United States Patent

Norris

[15] **3,668,485**

[45] **June 6, 1972**

[54] DRIVE FOR BELT CONVEYORS

[72] Inventor: **Melvin N. Norris**, 328 Crestview Dr., Franklin, Pa. 16328

[22] Filed: **July 2, 1969**

[21] Appl. No.: **838,468**

[52] **U.S. Cl.** **318/102**, 318/46, 318/91

[51] **Int. Cl.** **H02p 1/58**

[58] **Field of Search** 318/102, 91, 5, 46, 137, 55, 318/65

[56] **References Cited**

UNITED STATES PATENTS

1,796,210	3/1931	McCrea	318/137
1,796,220	3/1931	Seeley	318/137
2,252,762	8/1941	Feldhausen	318/55
2,418,806	4/1947	Reeves et al.	318/65
853,711	5/1907	Merrill	318/5
1,164,719	12/1915	Hitner	318/91
2,771,814	11/1956	Isom	318/102 X
2,809,334	10/1957	Hixson et al.	318/91

Primary Examiner—Benjamin Dobeck
Attorney—E. Wallace Breisch

[57] **ABSTRACT**

A method and apparatus of accelerating a belt conveyor wherein such acceleration is accomplished by means of sequential operation of two drive motors connected in tandem.

16 Claims, 6 Drawing Figures

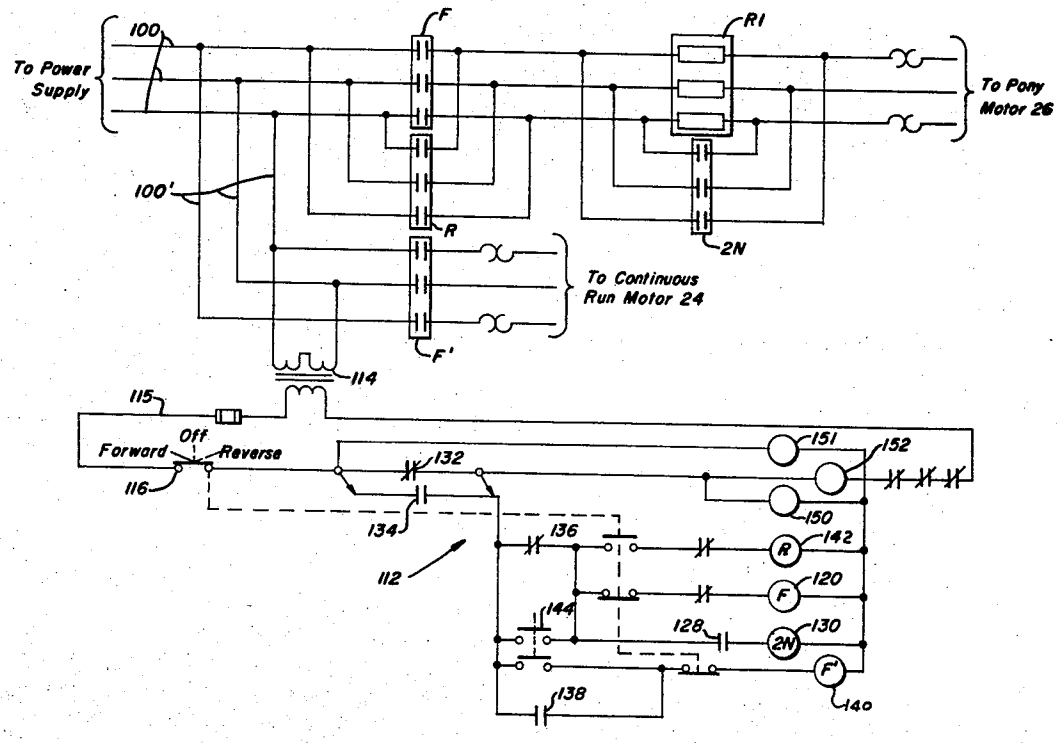


FIG. 1

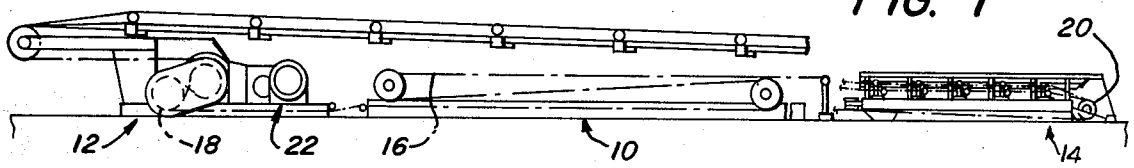


FIG. 2

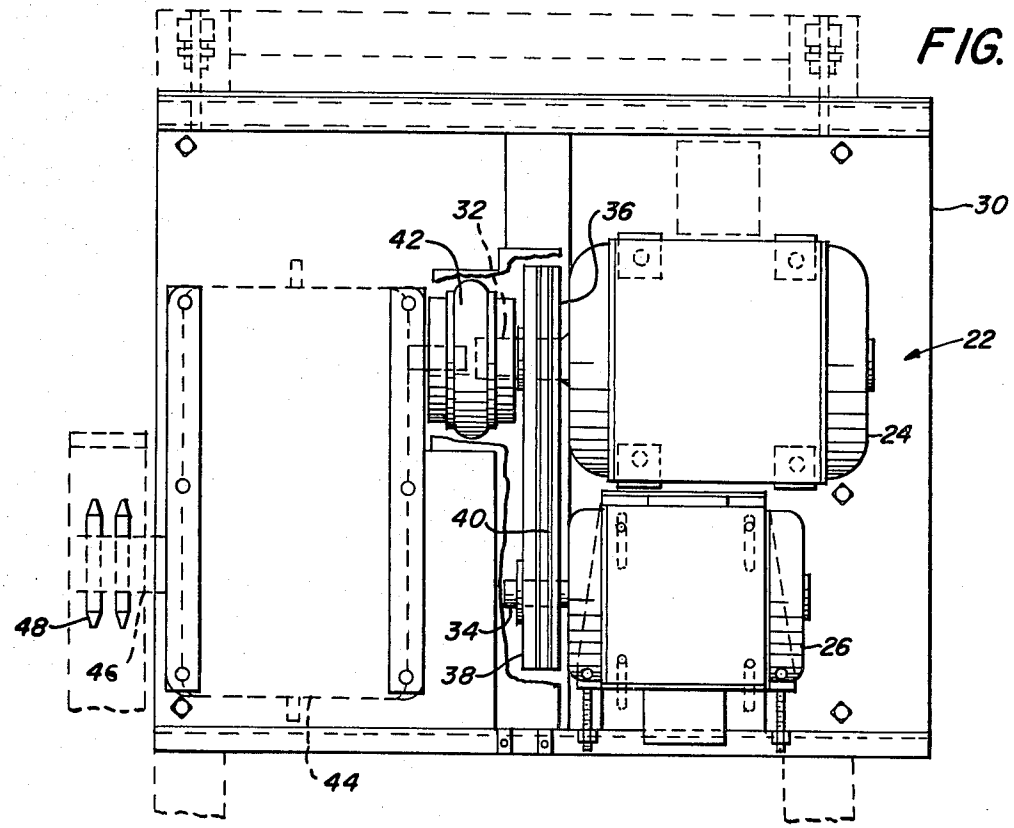
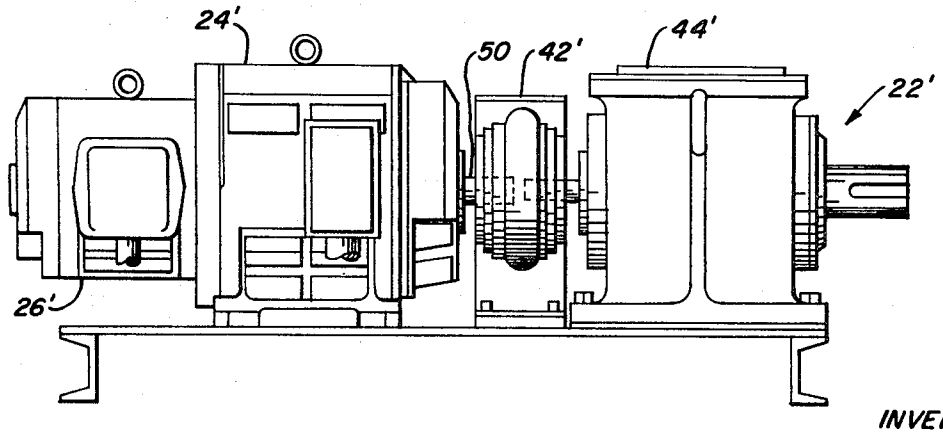


FIG. 3



INVENTOR
MELVIN N. NORRIS

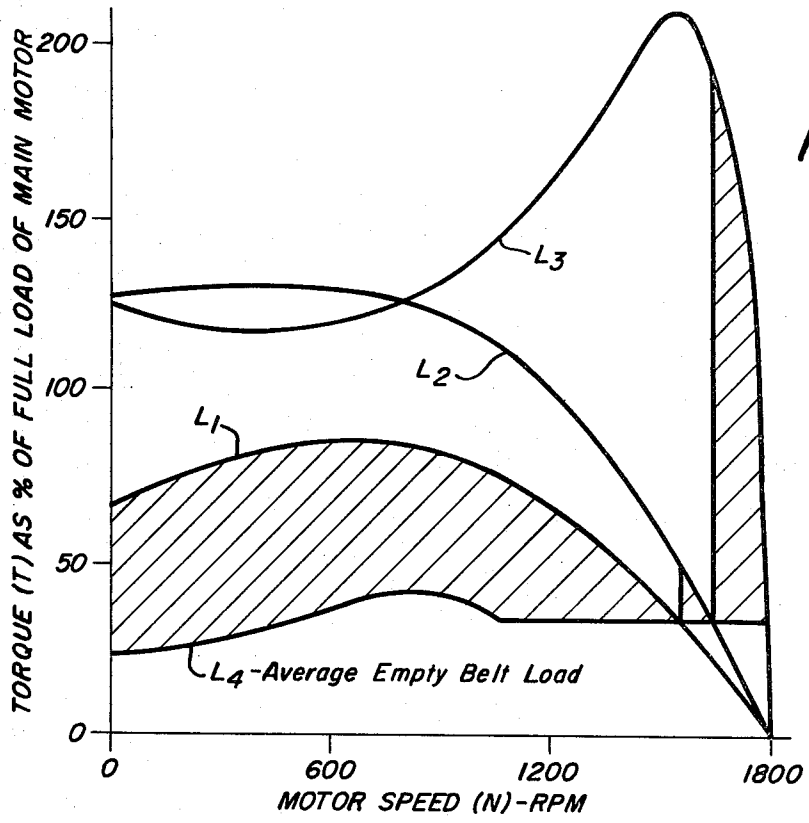


FIG. 4

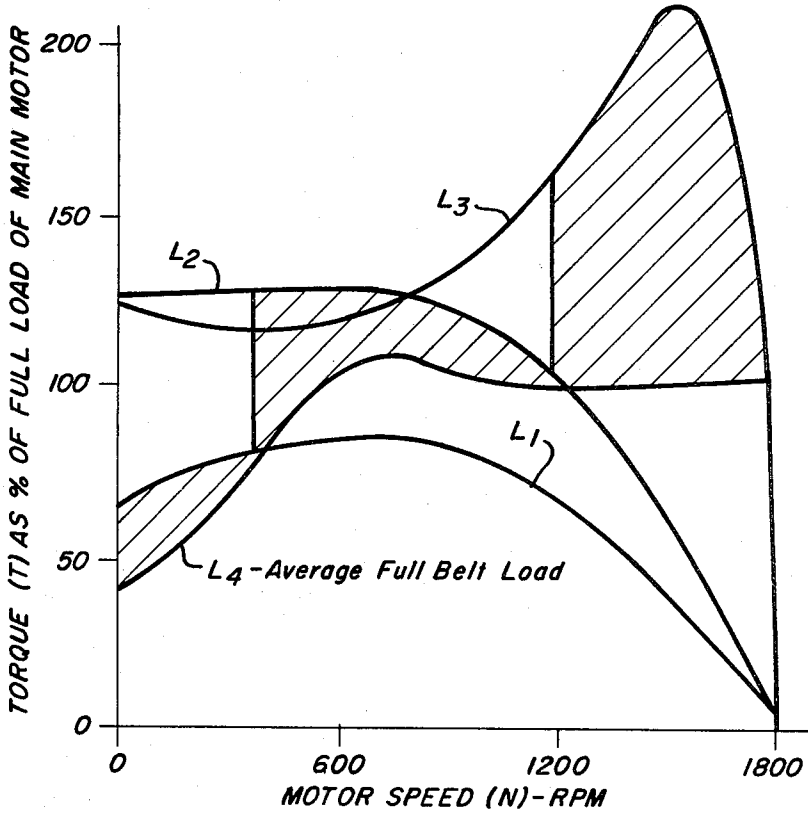
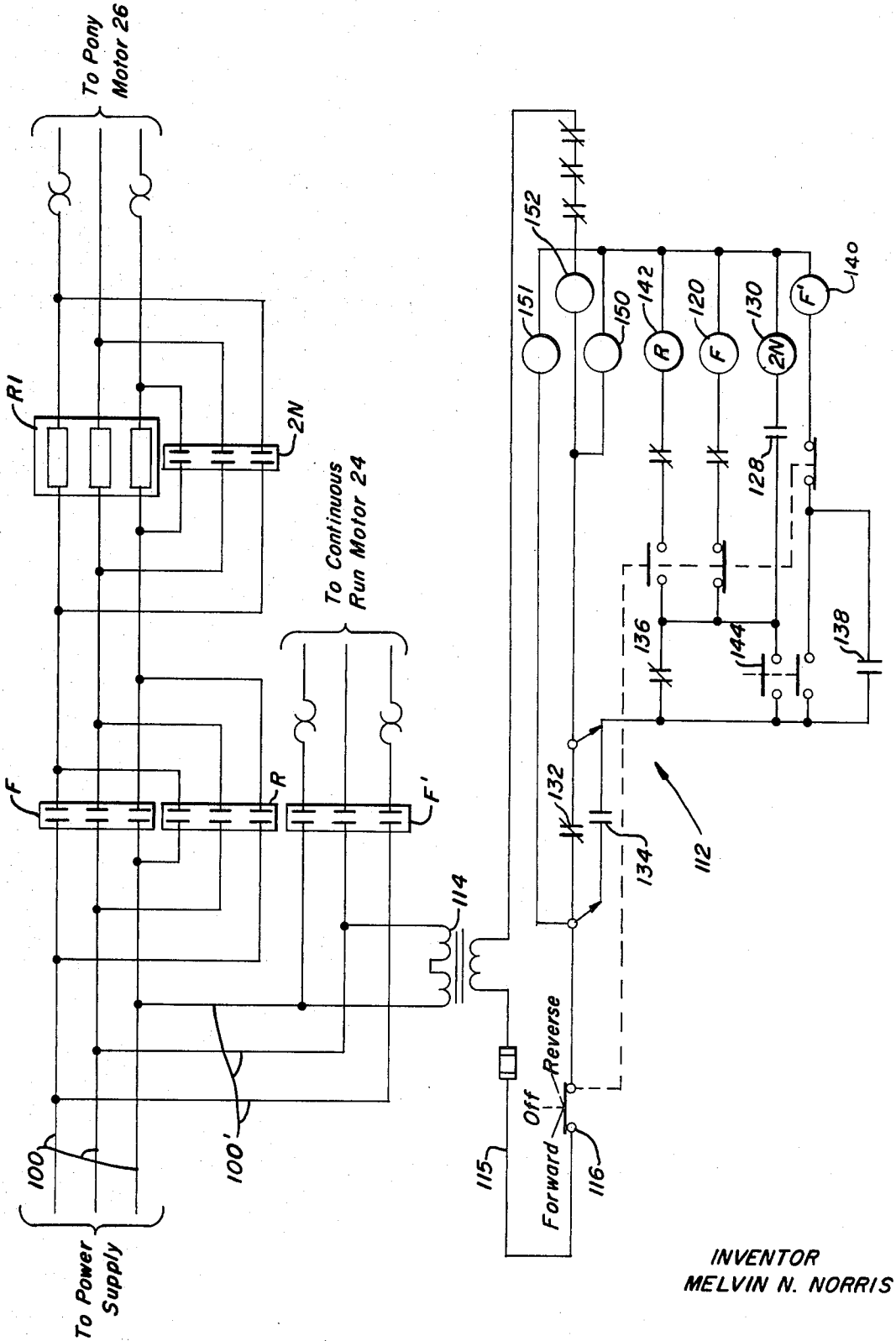


FIG. 5

INVENTOR
MELVIN N. NORRIS

FIG. 6



INVENTOR
MELVIN N. NORRIS

DRIVE FOR BELT CONVEYORS

A problem with belt conveyors, particularly of the type which are required to operate in a range varying from low inertia to high inertia loaded conditions, is to accelerate a load thereon smoothly and economically.

Prior approaches attempting to obtain this smooth and economical acceleration, included: the use of Nema "B" or Nema "C" motors in conjunction with fluid couplings, shot filled couplings, centrifugal shoe couplings or plain conventional couplings; two speed motors; reduced voltage controllers with Nema "C" motors; and wound rotor motors and controllers. With the exception of the wound rotor motors and controllers, all of the above mentioned approaches have at least one of the following disadvantages, which include: fast, rough start on the belt; high inrush currents; difficult adjustment problems; potential fire hazards through overheating; drive alignment problems; continual preventive maintenance and inspection; difficult voltage adjustments; and the like. The wound rotor motors and controllers achieve smooth acceleration at variable inertias; however, the initial cost thereof is relatively high in comparison with other systems.

The present invention provides a method and apparatus for smooth and economical acceleration of a belt conveyor with none of the hereinabove mentioned problems through the use of a lower horsepower motor to start the conveyor and accelerate it until a preset speed is reached or time has elapsed at which instant the conveyor load is transferred to a higher horsepower motor which accelerates the conveyor to a given speed and thereafter maintains such speed.

These and other objects and advantages of this invention will become more readily apparent from a reading of the following description and drawings in which:

FIG. 1 is a side elevational view of a conveyor assembly which embodies the principles of this invention;

FIG. 2 is a plan view of a dual motor drive system for the conveyor system shown in FIG. 1 which embodies the principles of this invention;

FIG. 3 is a side elevational view of another form of a dual motor drive system for powering the conveyor system shown in FIG. 1;

FIG. 4 is a graphical representation of torque T and speed N for various motor energizations and the average load for an empty belt;

FIG. 5 is a graphical representation of torque T and speed N for various motor energizations and the average load for a loaded belt; and

FIG. 6 is a grammatic view showing various control means for the dual motor drive assembly as shown in FIG. 2.

A belt conveyor assembly generally indicated at **10** (FIG. 1), comprises a drive section **12** and an axially spaced tail section **14**. Drive pulleys **18** and idler pulley **20** are respectively positioned within sections **12** and **14** in any well known manner to define an orbital path for an endless conveyor belt **16**. Suitable intermediate supports and idler assemblies are provided for supporting and guiding the belt **16** throughout the orbital path thereof. A drive motor assembly **22** of this invention is suitably positioned within drive section **12** to power pulleys **18** in a manner hereinafter described. Pulleys **18** have belt **16** trained thereabout and in suitable driving relationship therewith to be driven by pulleys **18** for a continuous orbital path thereof.

Drive motor assemble **22** (FIG. 2) comprises a main continuous run motor **24** and a startup, relatively low horsepower pony motor **26** mounted in parallel relationship on a common base **30**. Motors **24** and **26** have the respective drive shafts **32** and **34** thereof connected in driving relationship by means of respective pulleys **36** and **38** interconnected through a continuous multiple V driving belt **40** trained about such pulleys. A coupling member **42** couples drive shaft **32** to a suitable speed reducer **44** which increases the torque provided thereto to that torque necessary to drive the belt **16**. A reducer output shaft **46** is drivingly connected to drive pulleys **18** in any suitable manner, for example, a sprocket **48** is splined to output shaft **46** and is drivingly connected to pulleys **18**, such as by a drive chain extending therebetween (not shown).

With an arrangement such as drive assembly **22** as described hereinabove, the pony motor **26** is used to initiate the acceleration of belt **16** until a preset speed is reached or preset time has elapsed at which instant the conveyor **10** load is suitably transferred to main motor **24** which continues to accelerate the conveyor to a constant run speed and thereafter maintains such speed. Through the use of pony motor **26** for initial acceleration of belt **16**, a smooth and economical startup thereof is obtained when compared with a startup of belt **16** which would be obtained by use of a single motor which both initially accelerates and maintains constant running speed of a belt conveyor. Additionally, because belt **40** drivingly communicates between drive shafts **32** and **34**, drive shaft **32** is necessarily accelerated by pony motor **26** during the acceleration thereof such that, when the predetermined speed of belt **16** or preset time period has elapsed and motor **24** is energized, the startup torque of motor **26** is greatly reduced thereby resulting in a smooth and economical transition from startup of pony motor **26** to final acceleration and continuous run by motor **24**.

In FIG. **6** there is illustrated an electrical circuit for operating a conveyor assembly **10** by the use of the method of this invention, comprising: a forward contactor F disposed in power lines **100** leading to pony motor **26**; a reverse contactor R shunted with contactor F; a startup resistance R1 for providing initial resistance in the preliminary startup of motor **26** to reduce current surge thereto; a resistance bypass contactor 2N in shunt with resistance R1; a forward contactor F' disposed in power lines **100'** leading to motor **24**, power lines **100'** are connected across lines **100**; and an AC output control transformer **114** connected to power lines **100** and **100'** to provide current to a control circuit **112** for controlling the operation of the several contactors F, R, 2N and F'.

Power is delivered to control circuit **112** for operation thereof by control lines **115** connected to the output side of transformer **114**. A mechanically interlocked forward-reverse switch **116** is disposed in circuit **12** for selective operation of the belt conveyor **10** in the forward and reverse directions thereof. When switch **116** is in the forward position, a forward contactor coil **120** is energized. Upon the energization of the forward contactor coil **120** the normally open forward contactor F closes and current then flows through resistors R1 to initially energize pony motor **26**. Simultaneously with the energization of the forward contactor coil **120**, three time delay contactor coils **150**, **151** and **152** are energized. After a predetermined time has elapsed from the initial energization, for example 2 seconds, coil **150** operates to close a normally open contactor **128**. The closing of contactor **128** energizes a resistance bypass contactor coil **130** which operates to close the normally open resistance bypass contactor 2N thereby shunting out the resistance R1 and allowing full supply current to flow to pony motor **26**.

Subsequent to energization of coil **130**, for example an additional 6 seconds, the contactor coil **151** opens a normally closed contactor **132**. Contactor **132** is in parallel with a normally open centrifugal switch **134**, and contactor **132** and switch **134** are so positioned within circuit **112** that the current must pass through one of them in order to energize the forward contact coil **120**. Centrifugal switch **134** is keyed the speed of belt **16** or motor **26** such that switch **134** will close when the motor **26** has reached a predetermined speed, for example two-thirds of the rate of speed thereof. Accordingly, if the predetermined speed of centrifugal switch **134** is not obtained by the time the contactor **132** is opened by the energization of the time contactor coil **151**, the energization of the forward contactor coil **120** will cease and the start-up operation of motor assembly **22** will be discontinued. Assuming that the centrifugal switch **134** has closed prior to the opening of contactor **132** an additional predetermined time will elapse, for example, 2 seconds, whereat the energization of time contactor coil **152** will simultaneously open a normally closed contactor **136** and close a normally open contactor **138**. The opening of contactor **136** will discontinue the energization of forward contactor coil **120** and accordingly open the forward

contactor F. The closing of contactor 138, simultaneously with the opening of contactor 136, will result in the energization of forward contactor coil 140, which energization results in the closing of the normally open forward contactor F' thereby permitting the flow of current to the continuous run motor 24 for the energization thereof.

When switch 116 is in the reverse position, a reverse contactor coil 142 is energized. Upon the energization of the reverse contact coil 142 the normally open reverse contactor R closes and current flows through resistors R1 to energize pony motor 26 and operate the conveyor assembly 10 in a reverse direction from heretofore described. It is to be noted that the reverse operation of conveyor assembly 10 as shown is through the use of the pony motor 26 only.

A suitable manual interlock 144 is provided for simultaneous operation of pony motor 26 and main motor 24 in tandem if the need were to arise from extremely large torque requirement.

FIGS. 4 and 5, respectively, graphically illustrate the accelerations of a loaded and unloaded belt 16 from a stationary position to a constant run by the use of a method of this invention. The graphs of FIGS. 4 and 5, in which the torque (T), as measured by a percentage of the full load of the main motor, and motor speed (N), curves are drawn for: the pony motor 26 at reduced torque L1; pony motor 26 with no external resistance L2; main motor 24 L3; and the average belt load L4. The cross hatched sections between L4 and respective operating portions of L1, L2 and L3 indicate the amount of torque available for acceleration of belt 16. FIGS. 4 and 5 illustrate a time sequence of shifting one motor to another of a circuitry described hereinbefore with reference to FIG. 6; however, the means of sequencing motors 24 and 26 can be other than time, for example speed sequencing means are contemplated.

For purposes of illustration, graphs 4 and 5 were emperically obtained through the use of a 50 horsepower, constant horsepower, three phase, alternating current, high slip, high starting torque, start-up or pony motor 26; a 150 horsepower, single speed, constant horsepower, three phase, alternating current, low slip main motor 24; average load for the empty belt in the range of 100 to 120 amps or approximately 200 pound-feet of torque; and an average load for loaded belt in the range from 150 to 180 amps or approximately 315 pound-feet of torque, wherein the sequence of starting and switching was L1 for 2 seconds followed by L2 for 8 seconds and finally L3 until constant speed of the main motor 24 was achieved and thereafter. It is to be noted that the average load curves L4 for belt 16 are not constant as might be expected, however tests indicate that this seeming discrepancy results from initial belt stretching and continues until all slack is taken up, as indicated by the peaks of curves L4.

FIG. 3 illustrates another drive motor assembly 22' which can be used to drive a conveyor assembly 10 in accordance with the principles of this invention. Drive motor assembly 22' comprises a pony motor 26' and a continuous run main motor 24' coaxially positioned in tandem and having a common drive shaft 50. A coupling member 42' couples drive shaft 50 to a suitable speed reducer 44' for a purpose hereinbefore described with reference to motor assembly 22. The sequential energization of motor assembly 22' is essentially the same as the sequential energization of motor assembly 22 as previously described.

The essential feature of the invention described hereinabove is the acceleration of belt 16 by means of a sequential operation of a pony motor and a main continuous run motor. Accordingly, further modifications are contemplated without departing from the scope of this invention, for example: the switching sequence as previously described can be varied; centrifugal switches can be substituted for the time delay coils described hereinbefore; the initial resistance for the pony motor can be varied by means of variable resistors or varying sizes of drive pulleys; resistance R1 can be excluded from the circuit and another form of impedance such as reactance can be provided for resistance during the initial energization of the pony motor; and the like.

The scope of the invention is defined by the claims set forth hereinafter.

What is claimed is:

1. The method of starting the operation of a belt conveyor comprising the steps of: energizing a high slip start-up motor; substantially simultaneously with said energizing, accelerating said conveyor by rotational torque delivered thereto by the energized startup motor; substantially simultaneously with said energizing, rotating a rotor of a low slip, single speed, main motor by rotational torque delivered thereto by said energized start-up motor; after a period of time has elapsed from the energization of said start up motor, energizing said main drive motor; and substantially simultaneously with said last mentioned energization, further accelerating said conveyor and thereafter driving said conveyor at the normal continuous run speed thereof by rotational torque delivered thereto by the energized main motor.

2. The method of starting a belt conveyor as specified in claim 1 wherein during said period of time a speed responsive normally open switch for said drive motors is closed before the end of said period of time in response to a sensed drive speed at least as great as a preselected value.

3. The method as specified in claim 1 including the additional step of: deenergizing said start-up motor when said drive motor has been energized.

4. The method as specified in claim 1 wherein: said start-up drive motor has such a torque/speed characteristic for developing only sufficient torque for accelerating said belt conveyor smoothly from a stopped condition toward the normal continuous run speed; and said main drive motor has such a torque/speed characteristic for supplying the desired torque for driving said belt conveyor at the normal continuous run speed thereof.

5. The method as specified in claim 4 including the additional step of: selecting said period of time so that at the end thereof, when said main drive motor is energized, operation thereof is at a point on the torque/speed characteristic for supplying the desired torque for driving said belt conveyor at the normal continuous run speed thereof.

6. The method as specified in claim 4 wherein said step of energizing said start-up drive motor comprises: first energizing said start-up motor at a reduced level so as to provide only sufficient torque to said belt conveyor to accelerate said belt conveyor smoothly from a stopped position, and second, after a predetermined time, energizing said start-up motor to a full level to complete the acceleration of said belt conveyor toward the normal continuous run speed thereof.

7. In a belt conveyor drive system; first and second drive motors having the shafts thereof coupled to rotate together and drivingly coupled for driving said belt conveyor, said first drive motor being a high slip, start-up motor for accelerating said belt conveyor and said second drive motor being a low slip, single speed, main drive motor for accelerating to and driving said belt conveyor at the normal continuous run speed thereof; an electric circuit and a source of electric energy for energizing said motors; and means for connecting said first motor to said source; and delayed connection means for connecting said second motor to said source.

8. A belt conveyor drive system as specified in claim 7 wherein said delayed connection means is operated by an electric timer energized by said means for connecting said first motor.

9. A belt conveyor drive system as specified in claim 8 additionally comprising electrical impedance means normally in series with said start-up motor and delayed connection means for by-passing said impedance means.

10. A belt conveyor drive system as specified in claim 8 wherein a speed responsive normally open switch is connected to said timer means to continue operation thereof when a speed value at least as great as a preselected value is sensed.

11. A belt conveyor drive system as specified in claim 7 wherein said electric circuit comprises a primary circuit with multiple forward and reverse electromagnetic contactors for said start-up motor; multiple forward electromagnetic contac-

tors for said main motor and; a control circuit for operating all of said contactors.

12. In the belt conveyor drive system of claim 7 wherein: said delayed connection means operates to disconnect said first motor from said source when said second motor is connected to said source.

13. The system of claim 12 additionally including: reversing means for energizing only said first motor in such a manner, to accelerate and drive said belt conveyor in a reverse direction to the normal running direction thereof.

14. In the belt conveyor drive system of claim 7 wherein: said first drive motor has a torque/speed characteristic for developing only sufficient torque for smoothly accelerating said belt conveyor from a stopped position toward the normal continuous run speed thereof, and said second drive motor has a torque/speed characteristic for driving said belt conveyor at the normal continuous run speed thereof.

15. In the belt conveyor drive system of claim 14 wherein: said delayed connection means is operative to connect said second motor at a time when said second motor is operative at a point on the torque/speed characteristic thereof for supplying the desired torque for driving said belt conveyor at the normal continuous run speed thereof.

16. The system of claim 14 wherein: said delayed connection means includes first means for energizing said first motor at a reduced level so that only sufficient torque is supplied to said belt conveyor for accelerating it smoothly from a stopped position, and second means operative after a predetermined time from the energization by said first means to energize said first motor fully to complete the acceleration of said belt conveyor toward the normal continuous run speed thereof.

* * * * *