously engaged to the respective shafts. Therefore, the spinning unit (S), wherein the spinning yarn is broken, is only driven by the additional electric source (E2) at the predetermined lower driving speed so that the yarn piecing operation can be carried out easily.

After completion of the yarn piecing operation, the driving speed of the motor 18B is gradually increased up to the same level as the normal driving speed of the motor 18A so that the rotatable members 1A, 5A, 8 and 4 are driven at gradually increasing speed with the predetermined mutual relation. When the driving speeds of the motor 18B reaches the level of the normal driving speed of the motor 18A, the switch 91B is opened and the switch 91A is closed, while the clutches 88A, 89A, 90A are engaged with the respective shafts and the clutches 88B, 89B, 90B are disengaged from the respective shafts. Thereafter, the driving speeds of the motor 18B and the generator 14B are gradually lowered to their normal conditions to await the next yarn break.

In the above-mentioned embodiment shown in FIG. 7, wherein the engagement and disengagement of the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit to and from the driving shafts are directly driven by the first electric source (E1) or the second electric source (E2) takes place, if in a certain spinning unit (S1) the spinning yarn is broken during the yarn piecing operation of the other spinning unit (S2), as the other spinning unit (S2) is driven by the second electric source at the predetermined variable speed, it is necessary to await the engagement of the spinning unit (S1) with the second electric source (E2) until the above-mentioned yarn piecing operation of the spinning unit (S1) is completed. This delayed engagement is hereinafter referred to as a "waiting operation." The waiting operation can be carried out as illustrated in FIG. 4, wherein the pulses for the spinning units are supplied from the first spinning unit in order with a predetermined time interval.

In the above-mentioned embodiments, the electric sources (E1), (E2) and (E3) involve the respective generators so as to generate the respective output powers of variable frequency. However, instead of these types of electric sources, a static variable frequency electric source comprising elements such as "thyristors" can be preferably utilized. In an embodiment of a practical apparatus for driving the open-end spinning frame, shown in FIG. 8, the driving apparatus is almost similar to the embodiment shown in FIG. 3, except for utilizing a static variable frequency electric source instead of generators driven by the respective variable speed motors. The principle of the driving method of this embodiment is rather similar to the embodiment shown in FIGS. 2A, 2B and 2C. The draw-off rollers 5A, and take-up roller 8 of each spinning unit (S) is driven by the motor 13 by way of the gear box 21, the motor 13 is connected to an inverter 95A of the first electric source (E1) having a higher output frequency by way of a switch 99A. The feed rollers 1A are driven by a motor 10 which is connected via a switch 100A to an inverter 96A of the first electric source (E1), while the rotor 4 is driven by a motor 12 which is connected to an inverter 97A of the first electric source (E1) by way of a switch 101A.

The above-mentioned motors 13, 10 and 12 are connected to respective inverters 95B, 96B and 97B of the second electric source (E2) by way of respective switches 99B, 100B and 101B.

The opening roller 3 of each spinning unit (S) is driven by an individual motor 11 which is connected to an inverter 98 of the third electric source (E3). Therefore, when a spinning yarn is broken at a certain spinning unit (S), a detector detects the yarn break and the switches 99A, 100A, 101A and 102A are opened by an output signal of the detector, and a break circuit (not shown) is closed to break the rotation of the above-mentioned rotatable elements of the spinning unit (S) so as to stop them, and after a predetermined short time, the switches 99B, 100B, 101B and 102B are closed by utilizing a timer switch (not shown). Consequently, the motors 13, 10, 12 of this spinning unit (S) are commenced to rotate at a predetermined slow speeds by means of the additional electric source (E2) so that the yarn piecing operation can be
satisfactorily carried out. The gradual speeding up of these motors by the second electric source \((E_2)\) and changing the driving connection from the second electric source \((E_2)\) to the first electric source \((E_1)\) and vice versa, are carried out by the similar mode as the embodiment shown in FIG. 3.

However, in the embodiments shown in FIGS. 3, 5, 6, 7 and 8, if several yarns are broken during a yarn piecing operation of a spinning unit, the operation for changing the alternative connection with the electric sources must unavoidably wait to avoid this problem the above-mentioned engagement or disengagement operation of each spinning unit \((S)\) with respect to the first electric source \((E_1)\) or the second electric source \((E_2)\) can be carried out separately by applying a group control of the electric switching means, so that time for waiting the yarn piecing operation can be reduced.

An example of such a group control system is illustrated hereinafter by an embodiment shown in FIG. 9. The spinning rotor 4 of each spinning unit \((S)\) is directly connected to a shaft of the corresponding individual motor which is connected to a variable frequency electric source comprising a first electric source for driving the spinning units at the predetermined higher speed and a plurality of second electric sources. The engagement of each spinning unit \((S)\) of a certain group to the above-mentioned two kinds of electric sources can be alternatively attained without any relation to another spinning unit \((S)\) of other groups. Further, to save the production loss due to the waiting time which is inevitable in the embodiment shown in FIGS. 3, 5, 6, 7 and 8, when yarn breakage successively occur in several groups of spinning units \((S)\), each second electric source can only be connected to one of a plurality of spinning units \((S)\) which are designed so as to be able to control the operation as a group. Therefore, the open-end spinning frame is divided into several groups each comprising several spinning units \((S)\) which are electrically controlled by the corresponding or selected second electric source \((E_2)\). Therefore, even through yarn breakage simultaneously or successively takes place in several spinning units of different groups, the yarn piecing operation can be carried out by the respective second electric sources at once. The first electric source \((E_1)\) drives all the spinning units \((S_1)\) at the predetermined high speed in such a way that the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit \((S)\) are driven by the respective shafts 85A, 86A, 87A extended through all the spinning units \((S)\) from the gear box 19A which is driven by the variable speed motor 18A by way of the respective clutch 88A, 89A and 90A. A set of shafts 85B, 86B, 87B are extended from each second electric source \((E_2)\) so as to pass through the spinning units \((S)\) forming a group so that the feed rollers 1A, draw-off rollers 5A and take-up roller 8 of each spinning unit \((S)\) can be driven by the respective shafts 85B, 86B and 87B by way of the respective engageable and disengageable clutches 88B, 89B and 90B. Individual motor 12 is directly connected to each spinning rotor 4 which is driven by the generator 14A of the normal electric source \((E_1)\) by way of a switch 91A and is also driven by the generator 14B of the corresponding second electric source \((E_2)\) by way of a switch 91B.

As already illustrated, the generators 14A and 14B generate the output power of variable frequency in accordance with the variable rotational speed of the respective motors 18A and 18B. The opening roller 3 of each spinning unit \((S)\) is driven by the corresponding individual motor 11 which receives the output frequency generated by the generator 17 which is directly connected to the motor 20 involved in the first electric source \((E_1)\). As the driving speed of the opening roller 3 does not exert any influence on the yarn piecing operation, it is not necessary to connect the motor 11 to the second electric source \((E_2)\). In the above-mentioned operation, the spinning units \((S)\) are driven by the first electric source \((E_1)\) in the same manner as illustrated in the case of the embodiment shown in FIG. 7. However, at the time of yarn piecing operation during the normal spinning operation, the yarn piecing operation is carried out in the same manner as illustrated in the case of the embodiment shown in FIG. 7 within a group of the spinning units \((S)\). Therefore, the production loss, which may be expected when the yarn breaks took place simultaneously or successively in a plurality of spinning units, can be reduced remarkably.

In the above-mentioned embodiment, the following modification can be applied. That is, all of the spinning units \((S)\) are divided into a plurality of groups and each group is formed by a plurality of adjacent spinning units \((S_1)\) and a plurality of second electric sources \((E_2)\) are mounted on the spinning frame and are capable of selectively connecting each one to one of the above-mentioned spinning units. To carry out the above-mentioned selection of connection between one of the second electric sources \((E_2)\) and one of the groups of spinning units \((S)\), means for controlling the above-mentioned selection must be applied. In this modification, a plurality of actuating means for controlling the variable speed motor 18B of each second electric source and selecting means for selectively connecting one of variable speed motors 18B to one of the actuating means are utilized. Therefore, even though a plural number of spinning units \((S)\) belonging to different groups are required to be driven by the respective second electric sources, the respective motors 18B can be selectively connected to one of the actuating means. The above-mentioned selection is carried out by using the principle of the well known large number group system used in telephone communication exchange systems.

What is claimed is:

1. A method of driving an open-end spinning frame utilizing a plurality of spinning units each having a spinning rotor provided with a centrifugal rotary spinning cavity into which opened fibers are continuously introduced to spin them into a yarn which is continuously delivered from the cavity, comprising driving each of said spinning rotors directly by means of a separate motor energized from variable frequency source means, driving said motor at a predetermined variable higher speed for carrying out the normal spinning operation and lowering the frequency of said source means to drive said motor at a predetermined variable lower speed for carrying out a yarn piecing operation when a spun yarn is broken.

2. A method of driving an open-end spinning frame utilizing a plurality of spinning units each having a spinning rotor provided with a centrifugal rotary spinning cavity into which opened fibers are continuously introduced to spin them into a yarn which is continuously delivered from the cavity, an opening roller for separating a bundle of fibers into individual fibers, a pair of
feed rollers delivering a bundle of fibers to said opening roller and a pair of draw-off rollers delivering said yarn from said rotor and a take-up roller making a package of said yarn delivered from said draw-off rollers; comprising driving each spinning rotor directly by means of an individual motor, driving said motors of all spinning units at a predetermined variable high speed for carrying out normal spinning operations by connecting said motor with a first common variable frequency electric source, while driving the motor of a single spinning unit wherein yarn breakage is detected at a predetermined variable low speed by connecting said motor to a second variable frequency electric source for carrying out a yarn piecing operation after disconnection with said first electric source, and after completion of said yarn piecing operation, driving said motor of said particular spinning unit at said high speed by connecting again with said first electric source.

3. A method of driving an open end spinning frame utilizing a plurality of spinning units, according to claim 2, wherein said second electric source comprises a plurality of second variable frequency electric sources so that driving said motor of a single spinning unit wherein yarn breakage is detected is carried out by connecting said motor of a single spinning unit to one of said plurality of second variable frequency electric sources.

4. Driving method of an open-end spinning frame according to claim 2, wherein said low speed driving of said motor for driving said rotor of a next spinning unit, which is required to carry out said yarn piecing operation, must wait until a previous yarn piecing operation has been completed.

5. Driving method of an open-end spinning frame according to claim 2, wherein said high speed driving of all motors for driving respective rotors is commenced at a predetermined low speed and is gradually accelerated up to a predetermined high speed for carrying out normal spinning operations.

6. Driving method of an open-end spinning frame according to claim 2, wherein said low speed driving of said motor of a spinning unit wherein a yarn piecing operation is required is commenced at a predetermined low speed, and after completion of said yarn piecing operation, driving speed is gradually accelerated up to a predetermined high speed for carrying out normal spinning operations, thereafter driving connection of said motor with said second variable frequency electric source is changed to connection with said first variable frequency electric source.

7. Driving method of an open-end spinning frame according to claim 6, wherein variable speed driving of said motor by said second variable frequency electric source is carried out together with variable speed driving of said feed rollers, draw off rollers and take-up roller while maintaining constant relative speed ratios therebetween.

8. An apparatus for driving an open-end spinning frame utilizing a plurality of spinning units each having a spinning rotor provided with a centrifugal rotary spinning cavity into which opened fibers are continuously introduced to spin them into a yarn which is continuously removed from said cavity, a pair of feed rollers supplying a bundle of fibers to said spinning rotor by way of an opening roller and a pair of draw-off rollers delivering said yarn from said rotor, a take-up roller for producing a package from said yarn delivered from said draw-off rollers, comprising, an individual motor for directly driving said spinning rotor of each spinning unit, means for driving said motor, said driving means comprising a first variable frequency electric source connected to drive all of said motors at a predetermined high speed for carrying out the normal spinning operation, a second variable frequency electric source for driving said motor of a spinning unit which is required to carry out a yarn piecing operation, means for connecting said motor of a spinning unit with a yarn breakage to said second variable frequency electric source instead of said first electric source and for subsequently connecting said motor to said first electric source instead of said second electric source after completion of said yarn piecing operation.

9. Driving apparatus of an open-end spinning frame according to claim 8, wherein said first and second variable frequency electric sources are generators which are driven by respective variable speed motors.

10. Driving apparatus of an open-end spinning frame according to claim 8, wherein said first and second variable frequency electric sources are static variable frequency electric sources.

11. Driving apparatus of an open-end spinning frame according to claim 10, wherein said static variable frequency electric sources comprise a plurality of semiconductor elements such as thyristors.

12. Driving apparatus of an open-end spinning frame according to claim 8, wherein said connecting means is provided with a control member for waiting for said connection of said motor for driving said rotor of a next spinning unit which is required to carry out said yarn piecing operation to said second variable frequency electric source until a previous yarn piecing operation has been completed.

13. Driving apparatus of an open-end spinning frame according to claim 8, further comprising a mechanical driving means provided with a plurality of shafts extending from said driving means through all spinning units, a first set of clutches for engaging or disengaging said feed rollers, draw-off rollers and take-up rollers of all spinning units to respective shafts driven by said first variable frequency electric source, a second set of clutches for engaging or disengaging said feed rollers, draw-off rollers and take-up rollers of each spinning unit to respective shafts driven by said second variable frequency source only when said yarn piecing operation is required to be carried out.

14. Driving apparatus of an open-end spinning frame according to claim 8, wherein said second variable frequency electric source consists of a plurality of units of electric sources for driving said rotor, feed rollers, draw-off rollers and take-up roller of said spinning unit, which is required to carry out said yarn piecing operation, and said spinning units are grouped into several groups, each of said plurality of electric sources is utilized for operating said yarn piecing operation of a spinning unit which belongs to a corresponding group.

15. Driving apparatus of an open-end spinning frame according to claim 14 further comprising means for selectively connecting said spinning unit which is required to carry out said yarn piecing operation to one of said units of electric sources forming said second variable frequency electric source.