April 2, 1940. E. A. CAPOCEFALO 2,195,952

VARIABLE SPEED TRANSMISSION

Filed May 27, 1937 4 Sheets-Sheet 1

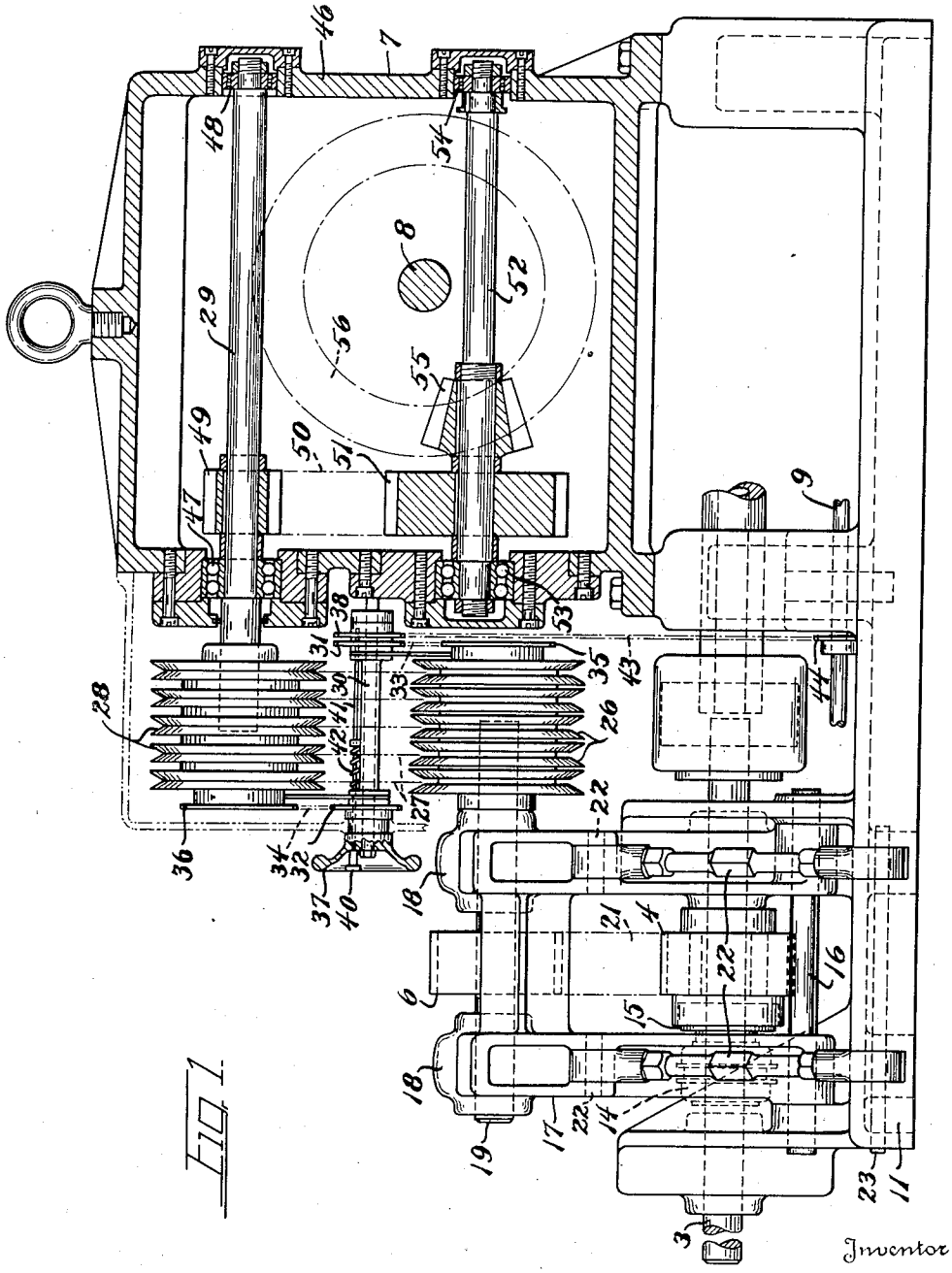


FIG. 1

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VARIABLE SPEED TRANSMISSION

Filed May 27, 1937 4 Sheets-Sheet 2

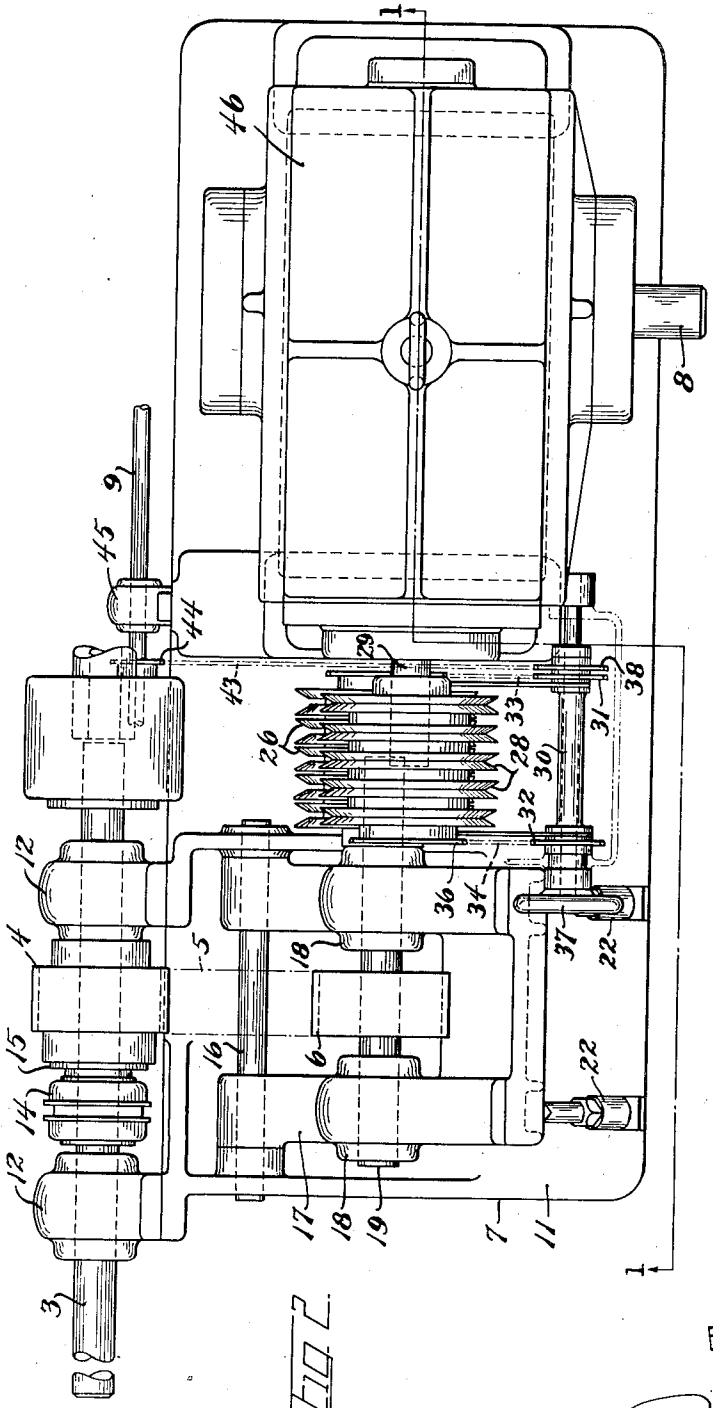


FIG 2

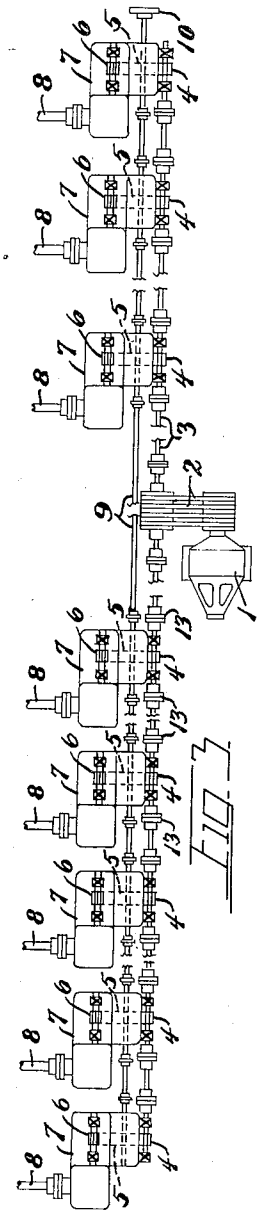


FIG 1

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VARIABLE SPEED TRANSMISSION

Filed May 27, 1937 4 Sheets-Sheet 3

FIG. 4.

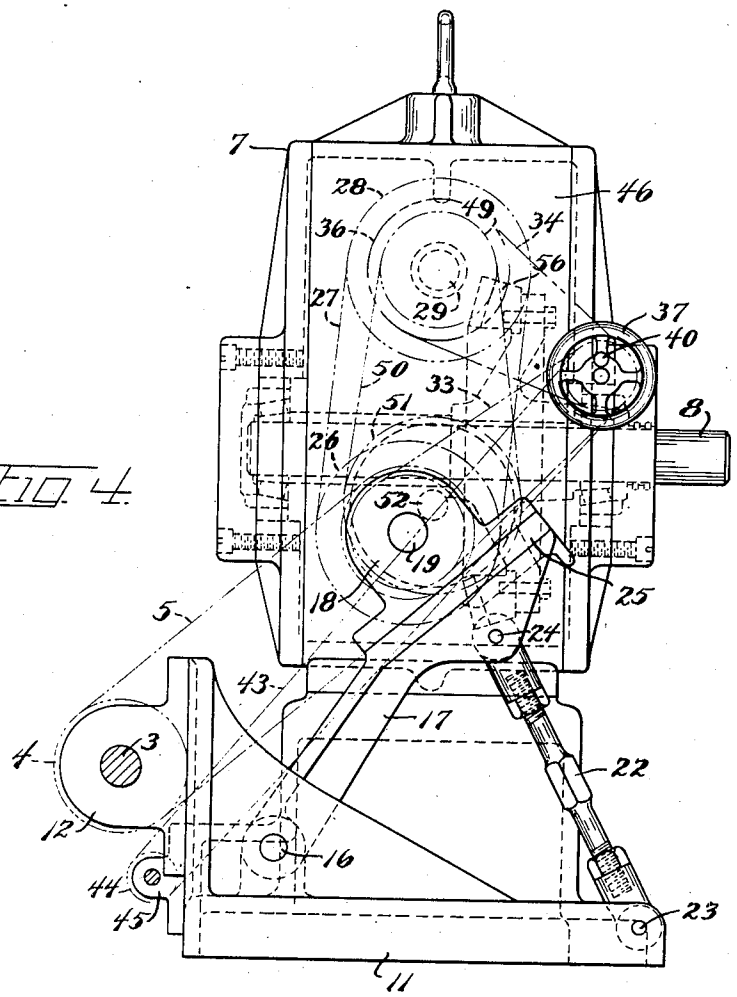
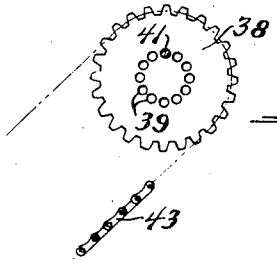


FIG. 5.



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VARIABLE SPEED TRANSMISSION

Filed May 27, 1937 4 Sheets-Sheet 4

Fig. 6.

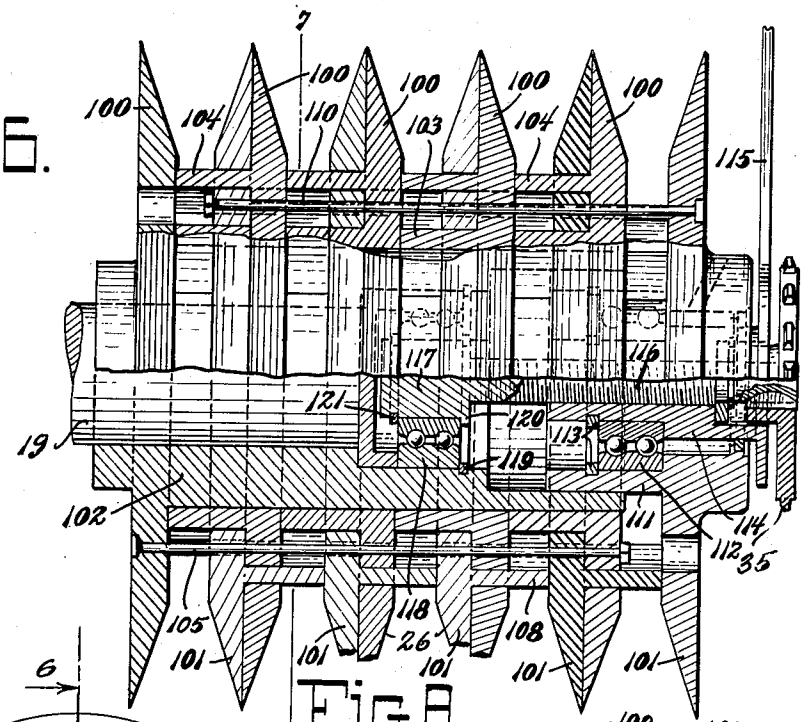


Fig. 7.

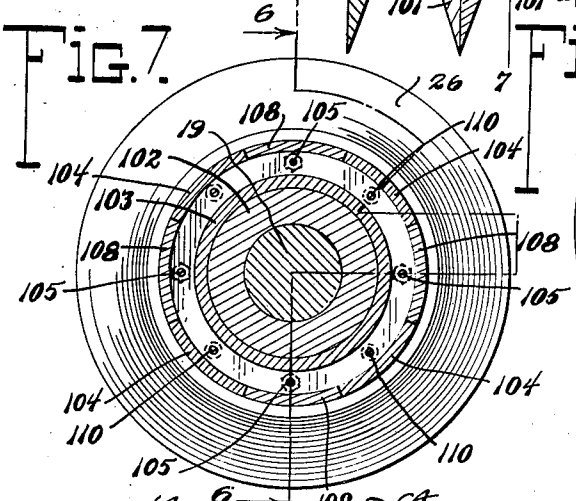


Fig. 8.

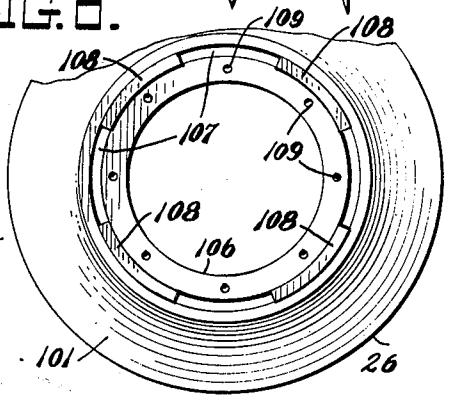
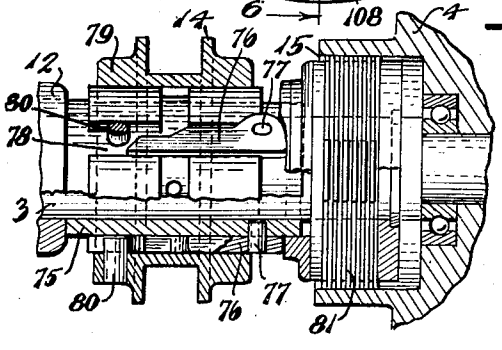


Fig. 9.



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Patented Apr. 2, 1940

2,195,952

UNITED STATES PATENT OFFICE

2,195,952

VARIABLE SPEED TRANSMISSION

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Application May 27, 1937, Serial No. 145,103

7 Claims. (Cl. 74—230.17)

This invention appertains to variable speed drive apparatus, and more especially, to means for controlling the speed variation in one or more sections of a paper making machine or the like, where close regulation of one or more rotatable parts is desired. It is to be understood that my invention is not limited to the field of paper making machines, since it is equally adaptable to other purposes, as will become apparent as the description hereinafter proceeds. The description of the invention, and illustration thereof, insofar as it relates to paper making machines, is therefore to be taken purely as one practical application of the invention, and the objects and advantages set forth will be seen to have more or less general utility.

In the case of paper making machines, the machines generally include a plurality of rolls which serve to guide and feed the material through the machines in the course of converting the material into paper. Since the material travels through the machine with a continuous motion, it therefore becomes desirable, to synchronize the speed of rotation of the various rolls in the different sections of the machine—otherwise the continuous strips or sheets of the paper material may become damaged. This problem of speed control of the different sections of paper making machines is one of comparatively long standing, and a number of attempts have been made to solve the problem, but such solutions, at best, are very inefficient and are more or less impractical.

At the present time, there are two types of drives which are commonly employed for paper machine drives. The first, and perhaps the most well known, is the so called Marshall drive, which embodies an arrangement of tapered cone pulleys and belt shifters which afford a variation of speed of each section of the machine over a range of approximately 10%. The drive is operated from a line shaft which is driven at a constant speed, and at intervals along this line shaft, the required number of tapered cone pulleys are mounted, each of which is connected by a flat belt to a complemental tapered cone pulley at each section of the paper making machine. Each belt is adapted to be shifted on the cone pulleys, independently of the other belts, by means of suitable belt shifting instrumentalities, but the adjustment is far from being a positive adjustment, as there will be a hunting effect between sections under the most ideal conditions. This hunting effect under ideal conditions is seldom, if ever, less than plus and minus 3% of the line shaft speed at each section, and in most cases, is substantially more. In some cases, it is frequently necessary to employ a vertical drive which is the most difficult in belted power transmission because a substantially constant belt tension must be maintained or slippage results. It is very difficult, if not impossible, to prevent belt slippage without the use of cumbersome idler pulleys, and hence the Marshall drive is even more impractical for vertical drives than for horizontal drives. Moreover, in the Marshall drive, variation of the speed of more than one, or all of the sections of the driven machine, at the same time, cannot be attained, by reason of the fact that there is no point of adjustment where all of the speed regulating units, or a predetermined number of the same, can be adjusted at one time. Thus, the results obtained by the Marshall drive have not proven satisfactory.

The other type of drive which is sometimes used in the paper making industry involves the use of electrical speed controllers and individual motors for driving the different sections of the paper making machine. Such an arrangement necessitates the provision of complicated electrical synchronizing mechanisms for speed adjustment. These mechanisms are quite complicated and expensive, and require the services of a skilled technician to install and maintain the same, not to mention the skill required to effect the frequent adjustments of the electrical mechanisms, due to the frequently changing conditions. In other words, there is a constant hunting between sectional motors, and those who have had experience with this type of drive are in constant difficulty in maintaining the desired adjustment between sections, because of the variables, to wit: voltage, current, speed and time lag, all of which must be compensated for through electrical instrumentalities of one kind or another. At no time can such electrical control be considered to be positive, and although it may be possible theoretically to obtain absolute synchronism, however, in actual practice, the limitations of the control equipment itself makes this impractical.

Having the foregoing in mind, it has been my aim to provide a comparatively simple, yet highly efficient, variable speed drive, by means of which positive synchronism between two or more units or parts is attained, with adjustable speeds for each unit or part, and an indefinite speed selection within a specified and more extensive speed range. My improved drive fulfills these aims and objects.

A still further object of the invention is to provide means for selectively, as well as simul-

taneously, adjusting the speed of one or more drive units of a group of such units used in combination, such adjustment being preferably attainable without discontinuing the operation of the drive. As a further extension of the increased degree of flexibility of such a system, I preferably provide means for selectively rendering one or more of the drive units inoperative without affecting the other drive units.

Among other objects of the invention, my improved drive is endowed with the following advantages: compactness of form and completely self-contained; ruggedly built for continuous duty, yet simple in design, assuring trouble-free operation and freedom from the usual maintenance troubles and expense, thereby resulting in minimum maintenance costs; low installation cost, and long life; each unit fully enclosed, assuring safety in operation; elimination of wasted power due to absence of belt slippage and positiveness of drive; standardization of drive units, so that units and all parts thereof are interchangeable; simplicity of adjustment and operation, thereby requiring no highly skilled technician to operate the drive or keep it running at the desired speed; and especially, when employed with any fixed or adjustable speed prime mover in the case of paper making, such as an electric motor or steam turbine, a complete selectivity of machine speeds independent of such prime mover for each section or all sections within a range of 34% or more.

Other objects and advantages of the invention will be hereinafter described, and the novel features thereof defined by the appended claims.

In the drawings:

Figure 1 is a view partly in longitudinal section, and partly in side elevation, of a variable speed drive unit constructed in accordance with my improved invention, the section being taken approximately on the line 1—1 of Figure 2;

Figure 2 is a top plan view of the drive unit shown in Figure 1;

Figure 3 is a diagrammatic view, showing, in top plan, a typical application of my improved variable speed drive unit to a paper making machine. In this view, eight drive units, driven from a common line shaft, which in turn is driven by a suitable power source, such as an electric motor, are shown, each of which units is adapted to drive one of the sections of the paper making machine (not shown), it being understood, of course, that the number of drive units may be increased or diminished as desired, according to the requirements of any specific installation.

Figure 4 is a view in end elevation of the drive unit shown in Figures 1 and 2;

Figure 5 is a fragmentary detail view of certain parts of the speed adjusting instrumentalities with which each variable speed unit is provided for selective and centralized control of the speed adjustment.

Figure 6 is a longitudinal sectional view, taken through one of the multiple sheave, variable pitch pulleys, the section being on a somewhat irregular line as indicated at 6—6 in Figure 7;

Figure 7 is a transverse sectional view, taken approximately on the line 7—7 of Figure 6;

Figure 8 is a fragmentary view in side elevation of one of the elements of the variable pitch pulley, more especially one of the relatively movable sheave sections; and

Figure 9 is a fragmentary detail sectional view of the clutch mechanism which forms a part of each drive unit.

Like reference characters designate corresponding parts in the several figures of the drawings.

My improved variable speed drive embodies, in general, a combination of gears, chain drives, an adjustable speed device or regulator such as an arrangement of variable pitch pulleys, all assembled together in a preferably unitary assembly of particularly compact and rugged construction. According to the construction shown in the drawings, the unit is primarily intended to be driven from a line shaft which is located at one side of the unit, and the power delivered by the unit is taken off at the opposite side of the unit through a power take-off shaft which is disposed at a right angle to the line shaft. Thus the unit may be termed a right angle drive, but it is to be understood that I do not wish to be limited to this precise arrangement, as the same may be varied to suit different requirements encountered in the application of my invention to different types of apparatus to be driven thereby.

Referring to Figure 3 of the drawings, 1 designates an electric motor or other equivalent prime mover which is connected by V-belts 2, or otherwise, to a line shaft 3, which, for the purposes of explanation of my invention, as given herein, shall be assumed to be the usual line shaft of a typical paper making machine. The other parts of the paper making machine have not been shown, since they form no part of the present invention, and it may therefore be assumed that such other parts may be of conventional construction, or otherwise, and include a plurality of rolls adapted to be driven by the line shaft 3. At intervals along the line shaft 3, I mount sprockets 4, and each sprocket is connected, preferably by means of a silent chain 5, with a sprocket 6 which forms a part of a variable speed drive unit, generally designated 7. According to Figure 3, there are eight such units 7, all driven by the common line shaft 3, and each of the units 7 is provided with a power take-off shaft 8, which is adapted to be operatively connected with a section of the paper making machine. While I have shown in Figure 3 eight variable speed units 7, the number of units is immaterial, and will depend upon the size and type of machine being driven.

Extending parallel to the line shaft 3, and preferably disposed at the same side of the unit 7 as the line shaft, there is shown in Figure 3 a common control shaft 9, which is preferably interconnected with each of the units 7, so that the speed adjustment of all of the units 7 may be effected simultaneously through adjustment of the control shaft 9 at a central control station. 10 designates a hand wheel mounted on one end of the control shaft 9, and by means of which the control shaft may be rotated to produce a simultaneous adjustment of all of the units 7 as hereinafter more fully explained.

Referring now to Figures 1, 2 and 4, it will be observed that each of the units 7 includes a base 11, at one side of which are mounted one or more (preferably two) bearings 12 for the line shaft 3. According to the preferred arrangement, the line shaft 3 is composed of a plurality of separate sections, and the sections are connected together by suitable couplings 13, as best seen in Figure 3, in a multiple unit installation, with the required space between the units 7. Each unit 7 preferably includes a short section of the line shaft 3, mounted in the bearings 12, and on this section, there is rotatably mounted the sprocket 4 pre-

viously referred to, the sprocket being free to turn on the shaft 3. The shaft 3 preferably has interposed therein a clutch unit which may be of any suitable construction. For the purposes of illustration, and without any intention of limiting the invention to any particular type of clutch, I have illustrated in Figure 9 one practical type of clutch which is of well known construction and marketed commercially under the trade-name "Pullmore", the same corresponding to the clutch disclosed in U. S. Patent No. 1,753,085, granted April 1, 1930, to J. L. Peterson. As shown, the clutch includes a sleeve 75 which is fixed to the shaft 3 so as to rotate therewith, and the sleeve has pivotally mounted thereon a plurality of cam levers 76, each of which is pivoted to the sleeve by a pin 77, the levers 76 being disposed in slots or recesses 78 formed in the outer face of the sleeve and extending longitudinally therealong. A shifting collar 79 encircles the sleeve 75, and is free to axially slide thereon and relative thereto so as to cause radially inwardly projecting pins 80 carried by the collar 79 to be moved into and out of engagement with the cam levers 76 responsive to axial movement of the shifting collar in opposite directions. The ends of the cam levers 76 adjacent to the pins 80 are provided with cam surfaces adapted to cooperate with the pins 80, and the opposite ends of the cam levers, adjacent to the pivots 77 are likewise provided with cam surfaces adapted to cooperate with a multiple clutch disc unit 81. When the shifting collar 79 is axially shifted to bring the pins 80 into engagement with the adjacent ends of the cam levers 76, the cam levers are rocked on their pivots 77 in one direction, causing the cam surfaces of the levers adjacent to the pivots 77 to energize the multiple discs 81 to transmit motion from the shaft 3 to the sprocket 4, thereby causing the sprocket 4 to be positively driven. To disconnect the sprocket 4 from the shaft 3, the shifting collar 79 is shifted in the opposite direction from that just described, thereby allowing the shaft 3 to operate continuously, if desired, without imparting any motion to the sprocket 4.

Pivotally mounted on the base 11, as at 16, is a yoke 17, which in turn is provided with a pair of spaced bearings 18 in which a short countershaft 19 is rotatably mounted. The sprocket 6 previously referred to is fixedly mounted on the countershaft 19 intermediate the bearings 18 and in alignment with the sprocket 4, and is preferably positively connected with the latter by a silent drive chain 5. Provision is made for pivotally adjusting the position of the yoke 17 and the parts carried thereby, and to this end, I have provided suitable take-up means 22, which, as shown in the drawings, have the form of adjustable tie rods, the opposite ends of which are pivotally connected respectively to the base, as at 23, and to the yoke, as at 24. As will be obvious from the drawings, rotation of the tie rods 22 in one direction serves to shift the yoke 17 about its pivotal axis 16 in one direction, whereas rotation of the tie rods in the opposite direction shifts the yoke in the opposite direction. Inasmuch as the pivotal axis 16 of the yoke 17 is eccentrically related to the center of the sprocket 4, provision is preferably made for uniformly maintaining the distance between centers of the sprockets 4 and 6 in order to maintain the chain length of the interconnecting chain 5 constant when the adjustment of the position of the yoke 17 is changed. Accordingly, the yoke 17 is provided with slotted pads 25 on which the bearings 18 are adapted to be adjustably secured, the securing being effected through means of suitable releasable fastening instrumentalities (not shown), as will be obvious to those skilled in the art.

The countershaft 19 is extended beyond the inner bearing 18, and on this end of the shaft, there is fixedly mounted a multiple sheave variable pitch pulley, generally designated 26. This pulley 26 is interconnected by a plurality of V-belts 27 with another multiple sheave variable pitch pulley 28 fixedly mounted on one end of a second countershaft 29, preferably positioned above the first mentioned countershaft or yoke shaft 19. Variation of the transmission ratio of pulleys 26 and 28 is attained through adjustment of the complemental parts of the sheaves towards and away from each other, so that the pitch diameter of the sheaves of one of the pulleys is increased, while at the same time, the pitch diameter of the other pulley is decreased, and vice versa. Such adjustment is effected by rotation of an integral assembly composed of handwheel 37, and sprockets 31 and 32, on a fixed stub shaft 30 mounted on and extending outwardly from casing 7, best seen in Figures 1 and 2. The sprockets 31 and 32 are interconnected by means of chains 33 and 34 with sprockets 35 and 36, which respectively form a part of the pulley assemblies 26 and 28. Obviously, the number of sheaves of each of the pulleys 26 and 28 may be varied as desired, according to the amount of power transmitted. The number of sheaves should be sufficiently great, however, to assure the provision of a positive variable speed drive, and to prevent slippage of the V-belts 27 during the transmission of power. By reason of the adjustability of the yoke 17 and parts carried thereby, including the multiple sheave pulley 26, the proper belt tension can be readily effected in the belts 27, and slack in the belts can be conveniently taken up as wear occurs, by a very simple and minor adjustment of the take-up means 22.

The variable pitch multiple sheave pulleys 26 and 28 are not in themselves new, but rather are more or less well known in the art of power transmission, and the principle of operation thereof to vary the transmission ratio is accordingly known to those skilled in the art (see British patent of Allis-Chalmers Manufacturing Company, No. 467,393, dated June 16, 1937). In Figures 6, 7 and 8, I have shown the details of the construction of the variable pitch multiple sheave pulleys, pulley 26 having been used as an example, and it being understood that both pulleys 26 and 28 may be identical. Each pulley unit includes a set of relatively stationary sheave sections and another set of relatively movable sheave sections, the same being assembled together in unitary form. As illustrated, the stationary sections are designated 100, and the movable sections are designated 101. One of the stationary sections 100, to wit, the section at the lefthand end as viewed in Figure 6, is formed as an integral part of a sleeve 102 which is mounted upon the shaft 19 and keyed or otherwise fixed thereto so as to rotate therewith. The other relatively stationary sections 100 are mounted upon the sleeve 102, and each is provided with an offstanding annular collar 103 which fits snugly about the sleeve 102. Spaced radially outwardly from the annular sleeve 102 is a plurality of offstanding segmental arcuate lugs 104 concentrically dis-

posed with respect to the collar 103. The free extremities of the collar 103 and the lugs 104 of each section 100 are disposed in the same plane and are adapted to abut against the adjacent relatively stationary sheave section. Tie bolts 105, extending through the abutting relatively stationary sheave sections 100, serve to hold these sections together and maintain the same in a rigidly assembled unitary assembly.

The relatively movable sheave sections 101 are formed complementary to the stationary sections, each being provided with a central opening 106 adapted to receive within the same the annular collar 103 of the adjacent stationary section 100. Spaced radially outwardly from the opening 106 in each section 101 is a plurality of arcuate segmental slots 107 which are respectively adapted to receive the lugs 104 on the stationary adjacent section 100. Intermediate the slots 107 the sheave sections 101 are provided with a plurality of offstanding segmental arcuate lugs 108 which are adapted to extend through corresponding slots formed in the stationary sheave sections 100 intermediate the lugs 104 of the latter. The lugs 108 abut against the adjacent movable sheave sections, each of which is provided with a plurality of apertures 109 to receive tie-bolts 110 which maintain these movable sheave sections in a rigidly assembled unitary condition. It will be understood from reference to Figures 7 and 8 that the lugs 104,108 and the corresponding slots in the respective sheave sections are formed on the same circle, or in other words, at equal distances from the axis of the shaft 19, thus permitting the parts to be put together in a simple manner and providing a strong construction which, to outward appearances, is generally similar to an ordinary multiple sheave pulley having V-grooves on the periphery thereof.

The movable sheave section at the outer end of the pulley unit on shaft 19 is provided at its inner side with an offstanding annular collar 111 which is received within the outer end of the sleeve 102 so as to be free to move axially therein. An anti-friction bearing 112 is mounted within the collar 111, and is prevented from axial displacement by the retainers 113. Within the bearing 112 and free to rotate relative to the collar 111 and movable sheave section 101, of which the collar 111 preferably forms an integral part, is an internally threaded nut 114, the outer end of which is provided with an offstanding arm 115 adapted to be connected to any convenient stationary part of the drive unit so as to prevent rotation of the arm 115, but permitting movement of the arm towards and away from the outer end of the shaft 19. Extending through the nut 114, is a screw 116, on the outer extremity of which is fixedly mounted the sprocket 35 hereinbefore referred to, the sprocket being keyed or otherwise fastened to the screw so as to impart rotation to the screw responsive to rotation of the sprocket. The inner end of the screw is provided with an enlarged head 117 which is free to rotate in an anti-friction bearing 118, the anti-friction bearing being fixed against axial displacement in the sleeve 102 by the retainer 119 and a shoulder 120 on the head 117. A retainer 121 is provided on the head 117 at the opposite side of the anti-friction bearing 118 so as to restrain the screw 116 against axial displacement in either direction, relative to the sleeve 102 and the shaft 19.

Now it will be seen that when the sprocket 35 is rotated in one direction, causing corresponding rotation of the screw 116, the nut 114 will be moved in one direction, on the relatively fixed screw, thereby causing the assembly of relatively movable sheave sections 101 to move in a corresponding direction through reason of the interconnection between the nut 114 and the end sheave section having the collar 111. The movable sheave sections 101 are all caused to correspondingly move simultaneously by reason of their unitary relationship resulting from the abutting engagement of the respective sections with each other and which is maintained by the tie-bolts 110. Rotation of the sprocket 35 in a direction opposite to that just described will cause movement of the movable sheave sections 101 in the opposite direction, as will now be obvious.

The above description applies in the same manner to the pulley 28, and for that reason the details of pulley 28 need not be specifically described. It will be understood, of course, that the pulley 28 is reversed with respect to pulley 26 as shown in the drawings, so that when the movable sheave sections of the latter are moved away from its relatively stationary sheave sections, the movable sheave sections of pulley 28 are moved towards its stationary sheave sections, and vice versa, thereby constituting a simple and very effective speed changing device which is interposed between the countershafts 19 and 29 of the drive unit. It is to be understood that I do not wish to be limited to this specific type of speed changing means, as other devices may be substituted therefor, if desired. I have found, however, that the speed changing instrumentalities above described are eminently suited for my purposes, particularly because of their adaptability to substantially infinite speed selection over a wide range. For example, I have found it possible with my variable speed drive to attain a positive and uninterrupted speed variation over a speed range of as much as 34%, whereas the permissible speed variation in the so called Marshall drive hereinbefore referred to is at best 10%.

As previously described the stub shaft 30 has mounted thereon a hand wheel 37 to facilitate manipulation of the sprockets 31 and 32 for adjusting the variable pitch pulleys, and in addition to the permissible adjustment of each drive unit 7 independently of the other units in a multiple unit system such as is shown in Figure 3, I preferably provide means for adjusting one or more of the units from a remote point or central station. To this end, I loosely mount a sprocket 38 upon the stub shaft 30, adjacent to the sprocket 31. This sprocket 38 is provided with a series of apertures 39, as best seen in Figure 5. Detent means 40, comprising an elongated axially shiftable pin 41, extends through an aperture provided therefor in the sprocket 32 and a corresponding aperture in the sprocket 31, the pin lying parallel to and at one side of the stub shaft 30. The inner end of the pin 41 is adapted to be selectively engaged with the apertures 39 in the sprocket 38, thereby interlocking the sprockets 31 and 38 together so as to cause both sprockets to be rotated at the same time when rotary movement is imparted to one or the other of the sprockets. A spring 42 serves to normally urge the pin 41 towards the apertures 39 in the sprocket 38. Sprocket 38 is interconnected by means of a chain 43 with a sprocket 44 fixedly mounted on the control shaft 9. The control shaft 9 is mounted in a bearing 45 provided at one side of the base 11 of the drive unit 7, and

in a multiple unit arrangement as shown in Figure 3, the control shaft 9 is preferably composed of a plurality of interconnected sections, generally corresponding to the sections which form the line shaft 3. Now when the sprockets 31 and 38 are connected together by engaging the detent pin 41 with one of the openings 39 in sprocket 38, rotation of the control shaft 9 will be transmitted through the chain 43 to the sprocket 38, and from the latter sprocket to the sprockets 31 and 32 which are interconnected therewith by detent means 41, thereby simultaneously actuating the sprockets 35 and 36 of the variable pitch pulley assemblies. Independent adjustment of the drive unit 7 can be effected by withdrawing the detent pin 41 from the apertures 39 in the sprocket 38, thereby disconnecting the sprocket 38 and allowing the sprockets 31 and 32 to be rotated independently of the sprocket 38 by manipulation of the local control wheel 37. After such independent adjustment has been effected, the detent means 40 can be released, thereby causing the detent pin 41 to be urged into the aperture 39 which happens to be registered therewith after the adjustment has been made, thereby conditioning the speed adjusting instrumentalities for adjustment by means of the control shaft 9.

The chain 33 interconnecting the sprocket 35, which forms a part of the variable pitch pulley 26, and the sprocket 31 which is rotatably mounted on the stub shaft 30, is preferably composed of detachable links so that the length of the chain may be conveniently adjusted by incorporating additional links in the chain, or removing one or more links therefrom. For ordinary purposes, the amount of slack in the chain 33 may be such that no adjustment of the length of the chain is necessary when the position of the countershaft 19 is adjusted by adjustment of the tie-rods 22 as hereinbefore described. In practice, this adjustment is made very infrequently, and even then it is usually in the nature of a very slight adjustment.

Countershaft 29 on which the variable pitch pulley 28 is mounted extends into a gear case 46 mounted on the base 11, and is rotatably supported by bearings 47 and 48 provided at opposite ends of the gear case. Fixedly mounted upon the shaft 29 and within the gear case 46 is a sprocket 49 which is preferably interconnected by means of a silent chain 50 with a sprocket 51 fixedly mounted upon another countershaft 52, positioned in parallel spaced relation to the countershaft 29 and preferably below the same. The shaft 52 is rotatably mounted in bearings 53 and 54 arranged at opposite ends of the gear case 46. Also fixedly mounted upon the shaft 52, at a point adjacent to the sprocket 51, is a bevel pinion 55, preferably of the Hypoid type, and this pinion 55 meshes with a bevel gear 56, also preferably of the Hypoid type. The gear 56 is fixedly mounted upon the power take-off shaft 8 which is disposed at a right angle to the countershafts 29 and 52, and extends through one side of the gear case 46 so that it can be utilized to deliver power to the apparatus, such as a paper making machine, which is to be driven by the variable speed drive unit.

Summarizing the operation of my improved variable speed drive unit, as applied to a multiple unit installation as shown in Figure 3, and assuming each of the drive units 7 has its power take-off shaft 8 connected to a section of a paper making machine or other equivalent apparatus, the silent chain 5 of each unit connects the sprocket 4 on the line shaft 3 with the sprocket 6 on countershaft 19. This chain drive can be of any desired ratio, but in the average installation for paper making machines, the ratio is preferably approximately 1:1 so as to maintain the speed of countershaft 19 high enough to obtain a relatively high normal belt speed of the V-belts 27. The countershaft 19 is connected to countershaft 29 through the variable pitch pulleys 26 and 28, and interconnecting V-belts 27, thereby causing the shaft 29 to be driven at any selected speed within a range of approximately 34% variation from the speed of the line shaft 3. The shaft 29 drives the countershaft 52 through means of the sprockets 49 and 51 and interconnecting silent chain 50, and shaft 52 drives the power take-off shaft 8 through the intermediary of the interconnecting bevel pinion 55 and gear 56.

After initial adjustment of the variable speed drive units 7, the units will operate in perfect synchronism by reason of their connection to a common line shaft 3. If, however, it is desired to further adjust all of the variable speed drive units simultaneously and preserve the transmission ratios of the various units respecting each other, this can be readily effected by adjusting the common control shaft 9, as for example, through manipulation of the hand wheel 10. Rotation of the control shaft 9 in one direction results in actuation of the chain 43 and sprocket 38, with which each of the drive units is provided, and this actuation results in adjustment of the local control shaft 30 of each drive unit, which, in turn, adjusts the variable pitch pulleys to increase or decrease the transmission ratios of the variable pitch pulleys which comprise the speed changing instrumentalities in each unit, according to which direction the control shaft 9 is rotated. On the other hand, if it is desired to change the speed of the output shaft of one or more of the variable speed units 7 independently, of the other units, then this can be accomplished by withdrawing or disengaging the detent means 40, and manipulating the local control instrumentalities 37 of that unit or those units. Following this independent adjustment, the common control can be reestablished by reengaging the detent means 40 with one of the apertures 39 in the sprocket 38. Thus it will be seen that my multiple arrangement of variable speed drive units is very flexible by reason of the provision of means for selectively as well as simultaneously adjusting the units of the system, yet more simple and efficient than anything previously proposed and of which I am aware.

Additional flexibility of the system as shown in Figure 3 is afforded by the provision of means for selectively rendering any drive unit 7 inoperative without affecting the other units, such means specifically comprising the friction clutch instrumentalities 14, 15, with which each unit is preferably provided. By shifting the movable clutch part 14 away from the other part 15, the drive unit may be conveniently disconnected from the line shaft 3. By shifting the clutch part 14 in the opposite direction to reengage the clutch, the drive unit can be restored to operative condition to deliver power at the power take-off shaft 8.

Automatic lubrication can be readily adapted to the drive units 7, thus assuring long life of the movable parts, and the ruggedness of the units and the simplicity of their construction assures practically complete freedom from maintenance expense.

While the specific details have been herein shown and described, the invention is not confined thereto, as changes and alterations may be made without departing from the spirit thereof as defined by the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is—

1. A variable speed transmission of the class described, comprising, in combination, a base, a driving shaft rotatably mounted on said base, a yoke pivotally mounted on said base, means for adjusting the position of said yoke about its pivotal axis, a countershaft rotatably mounted on said yoke and operatively connected with said driving shaft, a second countershaft rotatably mounted on said base in spaced relation to the first countershaft, adjustable speed changing means operatively interconnecting said first and second countershafts, a third countershaft rotatably mounted on said base in parallel spaced relation to the second countershaft and operatively interconnected with the second countershaft, a power take-off shaft rotatably mounted on said base and disposed transversely to said second and third countershafts, and means operatively connecting said third countershaft to said power take-off shaft.

2. A variable speed transmission of the class described, comprising, in combination, a base, a driving shaft rotatably mounted on said base, a yoke pivotally mounted on said base, an adjustable tie bolt pivotally connected at one end to the yoke and pivotally connected at its opposite end to the base at one side of the pivotal axis of the yoke, a countershaft rotatably mounted on said yoke, means operatively connecting said countershaft with said driving shaft, a power take-off shaft rotatably mounted on said base, and means operatively connecting said countershaft with said power take-off shaft, said last named means including adjustable speed changing instrumentalities for varying the transmission ratio at will.

3. A variable speed transmission of the class described, comprising, in combination, a base, a driving shaft rotatably mounted on said base, a sprocket rotatably mounted on said driving shaft, clutch means also mounted on said driving shaft and shiftable to connect said sprocket to and disconnect said sprocket from said driving shaft at will, a countershaft rotatably mounted on said base and having a sprocket mounted thereon, a chain interconnecting said sprockets, a multiple sheave variable pitch pulley mounted on said countershaft, a second countershaft rotatably mounted on said base above said first countershaft and having a multiple sheave variable pitch pulley mounted thereon, a plurality of V-belts interconnecting said multiple sheave variable pitch pulleys, a power take-off shaft rotatably mounted on said base and disposed transversely to said countershafts, bevel gear and pinion means interposed between the second countershaft and the power take-off shaft and operatively connected thereto to establish driving relation therebetween, and means for adjusting the pitch of said variable pitch pulleys.

4. Apparatus as claimed in claim 3, wherein the variable pitch pulleys each comprise a plurality of relatively stationary sheave sections and another plurality of relatively movable sheave sections mounted for movement towards and away from the former so as to vary the space therebetween, the respective pluralities of sheave sections being rigidly connected together, and the movable sheave sections being movable as a unit towards and away from the other sections.

5. A variable speed transmission mechanism including in combination, a driving shaft, a sprocket wheel mounted on said driving shaft, a friction clutch for securing said sprocket wheel to the driving shaft, a counter-shaft, a sprocket wheel mounted on said counter-shaft, a chain for positively imparting rotation of the sprocket wheel on the driving shaft to the sprocket wheel on the counter-shaft, a multiple sheave variable pitch pulley mounted on said counter-shaft, a second counter-shaft, a power take-off shaft positively driven from said second counter-shaft, a multiple sheave variable pitch pulley mounted on said second counter-shaft, V-belts interconnecting said variable pitch pulleys, means for simultaneously adjusting said variable pitch pulleys for varying the speed transmitted from the driving shaft to the power take-off shaft, and means for shifting the first-named counter-shaft relative to the second-named counter-shaft for varying the tension on the belts so as to prevent slippage of said belts on the variable pitch pulleys.

6. A variable speed transmission mechanism including in combination, a supporting base, a driving shaft, a counter-shaft, means for positively imparting rotation of the driving shaft to said counter-shaft, bearings carried by said base for said counter-shaft, said counter-shaft being disposed so as to project at one end beyond the bearings, a multiple sheave variable pitch pulley mounted on the free end of said counter-shaft, a second counter-shaft, bearings supported by said base in which said second counter-shaft is mounted so as to project at one end thereof beyond said bearings, a multiple sheave variable pitch pulley mounted on the free end of said second counter-shaft, V-belts interconnecting said variable pitch pulleys, a power take-off shaft positively driven from said second counter-shaft, means for simultaneously adjusting said variable pitch pulleys for varying the speed transmitted from the driving shaft to the power take-off shaft, and means for shifting one of said counter-shafts relative to the other for varying the tension on the belts so as to prevent slippage of said belts on the variable pitch pulleys.

7. A variable speed transmission mechanism including in combination a driving shaft, a driving wheel on said driving shaft, a friction clutch for securing said driving wheel to said driivng shaft, a counter-shaft, a driven wheel mounted on said counter-shaft, means for positively imparting rotation of the driving wheel on the driving shaft to the driven wheel on the counter-shaft, a multiple sheave variable pitch pulley mounted on said counter-shaft, a second counter-shaft, a power take-off means positively driven from said second counter-shaft, a multiple sheave variable pitch pulley mounted on said second counter-shaft, belts interconnecting said variable pitch pulleys, means for simultaneously adjusting said variable pitch pulleys for varying the speed transmitted from the driving shaft to the power take-off means, and means for shifting the first counter-shaft relative to the second counter-shaft for varying the tension on the belts so as to prevent slippage of said belts on said variable pitch pulleys.

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