May 29, 1945. P. L. HILTZ 2,376,917

FLUID PROPORTIONING APPARATUS

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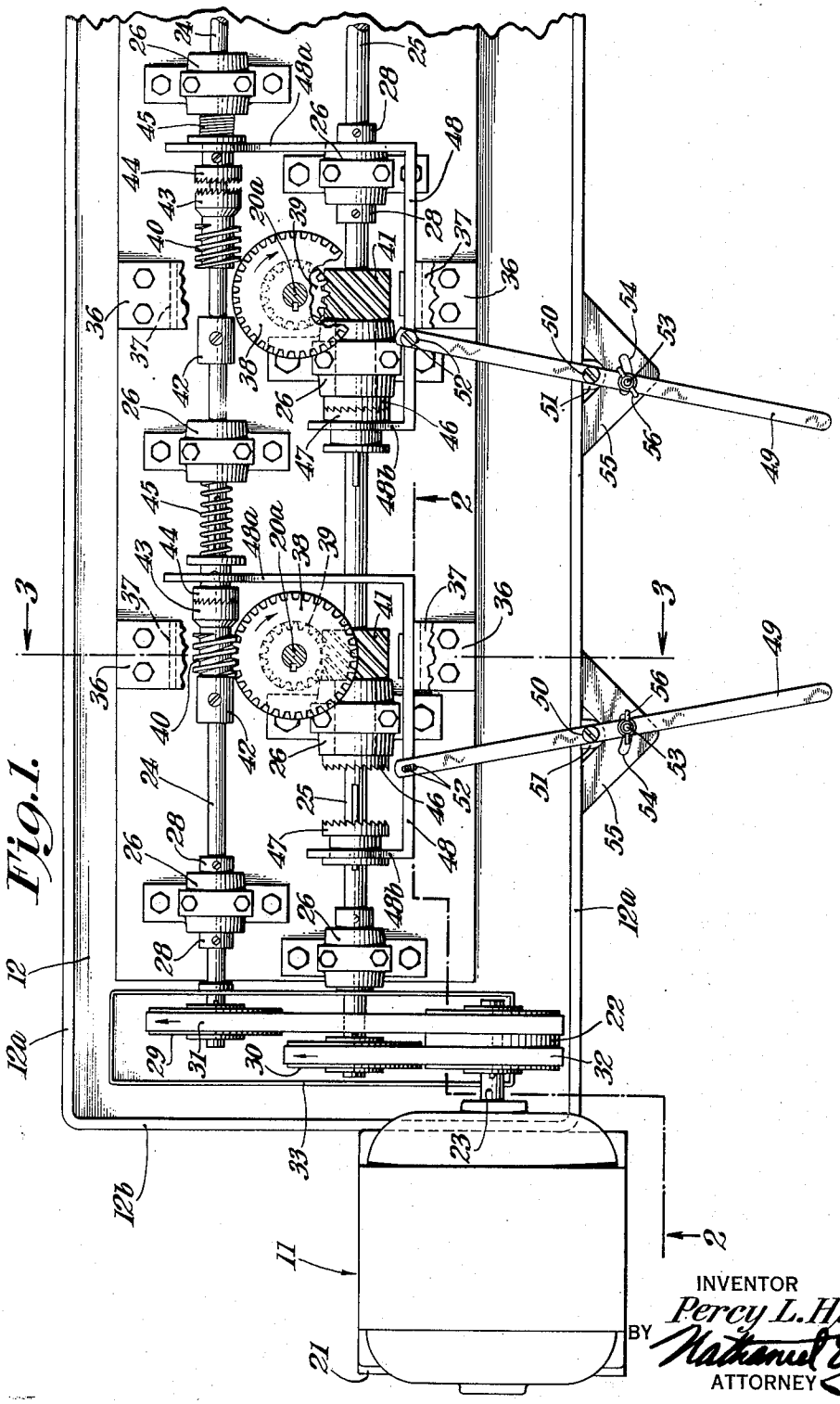


Fig. 1.

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Fig. 2.

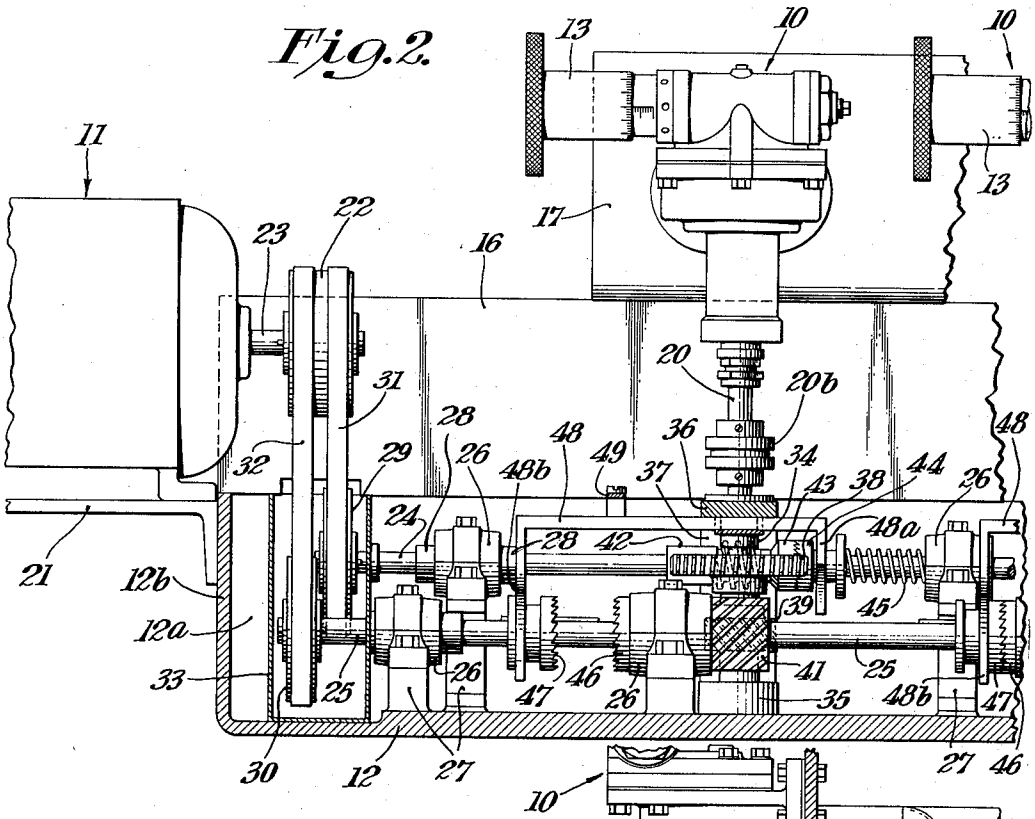
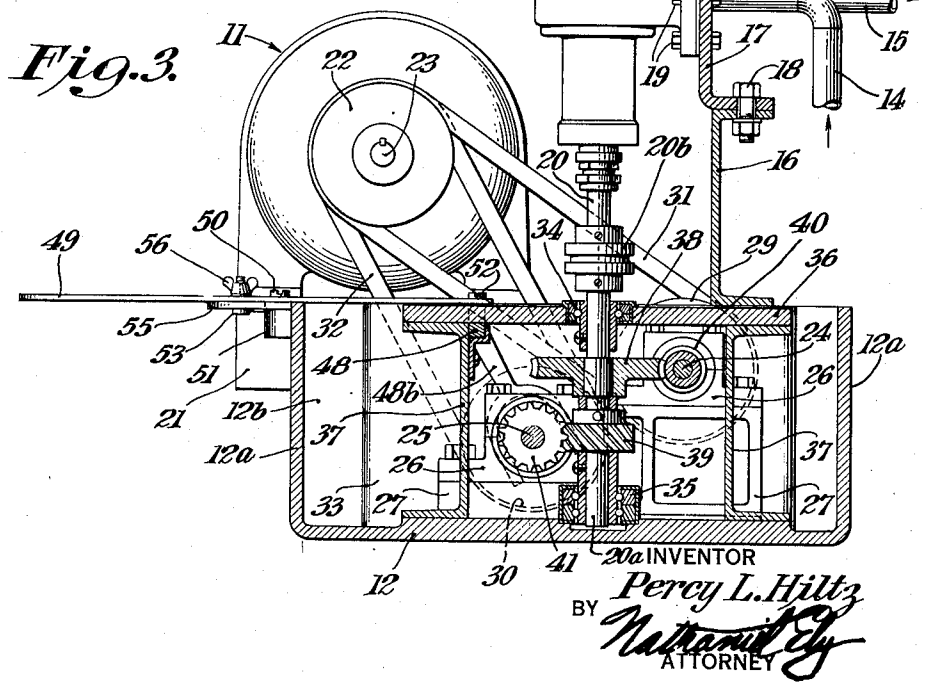


Fig. 3.



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FLUID PROPORTIONING APPARATUS

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10 Claims. (Cl. 74—425.5)

This invention relates to improvements in fluid proportioning apparatus of a type employed, for example, in a certain process of lubricating oil manufacture. In said process a number of different oil stocks are delivered in proper proportions to a blending device which thoroughly mixes or homogenizes the delivered oils. It is frequently required, in order to obtain a desired blend, to mix proportioned quantities of as many as four or five principal oil streams of different lubricating oil stocks and one or more minor streams of additives such as pour point depressants, or the like. The quantities of these streams must be controlled accurately in order to obtain the desired blended product.

A form of proportioning apparatus commonly employed in such an oil-blending process includes a number of positive displacement rotary pumps. Each of these pumps delivers one of the said component oil streams to the homogenizer and each pump is provided with an adjustable device for regulating the pump delivery per cycle of operation. The power equipment for operating the pumps includes a battery of electric motors, one for each pump, individual switches for the motors, individual transmission connections between the motors and the respective pumps, and connections between the motors to synchronize their operation. Such power equipment is quite expensive owing to the large number of motors employed and their connections.

An important object of the present invention is to simplify and materially reduce the cost of the power plant of a fluid proportioning apparatus by the provision of satisfactory means enabling the operation of the pumps in a required manner from a single motor.

A more specific object of the invention is to provide for operation of the pumps of a fluid proportioning apparatus from a single motor by the provision of an improved power transmission mechanism between the motor and pumps embodying satisfactory means for driving the pumps at required different relative speeds.

A still more specific object of the invention is to provide, in a transmission mechanism for the aforesaid purpose, means for conveniently varying the rate of operation of the pumps selectively and for conveniently disconnecting the drive of any selected one of the pumps without disturbing the power connections of the other pumps.

Another object of the invention is to provide a transmission mechanism for the aforesaid purpose, designed for operation with minimum care and maintenance cost, and designed also for quiet operation.

Further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawings illustrating a satisfactory form of the invention.

While the invention is described herein as employed in connection with a process for making a blended lubricating oil, it is well suited for use in the making of many other blended fluid products.

In the drawings,

Fig. 1 is a sectional top plan view of the improved power plant of the proportioning apparatus, with parts broken away;

Fig. 2 is a vertical section approximately on the line 2—2 of Fig. 1; and

Fig. 3 is a vertical section approximately on the line 3—3 of Fig. 1.

As shown in the drawings, the various parts of the improved proportioning apparatus are arranged and supported to form a unitary structure. The apparatus includes the pumps 10, the electric motor 11 and the power transmission apparatus, all supported upon a base 12.

In the present instance each pump is of a rotary, positive displacement type, such as that generally illustrated in the patent to Cornell, No. 2,109,331, issued February 22, 1938, and that of a type commonly made by the Yale and Towne Manufacturing Company. The pump is provided with a manually adjustable device 13 for regulating the displacement of the pump per cycle of operation. This device is provided with micrometer scales to indicate accurately its degree of adjustment. Since the device is part of a commercial form of the pump it is considered unnecessary to illustrate it in detail. One of the pumps is fully shown in elevation in the drawings, and a portion of another, adjacent pump is indicated. It will be understood that any desired number of the pumps may be included in the apparatus. An oil supply pipe 14 leads to the pump inlet from an oil source, not shown, and a discharge pipe 15 leads from the pump outlet for delivery to a blending device whose illustration is also omitted.

The base 12 is preferably a flat, rectangular casting formed with upstanding side and end walls 12*a* and 12*b*, respectively, to form an oil bath enclosure. Parts of the power transmission mechanism, to be described hereinafter, are located in this enclosure. A channel beam 16 extends longitudinally of the base and is rigidly secured by any suitable means upon the upper edges of

the base end walls 12b. Another beam 17 is bolted, as at 18, to the upper flange of the beam 16 and forms a support for the pumps which are bolted to one face thereof, as at 19. The pumps are arranged in a straight horizontal series along the beam 17, and each pump has a vertical operating shaft 20 extending downwardly therefrom.

A shelf 21 is rigidly secured to the outer side of one of the end walls 12b of the base and provides a support for the electric motor 11. A double-grooved pulley 22 is keyed to the shaft 23 of the motor and forms part of the power transmission mechanism between the motor and the pumps.

The transmission mechanism includes a pair of horizontal, parallel shafts 24 and 25 extending longitudinally within the base enclosure. These shafts are rotatably supported in bearings 26 bolted to pedestals 27 rigidly borne by the bottom of the base. Shaft 24 is supported at a higher level than shaft 25. Collars 28 secured to said shafts engage opposite ends of certain of the bearings to hold the shafts against endwise displacement. Grooved pulleys 29 and 30 are keyed to the shafts 24 and 25, respectively, and the pulley 22 upon the motor shaft is in driving connection with the pulleys 29 and 30, through belts 31 and 32, respectively. Preferably, these belts are of the molded V form to prevent slippage on the pulleys. A box-like casing 33, open at its upper side, is secured to the bottom of the base. This casing forms an enclosure for the pulleys 29 and 30 and excludes the oil bath from the belting.

A vertical shaft section 20a is releasably coupled, as at 20b, to the lower end of each pump shaft 20. Each shaft section 20a is rotatably supported in upper and lower ball bearings 34 and 35, respectively. Bearing 35 is supported in a recess in the bottom of the base, and bearing 34 is supported by a cross bar 36 bolted to pedestals 37 borne by the base. Each shaft section 20a has keyed to it a worm-wheel 38 and a spiral gear 39 spaced beneath said worm-wheel. Shaft 24 bears worms 40 spaced therealong to mesh with the worm-wheels 38 respectively, and shaft 25 bears spiral gears 41 spaced therealong and in mesh with the gears 39 respectively. Each worm is both rotatable and axially slidable upon shaft 24, for a purpose which will be explained hereinafter. Its sliding movement in one direction is limited by a collar 42 secured to the shaft by a set screw. Each gear 41 is rotatable upon the shaft 25 but secured against axial movement thereon.

Clutch means are provided for operatively connecting the worms 40 and the gears 41 selectively to the shafts 24 and 25, respectively. Each worm has an extended hub bearing a toothed clutch element 43. In opposition to said clutch element there is a companion, toothed clutch 44 keyed to shaft 24 and axially slidable thereon. A light compression spring 45 encircling the shaft bears against the element 44 and constantly urges the latter toward the clutch element 43. Each gear 41 has an extended hub rotatably fitted in an adjacent one of the bearings 26 for the shaft 25 and bearing a toothed clutch element 46. By engagement of the gear with one end of said bearing and by engagement of the inner face of said clutch element with the opposite end of the bearing the gear is held against axial displacement. In opposition to the clutch element 46 there is a clutch element 47 keyed to shaft 25 and axially slidable thereon. Each pair of the clutch elements 44 and 47, associated with the gearing for driving one of the pump shafts 20, is shiftable by a yoke 48 mounted upon one of the pedestals for sliding lengthwise of the shaft 25. Said yoke has a long arm 48a with a fork engaging in a peripheral groove in the clutch element 44, and a short arm 48b with a fork engaging in a peripheral groove in the clutch element 47. A clutch-operating lever 49 is fulcrumed intermediate its ends, as at 50, upon an ear 51 formed upon the outer side of one of the base walls 12a. At its inner end said lever has a pin-and-slot operative connection 52 with the said yoke. At the opposite side of its fulcrum the lever bears a clamping bolt 53 whose shank extends through an arcuate slot 54 in a bracket 55 borne by said base wall. The bolt has a winged nut 56 thereon for clamping the lever in different adjusted positions.

By rocking of any one of the levers 49 in one direction to the proper degree, the connected yoke 48 is shifted to move the associated clutch element 44 out of engagement with the worm-clutch element 43, against the resistance of spring 45, and move the associated clutch element 47 into engagement with the opposed clutch element 46 of the spiral gear 41. Clutch element 44 is reengaged with the worm-clutch element 43 and clutch element 47 is disengaged from the spiral gear clutch element 46 by rocking the lever in the opposite direction to the proper degree. The design and arrangement of the clutch elements and their operating yoke are such that, upon movement of the lever to unclutch the worm from the shaft 24 and clutch the spiral gear to shaft 25, clutch element 44 will first be fully disengaged from clutch element 43 of the worm and then clutch element 47 must be moved a material distance by continued movement of the lever before it engages the clutch element of the spiral gear. This provides for full unclutching at one point before clutching occurs at the other point and also enables both the worm and the spiral gear to be unclutched from their respective shafts by swinging the lever to an intermediate position. Thereby both of the driving connections between the motor and the respective pump may be disconnected. The lever may be clamped in this position to hold the pump out of service.

When one of the worm-clutch elements 43 is engaged by its companion clutch element 44 and the worm is in mesh with its companion worm-wheel and in engagement with the stop collar 28 a low-speed driving connection between the motor 11 and a selected one of the pumps is formed by the motor pulley 22, the belt 31, the shaft pulley 29, shaft 24, clutch elements 43 and 34, worm 40, worm-wheel 38 and shaft 20a. When it is required to drive the pump at a higher speed the worm is unclutched from its shaft 24 by movement of the lever 49 and, by continued movement of the lever, spiral gear 41 is clutched to its shaft 25. There is then a high-speed driving connection between the motor and the pump through pulley 22, belt 32, pulley 30, shaft 25, clutch elements 46 and 47, spiral gears 41 and 39 and shaft 20a. As previously mentioned herein, the worm 40 is axially shiftable upon its shaft. That is to enable demeshing of the worm from the worm-wheel so that it will not obstruct operation of the wheel. As soon as the said high-speed driving connection is established and rotation of the shaft 20a by the spiral gearing 41 and 39 commences, the consequent rotation of the worm-wheel, keyed to said shaft, will cause it to thrust the worm axially away from the stop collar 42 to a non-

obstructing position, for unimpeded rotation of the worm-wheel. When the lever is operated for shifting back to low gear, spiral gear 41 will first be unclutched from shaft 25 to break the high-speed driving connection, and then advance of the clutch element 44 will cause it to engage clutch element 43 and force the worm back into mesh with the worm-wheel. This movement of the clutch element 44 and the worm is caused by the spring 45 when the latter is permitted to expand by movement of the yoke 48. There is provision for lost-motion between the fork on yoke arm 48a and the clutch element 44, enabling the spring to advance said clutch element and the worm relatively to the fork for gentle engagement of the worm with the worm-wheel to prevent tooth mutilation.

It will be seen that the invention provides for driving of an entire battery of the proportioning pumps from a single motor and that it also provides for convenient regulation of the delivery of the individual pumps to the blending apparatus in order that a product of desired blend may be obtained. By mere manipulation of an appropriate one of the levers 49, the speed of any selected one of the pumps may be conveniently changed for delivery of the required volume of the particular stock supplied through that pump to the blending device. Having appropriately adjusted the speed of the pump, its delivery may be accurately regulated by adjustment of its micrometer device 13 which regulates the displacement of the pump per cycle of operation. The invention also provides for convenient cutting of one or more of the pumps into or out of service, according to the number of constituents required for a given blended product, by mere selective manipulation of the levers 49.

Other advantages are obtained by the location of the power transmission mechanism below the level of the pumps, the particular design of the gearing and the location of the motor with respect to the shafting and gearing. Location of the transmission mechanism beneath the pumps renders it practicable to use an oil bath, and the worm gearing and spiral gearing running in the oil bath are efficient and durable, require minimum maintenance care and are quiet in operation. In proportioning apparatus employing a battery of motors for the pumps, spur gearing is employed in the transmission connections between the motors and pumps. Such gearing is objectionably noisy. Furthermore, space limitations require that the spur gearing be made rather delicate so that the gearing lacks durability and requires frequent replacement. Space limitations also render it impracticable to use an oil bath for the spur gearing. These disadvantages are overcome by applicant's invention. In addition, the design of the power transmission mechanism enables the mounting of the motor in a position clear of the rest of the apparatus so that a motor of different size or design can be readily substituted when required. For example, it is often required that a vapor-proof motor be employed in such service to avoid fire hazard. A vapor-proof motor is jacketed and consequently much more bulky than an ordinary motor. Since there are no space limitations with respect to the mounting of the motor, the present apparatus will readily accommodate such a motor. It is also possible to drive the pulley 22 from a power source quite remote from the apparatus. Driving connections other than those shown between the drive shaft 23 and the transmission shafts 24 and 25 may be employed if desired. For examples, chain drives or gear drives may be substituted for the pulleys and belting.

Proportioning apparatus for lubricating oils commonly have provision for driving the pumps which deliver the major ingredients of a blend at the same speed as the motors driving said pumps, and have provision for driving the pumps which deliver the minor ingredients at one-tenth the speed of their motors. The transmission mechanism of the present invention provides for such desired differential speed driving of the pumps. The speed ratio of the gearing 41—39 is one-to-one and the speed ratio between each worm 40 and its worm-wheel 38 is preferably one-to-ten. Variation in the pump delivery at a given speed, in accordance with the requirements of a particular blend, is obtained by adjusting the micrometer device 13 of the pump. The clutch means 43—44 and 46—47 are of the toothed type so that when operative they form positive-drive couplings between the transmission shafts and the pump-operating shafts and ensure positive driving of the latter at the selected speeds. While the transmission mechanism is described and shown as employed in an oil-proportioning apparatus it can be employed to advantage in connection with other proportioning apparatus having rotary operating elements to be driven at different relative speeds.

While I have disclosed a satisfactory form of my invention it will be understood that it is possible to modify details of the structure disclosed without departing from the invention as defined in the appended claims.

I claim:

1. In a power transmission mechanism, a driven shaft, a worm-wheel and a gear upon said shaft and both secured to rotate with the shaft, a worm to mesh with said worm-wheel for low-speed driving of said shaft, a gear to mesh with said first gear for high-speed driving of said shaft, means for driving said worm and said second gear, clutch means operable to operatively connect said driving means to said worm or to said second gear selectively, and means rendering said worm shiftable axially out of mesh with the worm-wheel by rotation of the latter by said gears and shaft.

2. In a power transmission mechanism, a pair of rotatable follower elements, an interconnection between said elements for rotation thereof in unison, one of said follower elements being a worm-wheel, a worm to mesh with said worm-wheel to drive the latter, means for driving said worm and the other of said follower elements, clutch means operable to operatively connect said driving means to said worm or to said other follower element selectively, and means rendering said worm shiftable out of mesh with the worm-wheel by rotation of the latter through said other follower element and said interconnection.

3. In a power transmission mechanism, a pair of transmission shafts, means for driving said shafts simultaneously, a driven shaft, a worm-wheel and a gear upon said driven shaft and both secured to rotate with the shaft, a worm to mesh with said worm-wheel and rotatably and slidably mounted on one of said transmission shafts, a gear rotatably mounted on the other of said transmission shafts and meshing with said gear on the driven shaft, a clutch device operable to operatively connect said worm to its shaft, and a clutch device operable to operatively connect the second-mentioned gear to its shaft, said

worm being axially shiftable by said worm-wheel out of mesh therewith when the worm-wheel is driven by said gears.

4. In a power transmission mechanism, a pair of transmission shafts, means for driving said shafts simultaneously, a driven shaft, a worm-wheel and a gear upon said driven shaft and both secured to rotate with the shaft, a worm to mesh with said worm-wheel and rotatably and slidably mounted on one of said transmission shafts, a gear rotatably mounted on the other transmission shaft and meshing with said gear on the driven shaft, a clutch device operable to operatively connect said worm to its shaft, a clutch device operable to operatively connect the second-mentioned gear to its shaft, and a common operating device for said clutch devices, said worm being axially shiftable by said worm-wheel out of mesh therewith when the worm-wheel is driven by said gears.

5. In a power transmission mechanism, a pair of transmission shafts mounted in parallel relation to each other, means for driving said shafts simultaneously, a driven shaft mounted to extend transversely of said transmission shafts in a plane therebetween, a worm-wheel and a spiral gear on said driven shaft and both secured to rotate therewith, a worm to mesh with said worm-wheel and rotatably and slidably mounted on one of said transmission shafts, a spiral gear rotatably mounted on the other of said transmission shafts and meshing with said gear on the driven shaft, a clutch device operable to operatively connect said worm to its shaft, and a clutch device operable to operatively connect the second-mentioned gear to its shaft, said worm being axially shiftable by said worm-wheel out of mesh therewith when the worm-wheel is driven by said spiral gears.

6. In a transmission mechanism, a pair of transmission shafts, means for driving said shafts simultaneously, a driven shaft, a worm-wheel and a gear upon said driven shaft and secured to rotate with the shaft, a worm to mesh with said worm-wheel and rotatably and slidably mounted on one of said transmission shafts, a gear rotatably mounted on the other of said transmission shafts, a clutch device operable to operatively connect said worm to its shaft, a clutch device operable to operatively connect the second-mentioned gear to its shaft, and a common operating device for said worm-clutching device and said gear-clutching device, said operating device being operable in one direction for moving said clutch devices to first unclutch the worm from its shaft and subsequently clutch the second-mentioned gear to its shaft and operable in another direction to reverse said clutching and unclutching and operable also to shift both clutch devices to release position to render said driven shaft idle, said worm being shiftable axially by said worm-wheel out of mesh therewith when the worm-wheel is driven by said gears.

7. In a power transmission mechanism, a driven shaft, a worm-wheel and a gear upon said shaft and both secured to rotate with the shaft, a worm to mesh with said worm-wheel to form a low-speed driving connection for the shaft, a gear to mesh with said gear on said shaft to form a high-speed driving connection for the shaft, means for driving said worm and the second-mentioned gear, clutch means operable to operatively connect said driving means to said worm or to the second-mentioned gear selectively, means rendering said worm shiftable out of mesh with said worm-wheel by rotation of the latter by said gears and shaft, and spring means to shift the worm into mesh with the worm-wheel.

8. In a power transmission mechanism, a pair of transmission shafts, means for driving said shafts simultaneously, a follower shaft, a worm-wheel and a gear on said follower shaft and secured to rotate therewith, a worm to mesh with said worm-wheel and mounted for rotation and for axial sliding on one of said transmission shafts, a gear rotatably mounted on the other of said transmission shafts, a clutch device to operatively connect said worm to its shaft, a clutch device to operatively connect the second-mentioned gear to its shaft, said worm being shiftable axially by said worm-wheel out of mesh therewith when the worm-wheel is driven by said gears, and a compression spring encircling said worm-shaft to move the worm into engagement with said worm-wheel in response to operation of the first-mentioned clutch device.

9. In a power transmission mechanism, a vertical driven shaft, a worm-wheel and a gear upon said shaft and secured to rotate with the shaft, a worm to mesh with said worm-wheel for low-speed driving of said shaft, a gear to mesh with said first gear for high-speed driving of said shaft, means for driving said worm and said second gear, clutch means operable to operatively connect said driving means selectively to said worm or to said second gear, means rendering said worm shiftable out of mesh with the worm-wheel by rotation of the latter by said gears and shaft, and a casing enclosing said worm-wheel, worm and gears and forming an oil bath enclosure therefor, the upper end portion of said shaft protruding above said casing for operative connection of the shaft to a device to be driven thereby.

10. In a power transmission mechanism, a pair of power transmission shafts mounted in horizontal arrangement and in parallel relation to each other at opposite sides of a vertical plane, means for driving said shafts simultaneously, a driven shaft extending between said shafts and mounted in a vertical position, means for operatively connecting said driven shaft at the upper end thereof to a device to be driven, a low-speed driving connection between one of said transmission shafts and said driven shaft, a high-speed driving connection between the other of said transmission shafts and said driven shaft, means operable to render said driving connections operative selectively to alter the speed of said driven shaft, and a casing enclosing said driving connections and forming an oil bath enclosure for said driving connections, the upper end portion of said driven shaft protruding above said enclosure for operative connection of the shaft to a device to be driven thereby.

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