

Sept. 17, 1940.

E. F. TAFEL

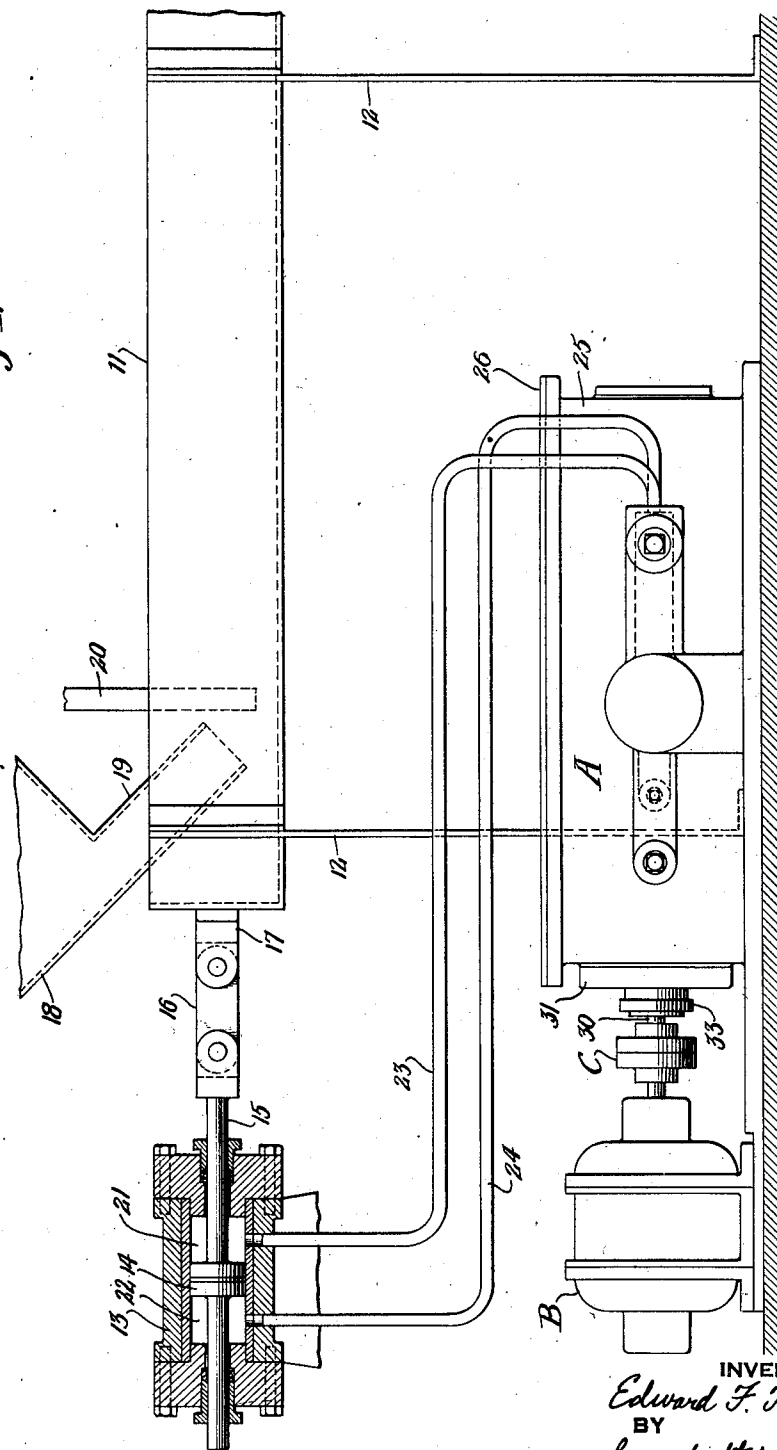
2,214,755

DRIVING MECHANISM FOR RECIPROCATING CONVEYERS

Filed April 13, 1937

7 Sheets-Sheet 1

Fig. 1.



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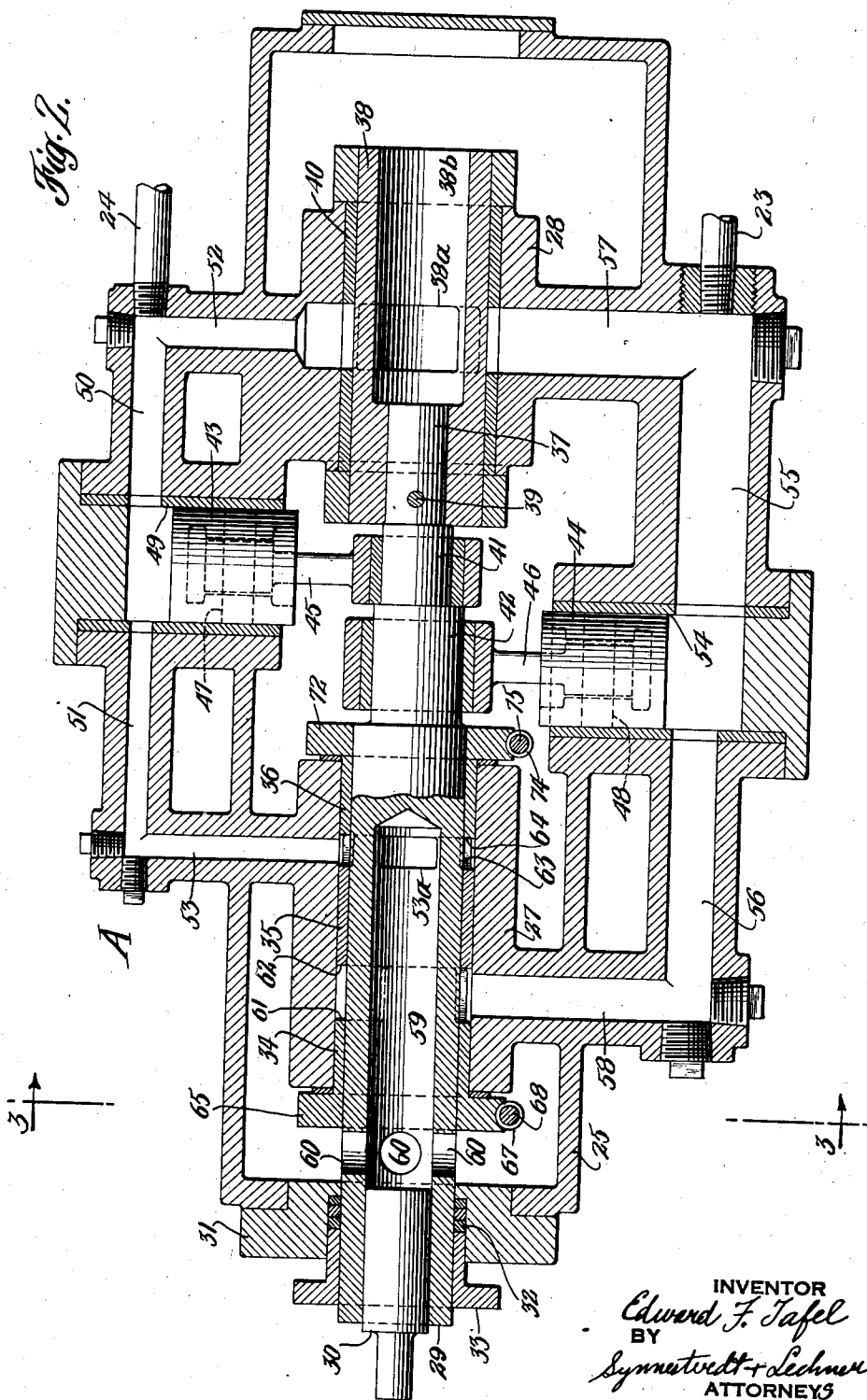
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7 Sheets-Sheet 2



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7 Sheets-Sheet 3

Fig. 3.

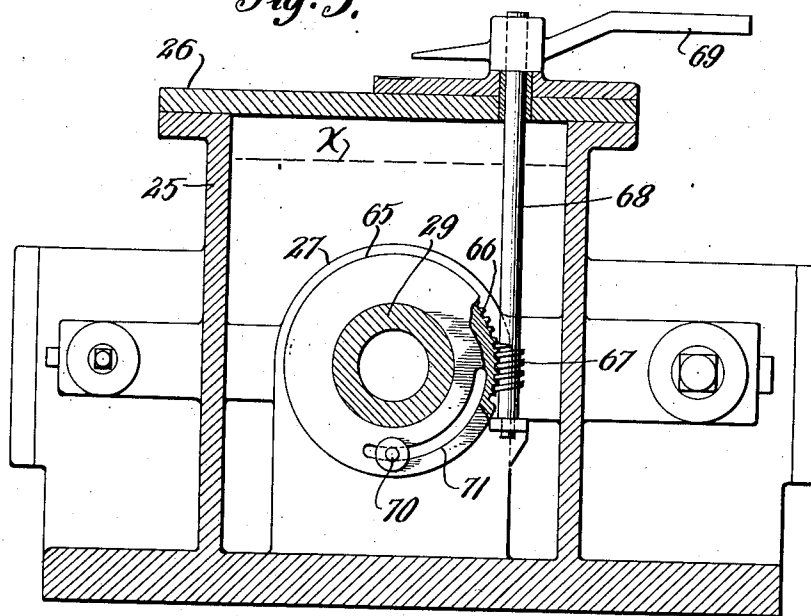
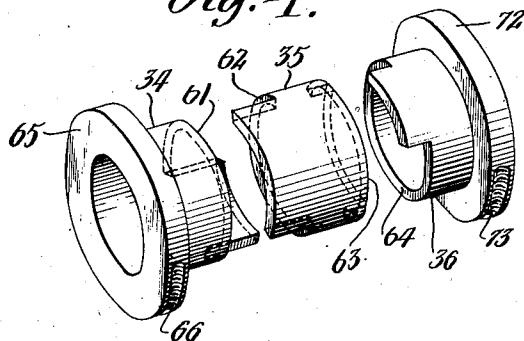


Fig. 4.



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7 Sheets-Sheet 4

Fig. 5.

**START OF LOW SPEED
COMPRESSION STROKE**

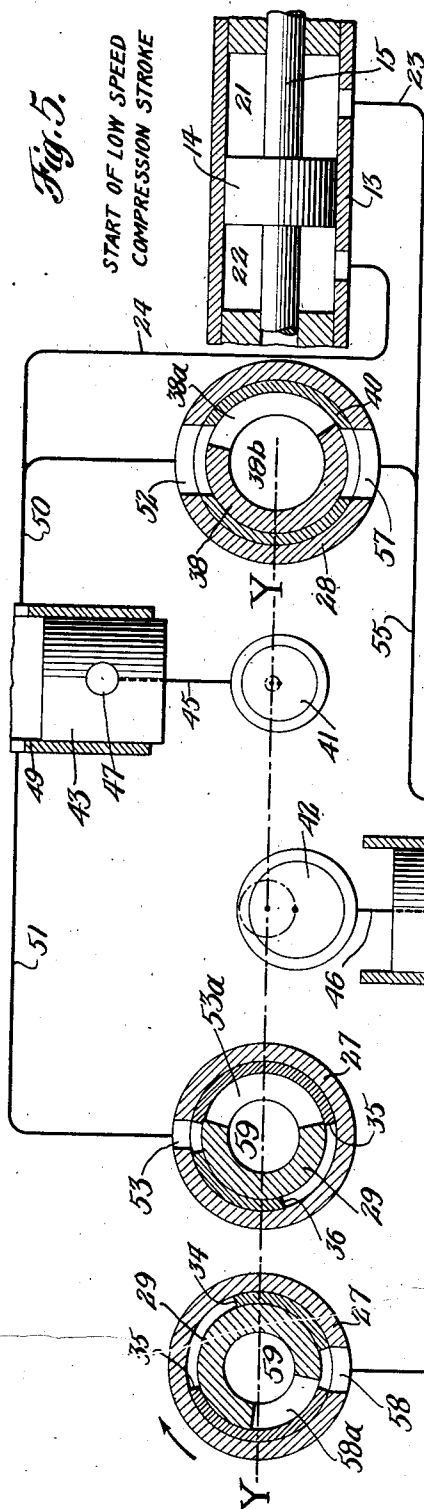
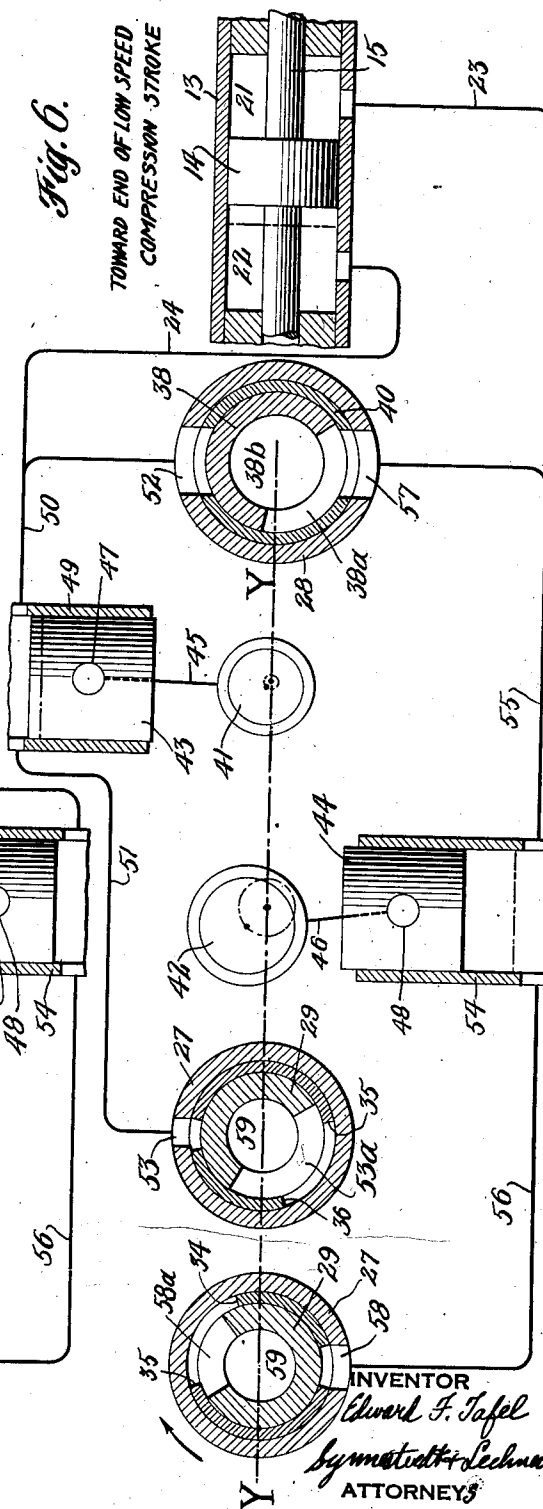


Fig. 6.

**TOWARD END OF LOW SPEED
COMPRESSION STROKE**



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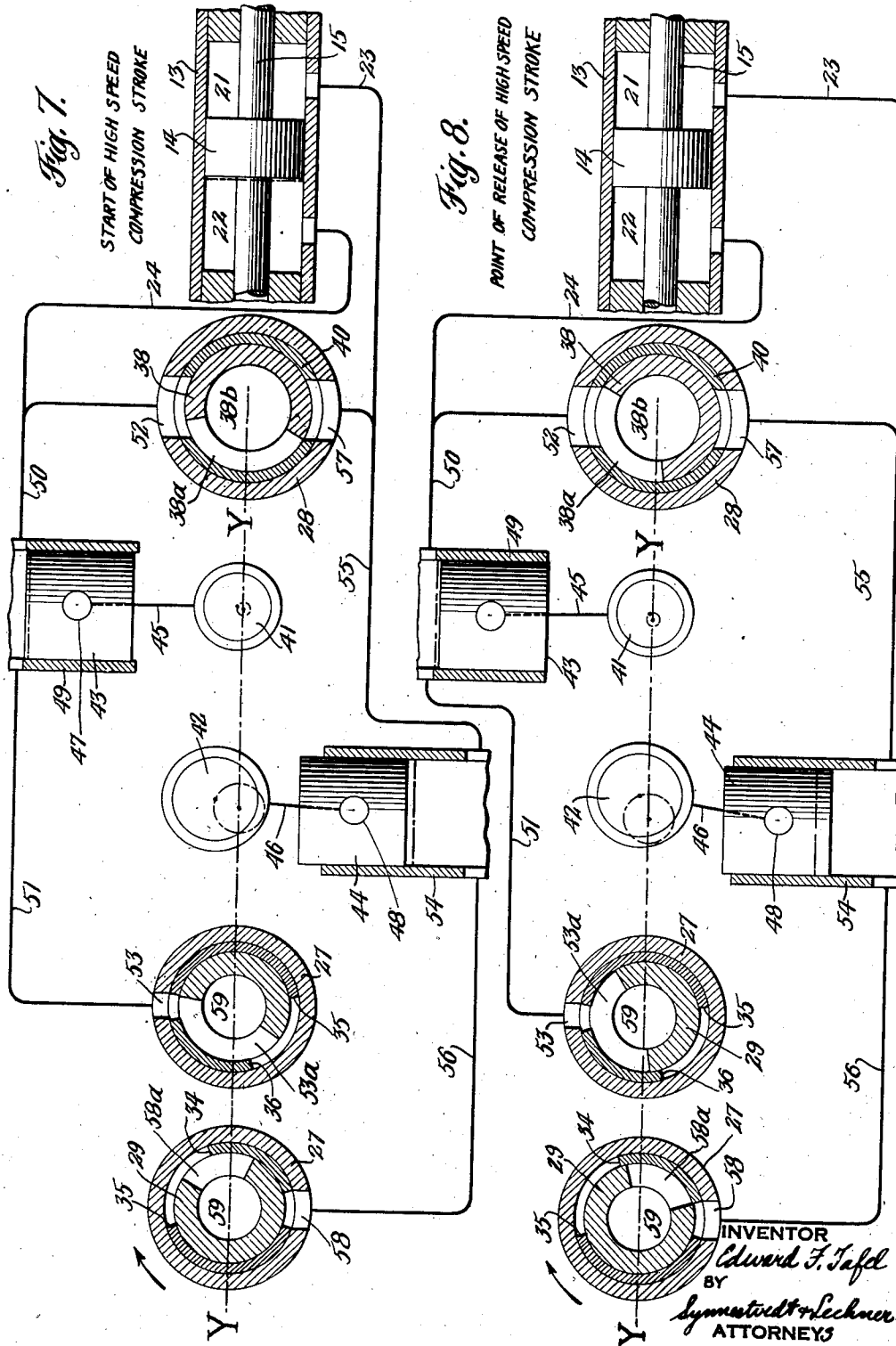
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DRIVING MECHANISM FOR RECIPROCATING CONVEYERS

Filed April 13, 1937

7 Sheets-Sheet 5



Sept. 17, 1940.

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2,214,755

DRIVING MECHANISM FOR RECIPROCATING CONVEYERS

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7 Sheets-Sheet 6

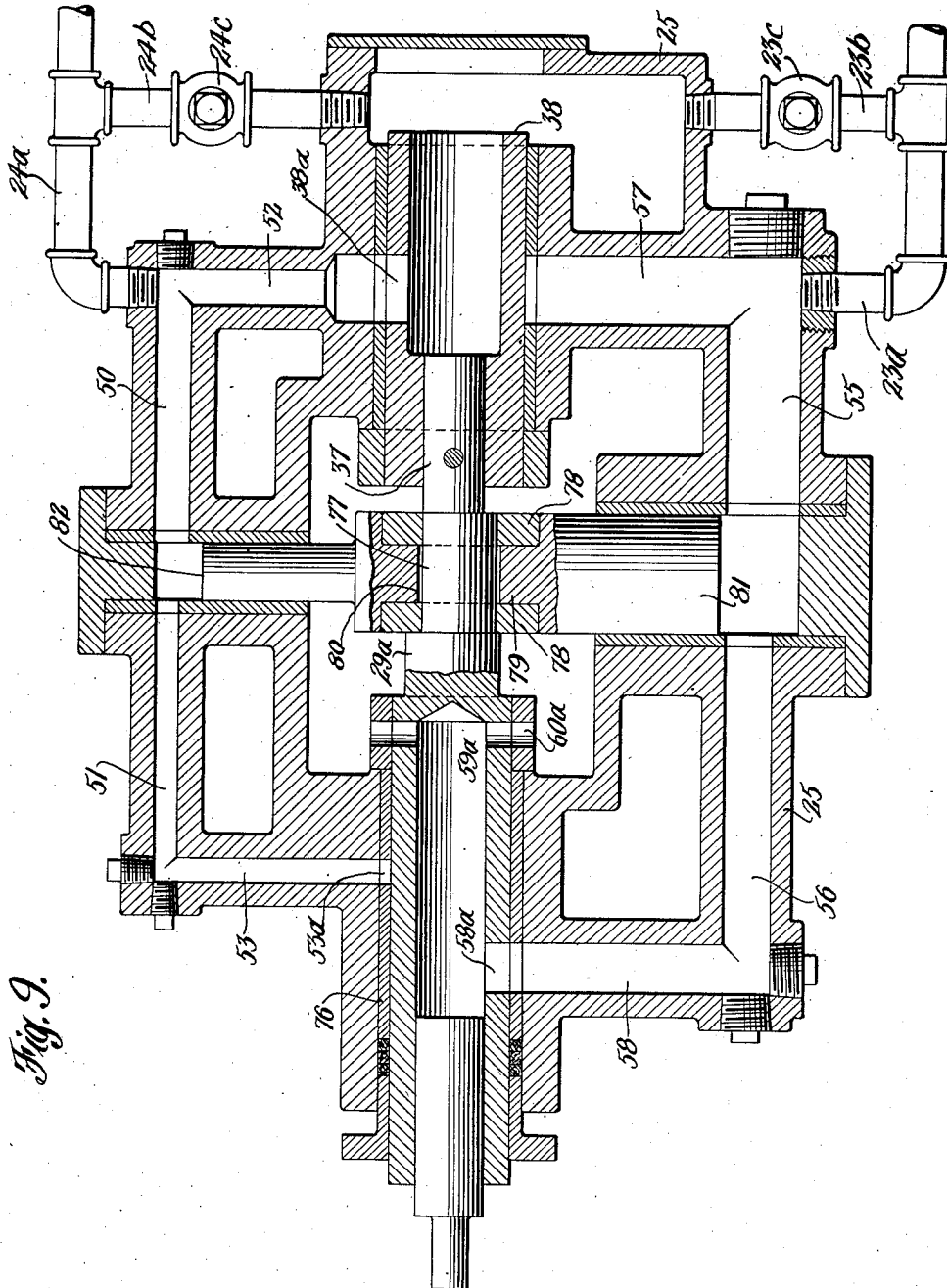


Fig. 9.

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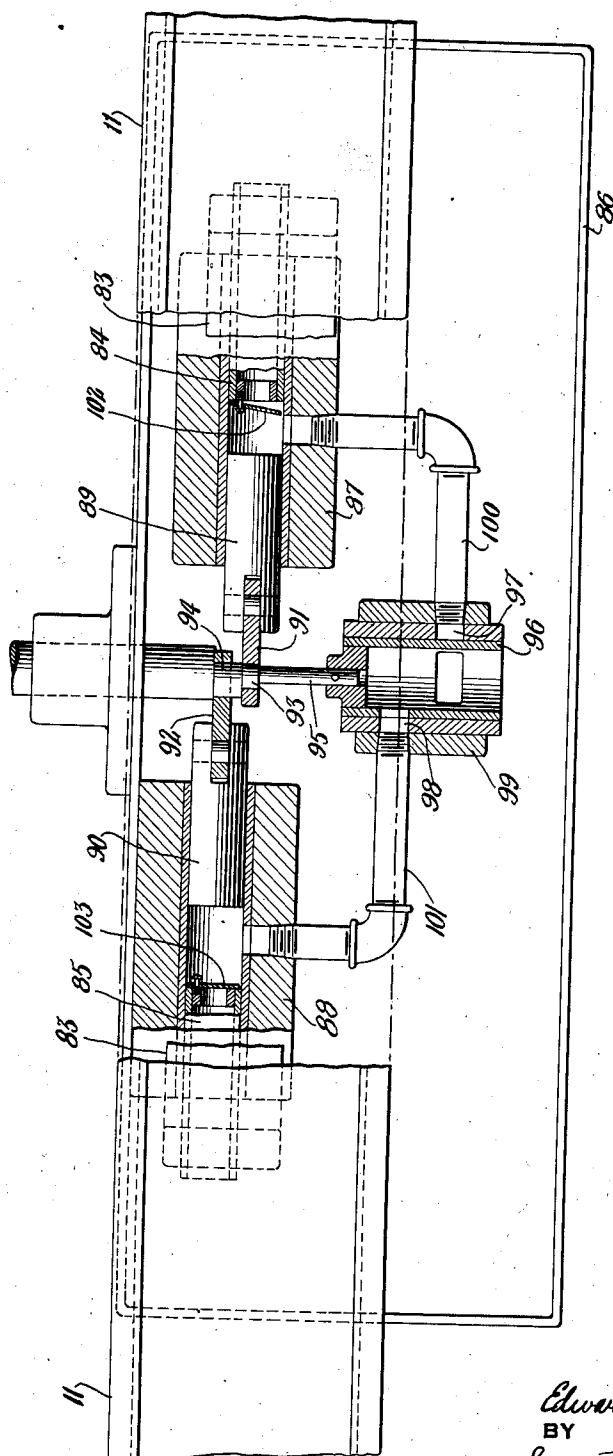
2,214,755

DRIVING MECHANISM FOR RECIPROCATING CONVEYERS

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7 Sheets-Sheet 7

Fig. 10.



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UNITED STATES PATENT OFFICE

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DRIVING MECHANISM FOR RECIPROCAT-
ING CONVEYERS

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Application April 13, 1937, Serial No. 136,556

23 Claims. (Cl. 198—220)

This invention relates to conveyers, and is more particularly concerned with a conveyer of the vibrating type, especially a conveyer in which the trough or equivalent member is vibrated or reciprocated with a very short but rapid stroke. Still further, the invention has particular reference to a mechanism adapted to impart to the conveyer trough a relatively fast movement in one direction of reciprocation as compared with the movement in the other direction.

In conveyers reciprocated in this way (an example appearing in my prior Patent No. 1,926,659, issued September 12, 1933) it is preferable to employ reciprocating movement upwards of about 500 or 600 cycles per minute. The relatively low speed stroke causes the material to move with the conveyer trough and the relatively high speed stroke "slips" the conveyer under the material in the reverse direction.

Generally stated, the invention has in view the provision of an improved conveyer mechanism of this type, especially as to the driving and controlling devices employed.

It is an object of the invention to make possible reciprocation of the conveyer trough at extremely high rates, for example 1500 to 2000 reciprocations per minute, this being of substantial advantage in eliminating power losses necessarily encountered with low speed long stroke reciprocating conveyers, which power losses arise by virtue of the fact that at each stroke the inertia of the mass of material being moved must be overcome. In contrast, the improved high speed short stroke type of movement maintains the materials handled in constant motion. As is well known, the power required to maintain any mass in motion is much less than that consumed in acceleration thereof.

Referring to the objects of the invention more specifically, it is first noted that the invention provides a hydraulic driving mechanism capable of operation at high rates with a minimum of wear and further with a minimum number of parts subject to wear.

A further and important object of the invention is the provision of control means for the hydraulic driving mechanism providing for variation of the length of both the high speed and the low speed strokes. In accordance with the invention, the variation provided for may extend from zero stroke to the maximum of which any particular unit is capable.

In addition to the above, the invention provides for infinite variation between the limits of the range covered, i. e., the adjustment is not of

"step-by-step" character, but may be set at any desired value.

In accordance with another aspect of the invention, the driving mechanism is arranged as a compact unit, which unit may be mounted at a point somewhat removed from the conveyer trough to be actuated thereby, it being necessary only to provide a few fluid pressure connections between the unit and a fluid pressure responsive device immediately associated with the conveyer trough. Thus the invention provides great flexibility in mounting arrangements and also permits alternative or simultaneous coupling of more than one conveyer trough with a single driving unit.

The invention further contemplates employment of oil as the actuating medium or liquid, and the several working parts, even including shaft bearings and the like, are arranged to run or operate in a bath of oil serving as a source of supply for the system.

How the foregoing objects and advantages, together with others which will occur to those skilled in the art, are attained, will be more apparent from a consideration of the following description referring to the accompanying drawings, in which—

Figure 1 is a side elevational view of a portion of a conveyer trough and various mechanisms and devices of the present invention associated therewith;

Figure 2 is a horizontal sectional view of one form of the hydraulic driving unit;

Figure 3 is a vertical sectional view taken substantially as indicated by the section line 3—3 on Figure 2;

Figure 4 is a perspective view of certain valve bushings employed in the unit shown in Figure 2;

Figures 5, 6, 7 and 8 are diagrams of valve and other parts shown in Figure 2, illustrating the relative positions of various parts at different points in the cycle of operation of the mechanism;

Figure 9 is a view similar to Figure 2 but illustrating a modified form of driving unit; and

Figure 10 is a sectional view of a second modified construction.

Referring first to Figure 1, a conveyer trough is shown at 11, this trough being supported by up-rights 12 having sufficient inherent rigidity to give adequate support to the trough and the material flowing therein, but of sufficient flexibility to permit the desired short stroke and rapid reciprocation.

The operating cylinder 13 for the trough may be rigidly mounted on any convenient fixed support, and the piston 14 is coupled by means of

the piston stem 15 and link 16 with a fitting 17 carried directly on the trough 11. By way of illustrating the operation, I have further shown a feed hopper 18 having a discharge spout 19 delivering the material to be conveyed to the trough 11. The trough may, of course, be employed to handle a wide variety of lump, granular or even substantially pulverized materials. Adjacent to the discharge spout 19 I prefer to employ a gate 20 which is vertically adjustable and which serves to control the amount or depth of material fed to the trough. This gate is desirably positioned very close to the discharge opening of the discharge spout 19. Because of the high speed vibration or reciprocation of the trough, I have found this type of gate control to be highly effective in controlling the depth of material fed.

The piston 14 in operating cylinder 13 is driven by a hydraulic unit indicated generally by the letter A, this unit in turn being actuated by a driving motor B through the intermediation of a flexible coupling or aligning device such as shown at C. The unit A is coupled with the cylinder 13 by fluid pressure connections referred to more fully hereinafter.

Referring further to Figure 1, the cylinder 13 has chambers 21 and 22 at opposite sides of the piston 14, which chambers are coupled by means of pipes 23 and 24 with the hydraulic driving unit shown at A in Figure 1 and now to be described.

The driving unit (see Figures 2 and 3) includes a casing 25 having a removable cover or lid 26, and as clearly seen in Figure 3 the casing serves as a reservoir for the actuating fluid for the system, preferably oil, the oil level being indicated at X. In connection with this reservoir, it is to be understood that the oil therein is subject to atmospheric pressure at its surface.

The casing 25 also serves as a mounting means for the actuating parts, it being here noted that in the preferred arrangement, all of these actuating parts are so mounted as to be immersed below the level X of the oil in the casing.

Internally of the casing there are provided a pair of bearing supports or blocks 27 and 28, these being arranged with their axes in alignment so as to receive and journal the shaft 29 having a connecting element 30 at one end thereof projecting from the casing 25 for cooperation with the driving motor B shown in Figure 1. A removable fitting 31 surrounds the adjacent end of the shaft at the point where the shaft passes through the casing wall, this fitting being provided for the purpose of permitting insertion and withdrawal of the shaft. The fitting 31 further serves to provide an annular space to receive the packing 32 adjustable by means of the gland 33.

Between the bearing support 27 and the shaft 29 there are provided three sleeves 34, 35 and 36 serving as bearing sleeves and also as adjustable valve parts in the manner described more fully hereinafter with particular reference to Figure 4.

Toward its other end the main driving shaft 29 is provided with a reduced portion 37 fitting an aperture in the shaft extension and valve member 38 and keyed or pinned thereto as indicated at 39. As clearly shown, the member 38 projects into the bearing block 28 and serves as a support for this end of the main shaft 29. A fixed bearing sleeve 40 is interposed between member 38 and the bearing support proper.

At a point intermediate the two bearings, the shaft 29 is provided with eccentrics 41 and 42, the first driving a piston 43 and the latter a piston

44 by means of connecting rods 45 and 46 and wrist pins 47 and 48, respectively.

Piston 43 works in cylinder 49 from which passages 50 and 51 extend. The pipe 24 extended to the operating cylinder 13 communicates with passage 50, as does also the additional passage 52 which is extended to the valve member 38, hereinafter referred to as the suction valve.

Passage 51 is coupled by means of an additional passage 53 with another valve device hereinafter referred to as the exhaust valve, which valve, in the embodiment shown in Figure 2, comprises a suitably ported section of the shaft 29 itself.

Piston 44 works in cylinder 54 which cylinder is provided with communicating passages 55 and 56, the former in communication with pipe 23 extended to the operating cylinder 13 and also with passage 57 extended to the suction valve 38. The passage 56 is connected with passage 58 extended to the exhaust valve mentioned above and described fully herebelow.

Before setting out in detail the sequence of valve and piston events (as shown fully on the diagrams of Figures 5 to 8 inclusive) it may here be noted that piston 43 and the associated cylinder and passages constitute the "low speed side" of the unit, i. e., the driving mechanism which sets up the low speed movement of the conveyer trough 11 in response to movement of operating piston 14 upon the admission of a fluid or liquid impulse through the pipe 24 in the chamber 22. This low speed movement advances the material in the conveyer trough. Piston 44, with its associated cylinder and passages, constitutes the "high speed side" of the unit which effects movement of operating piston 14 and the trough 11 in the reverse direction so as to cause the trough to "slip" under the material on the return stroke.

In the form illustrated in Figure 2, the difference between the character of the two strokes is in large part set up because of the employment of eccentrics 41 and 42 for actuating the pistons 43 and 44, which eccentrics are of different eccentricity. More specifically, the eccentric 42 is offset from the axis of shaft 29 to a greater degree than the eccentric 41 and in consequence of this piston 43 has a shorter stroke and therefore a smaller displacement than piston 44.

With reference to the suction valve it is noted that this valve takes the form of a sleeve having a central bore 38b in communication with the oil reservoir and further that the sleeve is provided with a port 38a adapted to be brought into registry with passages 52 and 57, which passages are provided with ports opening through the bearing surface of the bearing support 28.

Referring again to the exhaust valve, as above noted this valve is formed as a part of shaft 29. The left end of shaft 29 is provided with a central bore 59 which is in constant communication with the oil in the reservoir through radial ports 60. Passages 53 and 58 on the low speed and high speed sides, respectively, are extended to open through the bearing surface of the bearing support 27, so as to form valve ports.

Additional ports 53a and 58a are provided for establishing communication between the bore 59 and passages 53 and 58 respectively.

As best seen in Figure 4, the valve and bearing sleeves 34, 35 and 36 are provided with recessed portions 61, 62, 63 and 64. The sleeves 34, 35 and 36 are shown in somewhat separated relation in Figure 4, but it will be apparent that when brought together, the three sleeves will form slots, the slot between the recessed portions 61 and 62

being in registry with the port of passage 58 and cooperating with port 58a, and the slot between recessed portions 63 and 64 being in registry with the port of passage 53 and cooperating with port 53a.

The central sleeve 35 is non-rotative and positioned with one end of recessed part 62 in registry with the port of passage 58, and with one end of recessed part 63 in registry with the port of passage 53. The other sleeves (34 and 36) are angularly adjustable so as to lengthen or shorten the effective slot in the bearing sleeves which is in communication with the respective ports for passages 53 and 58. This adjustable valve mechanism is provided for the purpose of controlling the length of stroke of the operating piston 14 and thus of the trough 11, and the manner in which this is accomplished will be pointed out more fully herebelow after a consideration of the diagrams of Figures 5 to 8 inclusive, in which diagrams it is assumed that the adjustable valves are set to provide maximum stroke of the operating piston 14 and the conveyer trough.

As briefly pointed out in the description of figures, the diagrams of Figures 5 to 8 inclusive show the relation of various parts at different points in the cycle of operation. Legends are applied to these figures to identify the point in the cycle represented by each. The dot-and-dash line Y—Y represents the axis of the main shaft 29. The several parts positioned along this axis line represent fragmentary sectional views of various parts of the mechanism shown in Figure 2. Proceeding from left to right, the first portion of Figure 5 is a section through exhaust port and passage 58a and 58. The second is a view through the exhaust port and passage 53a and 53. The third shows the eccentric 42, the next the eccentric 41, and finally the last indicates a section through the suction valve and its ports. At the extreme right of the figure is a diagrammatic representation of the operating cylinder 13.

With further reference to the diagrams of Figures 5 to 8 inclusive, it is noted that the eccentricity of the elements 41 and 42 is exaggerated for the purpose of facilitating reading of the figures. As an example of suitable eccentricity in an actual installation, it is noted that an offset of about $\frac{1}{8}$ of an inch for eccentric 41 and of about $\frac{1}{4}$ of an inch for eccentric 42 will be found to be satisfactory, the ratio preferably being somewhere in the neighborhood of 1—4, which ratio is used in the diagrams.

As an aid to reading the diagrams, dot-and-dash lines are used in Figures 6, 7 and 8 to indicate the movement of the pistons from one diagram to the next.

Proceeding now with a description of the valve and piston events represented in these diagrams, it is first noted that in Figure 5 the parts are shown in the position representing the start of the low speed stroke, i. e., the start of the compression stroke of piston 43. With shaft 29 rotating in the direction indicated by the arrow in the diagram, it will be observed that port 53a has just moved out of registry with the port for passage 53, in consequence of which passage 53 is no longer in communication with the bore 59 and through the bore with the reservoir. The suction valve 38 is just about to close the port for passage 52, and in view of this, as piston 43 advances in its compression stroke by virtue of rotation of eccentric 41, the liquid filling cylinder 49 and the associated passages delivers an im-

pulse through pipe 24 to chamber 22 of the operating cylinder 13. Piston 14 is thus caused to move in its low speed stroke so as to advance the material in the conveyer trough.

Simultaneously with the above, the piston 44 is commencing its suction stroke, this because of the fact that the two eccentrics 41 and 42 are both offset from the axis of the shaft toward the same side thereof. In order to avoid setting up a vacuum in cylinder 54 and the associated passages, it is, of course, necessary to provide for the introduction of liquid into this side of the system. Movement of operating piston 14, of course, displaces liquid in chamber 21, and this enters the high speed side of the system through 23. In addition, port 58a is still in communication with the port for passage 58, and thus this passage 58 is in communication (through the central bore 59) with the supply or reservoir of oil. Atmospheric pressure (to which the reservoir is subject) may then still force some oil through the exhaust valve for the high speed side, and in addition, upon slight angular movement of shaft 29 beyond the point shown in Figure 5, the suction valve 38 will be moved to bring its port 38a into communication with the port for passage 57. Port 38a being of considerable arcuate dimension, retains the high speed side of the system in communication with the reservoir through the bore 38b, so that during substantially the entire low speed compression stroke, fluid may be forced into the high speed side (as the piston 44 progresses on its suction stroke) under the influence of atmospheric pressure to which the reservoir is subject. If desired, the suction valve and its ports may be modified somewhat in order to change the moment of opening and closing of port 38a to either of the ports 52 and 57. For example, port 57 may be widened circumferentially beyond the width indicated in Figure 5 in order to cause the suction valve to open to the high speed side of the system a little sooner and thus supplement the fluid entering through the exhaust valve port 58 during commencement of the suction stroke of piston 44.

Proceeding now to the diagram of Figure 6 illustrating the same parts as Figure 5, it is noted that this second diagram represents the positions of the several devices at a point toward the end of the low speed stroke of the operating piston 14, i. e., the compression stroke of piston 43. Here it will be seen that exhaust port 53a for the low speed side is moving toward port 53 which, at about the end of the stroke, will establish communication with the reservoir through the central bore 59. Furthermore, upon slight additional angular movement of valve 38, passage 38a will come into registry with the port for the passage 52, and this will also place the low speed side of the system in communication with the reservoir (at atmospheric pressure) to provide for introduction of liquid into the low speed side during the suction stroke of piston 43.

With regard to the suction valve 38, it should also be noted that in the position of Figure 6, the port 38a is still in communication with the port for passage 57, this being of importance in order to avoid constriction of the passage through which liquid is flowing into the high speed side toward the end of the suction stroke of piston 44. Valve 38 and its associated passages are also preferably arranged so as to maintain communication between the reservoir and passage 57 until shortly after the high speed stroke has commenced, i. e., the compression stroke of piston 43.

44. The underlying object in this provision is to delay the point at which the high speed stroke of the operating piston 14 will commence. The delay should preferably be sufficient to provide a rapid acceleration at the commencement of the high speed stroke. Movement of the eccentric 42 in the region approximating dead center results in only very slight advancement of piston 44. However, as the movement of the eccentric 42 advances, the movement of piston 44 increases in speed and, in order to obtain the desired "slip" of the trough under the material on this high speed or return stroke, it is desirable to delay commencement of the stroke until the eccentric 42 has been rotated somewhat past dead center.

Further reference to Figure 6 will show that the exhaust valve for the high speed side is in position to close passage 58, so that during the effective portion of the compression stroke of piston 44, no liquid will escape through the exhaust valve.

Proceeding then to the diagram of Figure 7, representing the point in the cycle at which the high speed stroke of the operating piston 14 commences, it will be noted that the suction valve 38 has just closed the port for passage 57. The high speed side of the system is thus completely closed and the liquid is then forced through pipe 23 into chamber 21 of the operating cylinder in order to effect a rapid movement of piston 14 and of the conveyer trough 11.

During this compression stroke of piston 44, piston 43 is returning through its suction stroke. At the commencement of the suction stroke of piston 43 (shortly prior to the condition shown in Figure 7) the exhaust valve for the low speed side of the system is open, thus placing passage 53 into communication with bore 59 and the reservoir, in view of which oil enters the low speed side of the system through this exhaust valve during the initial portion of the suction stroke of piston 43. This is of importance in order to avoid any tendency to start the return or "slip" stroke of the operating piston 14 until the movement of this piston in the return direction is initiated by the compression stroke of piston 44.

Referring further to the suction stroke of piston 43, when the parts reach the positions shown in Figure 7, the exhaust valve 38 opens passage 52 to the bore 38b and thus to the reservoir, so that throughout the following portion of this stroke oil may enter the low speed side of the system through both the exhaust and suction valves.

During the suction stroke of piston 43, liquid will also be displaced from chamber 22 of the operating cylinder by virtue of movement of piston 14. Since the movement of piston 14 in this direction is very rapid (four times as rapid as the other stroke with eccentrics having a 4-1 ratio, as hereinbefore suggested), it displaces an amount of liquid from chamber 22 which is greater than the corresponding increase in volume during the simultaneous portion of the suction movement of piston 43. However, since both the exhaust and suction valves are open at this time to the low speed side of the system, the excess liquid is freely discharged through the two valves back into the reservoir. This is of importance in ensuring that the full benefit of the rapid or "slip" stroke of piston 14 shall be obtained.

Proceeding now to the diagram of Figure 8 representing the condition at the point of release of the high speed compression stroke, it will be

noted that the exhaust valve for the high speed side of the system is just commencing to bring port 58a into registry with the slot between valve sleeves 34 and 35 and thus with the port for passage 58. The "cracking open" of this port terminates the positively imparted portion of the high speed stroke of the operating piston 14 although it is now free to float to rest with the conveyer trough to which it is connected. During the balance of the compression stroke of piston 44, liquid is discharged from the high speed side through passage 58, port 58a and bore 59, to the reservoir. On the low speed side of the unit the balance of the suction stroke of piston 43 is accompanied by introduction of oil through both the exhaust valve and the suction valve, both of these valves being open until the point of commencement of the low speed compression stroke shown in the diagram of Figure 5, after which the cycle is repeated.

As hereinbefore brought out, the driving unit and the several operating parts thereof are arranged for operation at a rate providing for reciprocations upwards of about 500 or 600 cycles per minute. It will now be apparent that this high speed operation may readily be obtained because of the arrangements of the parts, including the fact that the entire cycle of fluid impulses is effected merely by means of a single rotative shaft carrying a pair of pistons driven by eccentrics which relatively are of very small offset, thus reducing vibration and the like to a minimum.

With regard to the valve sleeves 34, 35 and 36, reference is first made to the diagrams of Figures 5 to 8 inclusive. Since the point of termination of the low speed stroke is determined by the point at which the exhaust valve for the low speed side opens communication between passage 53 and the central bore 59 to the reservoir (see Figure 6), angular movement of the sleeve 36 counterclockwise as viewed in that figure, will advance the point at which the low speed stroke will terminate. As mentioned hereinbefore, the condition in the diagrams of Figures 5 to 8 represent valve sleeve positions when adjusted for maximum stroke. With valve sleeve 36 rotated to its extreme counterclockwise position when viewed as in the diagrams, the point of "cracking open" of the exhaust valve for the low speed side will occur early enough to virtually eliminate the effect on the operating piston 14.

Similarly, movement of the valve sleeve 34 for the high speed exhaust valve in a counterclockwise direction (see Figure 8) will advance the point of release during the compression stroke of high speed piston 44, and this advancement with the arrangement shown may be sufficient to virtually eliminate all effect on the operating piston 14.

The foregoing valve arrangements and adjustments may also be employed to somewhat vary the character of the fluid impulses delivered to the operating cylinder and, in addition, by modifications of the valves, quite a variety of types of impulses may be set up, so as to meet differing operating conditions such, for example, as the necessity for conveying materials of varying character or weight.

For the purpose of adjusting the valve sleeves, I prefer to employ a flange 65 on sleeve 34 (see Figure 3) having a gear segment 66 meshing with worm 67, operable by shaft 68 which extends through the cover for the unit, and externally thereof is provided with an operating handle 69. As seen in Figure 3, a stop member 70 projecting

through a slot 71 may be employed to limit angular displacement of the sleeve 34.

A similar construction is used to control the angular position of sleeve 36. Here a flange 72 is provided with a gear segment 73 operable by the worm 74 carried by the actuating shaft 75, these parts being clearly shown in Figure 2. It will be understood that an actuating handle similar to that identified 69 in Figure 3 will be employed for rotating shaft 75.

In considering the foregoing structure and the operation thereof as fully set out in connection with Figures 5 to 8 inclusive, it should be noted that highly effective adjustment of the stroke of the operating piston and thus of the conveyer itself is made possible, this adjustment being infinitely variable between "no stroke" condition and maximum stroke condition.

A further and highly important advantage of this arrangement is the fact that the main driving shaft 29 of the unit may be coupled with and constantly operated at a uniform rate of speed.

It will also be clear from the foregoing that the mechanism is in reality composed of relatively few and simple parts, the functions of which are all controlled by the single main driving shaft.

The several parts are still further advantageously submerged in the oil reservoir serving as the source of supply for the system, so that all bearings and working parts move in oil. Because of the periodic pressure flow of oil through the valves, these valves are in reality subject to pressure lubrication. Wear of the parts is thereby reduced to a minimum.

From the foregoing it will also be apparent that the improved driving mechanism is of a type affording maximum convenience and flexibility as to installation, and thus making it possible to meet a variety of different situations. The operating cylinder 13 and the piston working therein are the only parts which need be substantially immediately associated with the conveyer trough. The driving unit itself may conveniently be located and mounted apart from the conveyer trough and its mounting, in consequence of which the vibrations of the conveyer are not imposed on the driving unit proper.

Turning now to the arrangement shown in Figure 9, it is first pointed out that this view illustrates a driving unit similar to that shown in Figure 2 in many important respects. Similar reference numerals are therefore applied to corresponding parts in Figure 9. In this arrangement the main driving shaft 29a is provided with a bore 59a toward the left-hand end. In this case the inner end of this bore is placed in communication with the reservoir through radial ports 60a, and exhaust ports 53a and 58a are again arranged to register with passages 53 and 58, respectively.

The arrangement of Figure 9 also shows a fixed bearing sleeve 76, it being the intention that the exhaust valves shall be arranged for a given setting to meet the conditions of operation for which the unit is designed. The adjustable valve sleeves may, of course, be incorporated in the form of Figure 9 just as readily as in Figure 2. Alternatively, as a means for adjusting the high and low speed strokes, the connections 23a and 24a extended to the operating cylinder 13 (not shown in Figure 9) may be coupled by means of by-pass pipes 23b and 24b with the reservoir space in the unit, it being the intention that the pipes 23b and 24b shall be controllable by suitable valves 23c

and 24c, whereby a portion of the liquid may escape to the reservoir during the high and low speed strokes. The valves 23c and 24c may therefore be used to control the length of the strokes.

In place of the employment of two eccentrics for actuation of the low speed and high speed pistons, the form of Figure 9 employs only a single eccentric 77 cooperating with a pair of eccentric blocks 78—78 which are vertically movable in slots formed at opposite sides of the double-ended piston plunger 79. This plunger is, of course, provided with a central aperture 80 of size sufficient to pass and permit free movement of the eccentric 77 during reciprocation of the piston plunger. The motion of the eccentric is transmitted to the piston plunger through the eccentric blocks 78, and a further distinction in Figure 9 over the arrangement of Figure 2 is that the piston plunger 79 is provided with piston ends 81 and 82 of different diameter. Thus the differential displacement (which was provided in the arrangement of Figure 2 by virtue of employing eccentrics having unequal offset from the axis of the driving shaft) is here provided by virtue of the employment of pistons of different diameters, the throw of the pistons being equal.

As compared with the arrangement of Figure 2, the form of Figure 9 has the distinctive advantage of necessitating the use of a still smaller number of parts, and further of providing a more balanced condition and one which is less subject to vibration during operation.

Figure 10 shows a further modified construction. In this arrangement the trough 11 is coupled as by means of brackets 83 to a pair of operating plungers or pistons 84 and 85, the plungers 84 and 85 and also other operating parts to be described herebelow all being located within a reservoir indicated at 86 and adapted to contain a supply of oil as the actuating fluid and as a medium of lubrication of the parts. In this form a pair of cylinders 87 and 88 are employed, the cylinders having a single bore extended all the way therethrough and receiving, at one end, one of the plungers 84 or 85. In the other end of these cylinders actuating plungers 89 and 90 are arranged, these actuating plungers being coupled as by means of links 91 and 92 with eccentrics 93 and 94 which are formed on the driving shaft 95 and which have different degrees of offset from the axis of the shaft. The driving shaft also actuates the rotary exhaust valve 96 which has ports 97 and 98 in the casing 99 thereof, which ports are adapted to be brought into registry with corresponding ports for passages 100 and 101 extended to communicate with the central part of the cylinders 87 and 88, i. e., to communicate with the space between the pairs of pistons in the actuating cylinders. In this arrangement the function of the rotary suction valve 38 described above particularly in connection with Figures 2 and 5 to 8 inclusive, is assumed by flap or check valves 102 and 103 adapted to open and close a port extending through the inner end of the operating plungers 84 and 85, respectively.

Bearing in mind that the outer ends of the operating plungers 84 and 85 are open for communication with the supply of oil in the reservoir, it will be seen that upon suction stroke of plunger 90, which is at the high speed side of the unit, oil will enter through the left end of operating plunger 85 and thence through the flap valve into the interior of the cylinder. Similarly, during a suction stroke of the low speed actuating plunger 89, the flap valve 102 for the other operating

plunger 84 will open to permit inflow of oil. The exhaust valve port 98 at the high speed side operates similarly to the port 58a of Figure 2 to release the pressure in high speed cylinder 88 in order to terminate the high speed or "slip" stroke of the conveyer. In the same way exhaust port 97 corresponds to exhaust port 53a of Figure 2, the operation being essentially similar.

During compression strokes of actuating plungers 89 and 90 the flap valves on the operating plungers or pistons 84 and 85 will be closed automatically, thus initiating the respective strokes of the conveyer trough itself, the operating plungers both being rigidly connected with the trough 11.

When employing an arrangement of the type shown in Figure 10, the flap valve at the high speed side, i. e., a valve 103 for piston 85, is preferably permitted a greater degree of opening movement than the flap valve 102 for the low speed operating piston, this for the purpose of providing a "slip" between the commencement of the compression stroke of plunger 90 and the commencement of the high speed "slip" stroke of operating piston 85 and the trough.

The arrangement here shown is also capable of modification to incorporate adjustable valve sleeves for controlling the point of release by the exhaust valve, in a manner fully described above. These parts are not shown as incorporated in this view since the operation thereof has also been fully set forth.

A distinctive advantage of the arrangement shown in Figure 10 is that the entire mechanism is incorporated in a single unit, this unit not only including the driving parts but also the operating pistons and cylinders. Furthermore, the arrangement of Figure 10 reduces certain losses incident to the separation of the actuating and operating pistons or plungers. For example, friction losses in piping and the like are eliminated since each pair of actuating and operating pistons are located very close to each other in a single cylinder.

I claim:

1. A driving mechanism for a vibrating conveyer, including a pair of fluid pressure piston devices, means for driving one of said devices, means connecting the other of said devices to the conveyer, fluid pressure means interconnecting the devices and transmitting movements of the driven device to the other device whereby to effect movement of the conveyer in one direction, and an additional pair of fluid pressure piston devices, with means for driving one and connecting the other to the conveyer, and further with fluid pressure means interconnecting them and transmitting movements of the driven device of the second pair to the other device and thence to the conveyer in the other direction, the movements of the driven devices of the respective pairs being of different duration.

2. A hydraulic driving mechanism for a vibrating conveyer, including a trough, a cylinder and piston device one element of which is connected with the trough, means for relatively reciprocating the cylinder and piston to effect vibration of the trough including a rotative shaft with eccentric means thereon, piston elements actuatable by the eccentric means, cylinders for the pistons adapted to receive the operating liquid and being in communication with the cylinder device first mentioned, there being a pair of piston elements of different displacement, and means for venting liquid from the cylinder containing the piston of greater displacement during a portion of the stroke of that piston.

3. A hydraulic driving mechanism for a vibrating conveyer, including a trough, a cylinder and piston device one element of which is connected with the trough, means for relatively reciprocating the cylinder and piston to effect vibration of the trough including a rotative shaft with eccentric means thereon, piston elements actuatable by the eccentric means, cylinders for the pistons adapted to receive the operating liquid and being in communication with the cylinder device first mentioned, there being a pair of piston elements of different displacement, and means for venting liquid from the cylinder containing the piston of greater displacement during a portion of the stroke of that piston, said last means being actuatable by said shaft.

4. A hydraulic driving mechanism for a vibrating conveyer, including a trough, a cylinder and piston device one element of which is connected with the trough, means for relatively reciprocating the cylinder and piston to effect vibration of the trough including a rotative shaft with eccentric means thereon, piston elements actuatable by the eccentric means, cylinders for the pistons adapted to receive the operating liquid and being in communication with the cylinder device first mentioned, there being a pair of piston elements of different displacement, means for venting liquid from the cylinder containing the piston of greater displacement during a portion of the stroke of that piston, and means for varying the duration of venting.

5. Conveyer mechanism of the character described including a trough, an operating cylinder and piston one element of which is connected with the trough for moving it in one direction, means for moving the trough in the opposite direction, hydraulic pressure mechanism for actuating the cylinder and piston device to move the trough in said one direction, said mechanism including an actuating cylinder in communication with the operating cylinder and adapted to receive the actuating liquid, an actuating piston working in the actuating cylinder for setting up impulses in said liquid, and means for venting the actuating cylinder during a portion of the stroke of the piston working therein.

6. Conveyer mechanism of the character described including a trough, an operating cylinder and piston one element of which is connected with the trough for moving it in one direction, means for moving the trough in the opposite direction, hydraulic pressure mechanism for actuating the cylinder and piston device to move the trough in said one direction, said mechanism including an actuating cylinder in communication with the operating cylinder and adapted to receive the actuating liquid, an actuating piston working in the actuating cylinder for setting up impulses in said liquid, and means for venting the actuating cylinder during a portion of the stroke of the piston working therein, said means being timed in its operation to vent the actuating cylinder during an end portion of the stroke of the piston therein.

7. Conveyer mechanism of the character described including a trough, an operating cylinder and piston one element of which is connected with the trough for moving it in one direction, means for moving the trough in the opposite direction, hydraulic pressure mechanism for actuating the cylinder and piston device to move the trough in said one direction, said mechanism including an actuating cylinder in communication with the operating cylinder and adapted to

receive the actuating liquid, an actuating piston working in the actuating cylinder for setting up impulses in said liquid, and means for venting the actuating cylinder during a portion of the stroke of the piston working therein, said means being timed in its operation to vent the actuating cylinder during periods at the beginning and at the end of the compression stroke of the piston therein.

10 8. Conveyor mechanism of the character described including a trough, an operating cylinder and piston one element of which is connected with the trough for moving it in one direction, means for moving the trough in the opposite direction, hydraulic pressure mechanism for actuating the cylinder and piston device to move the trough in said one direction, said mechanism including an actuating cylinder in communication with the operating cylinder and adapted to receive the actuating liquid, an actuating piston working in the actuating cylinder for setting up impulses in said liquid, means for venting the actuating cylinder during a portion of the stroke of the piston working therein, said means being timed in its operation to vent the actuating cylinder during an end portion of the stroke of the piston therein, and means for varying the length of said vented portion of said stroke.

9. A hydraulic driving mechanism for a vibrating conveyor including, in combination with a conveyor trough, operating means for the conveyor including piston and cylinder means associated therewith for reciprocating the conveyor in each of two substantially opposite directions, and mechanism for setting up and delivering liquid impulses to said means whereby to effect reciprocation of the conveyor, said mechanism including a low speed fluid containing actuating cylinder in communication with one side of the operating means, a high speed fluid containing actuating cylinder in communication with the other side of the operating means, and low and high speed pistons working respectively in the low and high speed cylinders and being of small and large displacement, respectively, whereby to impart impulses to the liquid, which impulses are of lesser duration for the high speed side than for the low speed side.

10. A hydraulic driving mechanism for a vibrating conveyor including, in combination with a conveyor trough, operating means for the conveyor including piston and cylinder means associated therewith for reciprocating the conveyor in each of two substantially opposite directions, mechanism for setting up and delivering liquid impulses to said means whereby to effect reciprocation of the conveyor, said mechanism including a low speed fluid containing actuating cylinder in communication with one side of the operating means, a high speed fluid containing actuating cylinder in communication with the other side of the operating means, low and high speed pistons working respectively in the low and high speed cylinders and being of small and large displacement, respectively, whereby to impart impulses to the liquid, and means for venting the high speed cylinder during a portion of its compression stroke.

11. A hydraulic driving mechanism for a vibrating conveyor including, in combination with a conveyor trough, operating means for the conveyor including piston and cylinder means associated therewith for reciprocating the conveyor in each of two substantially opposite directions, mechanism for setting up and delivering liquid

impulses to said means whereby to effect reciprocation of the conveyor, said mechanism including a low speed fluid containing actuating cylinder in communication with one side of the operating means, a high speed fluid containing actuating cylinder in communication with the other side of the operating means, low and high speed pistons working respectively in the low and high speed cylinders and being of small and large displacement, respectively, whereby to impart impulses to the liquid, a source of supply of an actuating liquid, valve means operative to place the low speed cylinder in communication with said source during the suction stroke of the piston therein, valve means operative to place the high speed cylinder in communication with said source during the suction stroke of the piston therein, and valve means operative to place the high speed cylinder in communication with said source during a portion of the compression stroke of the piston therein.

12. A hydraulic driving mechanism for a vibrating conveyor including, in combination with a conveyor trough, operating means for the conveyor including piston and cylinder means associated therewith for reciprocating the conveyor in each of two substantially opposite directions, mechanism for setting up and delivering liquid impulses to said means whereby to effect reciprocation of the conveyor, said mechanism including a low speed fluid containing actuating cylinder in communication with one side of the operating means, a high speed fluid containing actuating cylinder in communication with the other side of the operating means, low and high speed pistons working respectively in the low and high speed cylinders and being of small and large displacement, respectively, whereby to impart impulses to the liquid, a source of supply of an actuating liquid, valve means operative to place the low speed cylinder in communication with said source during the suction stroke of the piston therein, valve means operative to place the high speed cylinder in communication with said source during the suction stroke of the piston therein, and valve means operative to place the low speed cylinder in communication with said source during a portion of the compression stroke of the piston therein.

13. A hydraulic driving mechanism for a vibrating conveyor including, in combination with a conveyor trough, operating means for the conveyor including piston and cylinder means associated therewith for reciprocating the conveyor in each of two substantially opposite directions, mechanism for setting up and delivering liquid impulses to said means whereby to effect reciprocation of the conveyor, said mechanism including a low speed fluid containing actuating cylinder in communication with one side of the operating means, a high speed fluid containing actuating cylinder in communication with the other side of the operating means, low and high speed pistons working respectively in the low and high speed cylinders and being of small and large displacement, respectively, whereby to impart impulses to the liquid, a source of supply of an actuating liquid, valve means operative to place the low speed cylinder in communication with said source during the suction stroke of the piston therein, valve means operative to place the high speed cylinder in communication with said source during the suction stroke of the piston therein, valve means operative to place the low speed cylinder in communication with said source

during a portion of the compression stroke of the piston therein, and valve means operative to place the high speed cylinder in communication with said source during a portion of the compression stroke of the piston therein.

14. A hydraulic driving mechanism for a vibrating conveyer including in combination with a conveyer trough, hydraulic means for moving the trough in one direction, hydraulic means for moving the trough in the other direction, a rotative driving shaft, an eccentric on the driving shaft, an eccentric block, a double-ended piston actuable by said block, the two ends of the piston being of different diameter, cylinders for said ends, and means for placing said cylinders in communication with the two means first mentioned for moving the conveyer in each of two opposite directions.

15. A reciprocating conveyer including a conveying element, supporting means having sufficient inherent rigidity to support the conveying element while permitting very short stroke but rapid reciprocation thereof as herein described, hydraulically actuated motor means adapted to displace said conveying element and slide it beneath the material being conveyed, a continuously operable liquid circulating system, conduit means connecting said system with said hydraulically actuated motor means, and valve means for periodically interrupting the continuous circulation of said liquid and simultaneously forcing it into the motor device through said connecting conduit means so as to cause said sliding movement of the conveying element as aforesaid, the duration of the stroke in the sliding direction being less than in the opposite direction.

16. The conveyer of claim 15 wherein means are provided for varying the length of time of said periodic interruption.

17. A reciprocating conveyer including a conveying element, supporting means having sufficient inherent rigidity to support the conveying element while permitting very short stroke but rapid reciprocation thereof as herein described, an actuating piston connected to said element, a reservoir of operating liquid, a motor device for delivering liquid from the reservoir to the actuating piston under pressure and with sufficient suddenness to slip the conveying element beneath the material being conveyed, and means for venting the liquid to said reservoir so as to relieve the pressure prior to the commencement of the return stroke of the conveying element, the duration of the stroke in the slipping direction being less than that of the return stroke.

18. Reciprocating conveyer mechanism including a trough, resilient supporting means therefor, a piston and cylinder device one element of which is connected with a trough to move therewith and the other of which is stationary, and a hydraulic pulsator, said pulsator having a high speed piston for delivering liquid to one side of said piston and cylinder device with sufficient suddenness to displace the trough and slide it under the material being conveyed and a low speed piston for delivering liquid to the other side

of said piston and cylinder device with sufficient slowness to return the trough together with the material being conveyed, the duration of the high speed impulse being less than that of the low speed impulse.

19. Reciprocating conveyer mechanism including a trough, resilient supporting means therefor, and a hydraulic actuating mechanism, said actuating mechanism comprising a double acting piston connected to the trough, a high speed piston mounted independent of the trough for forcing liquid against one face of said double acting piston so as to cause it to slide the trough beneath the material being conveyed, valve mechanism for terminating such high speed impulse prior to completion of the high speed stroke, and a low speed piston mounted independent of the trough for forcing liquid against the opposite face of said double acting piston so as to cause it to move the trough with the material being conveyed in the opposite direction.

20. A reciprocating conveyer including a trough, resilient supporting means therefor, and a hydraulic actuating mechanism for longitudinally reciprocating said trough with a stroke which, in one direction, is of sufficient speed to slide the trough beneath the material being conveyed and, in the other direction, is sufficiently slow to carry the material with the trough, said actuating mechanism having means for terminating the positively imparted high speed impulse prior to completion of the high speed stroke, the duration of the sliding impulse being less than that of the conveying impulse.

21. The mechanism of claim 12 wherein means are provided for varying the portion of the compression stroke during which the valve means is effective to place the low speed cylinder in communication with said source.

22. The mechanism of claim 13 wherein means are provided for varying the portion of the compression stroke during which the valve means is effective to place the high speed cylinder in communication with said source.

23. Reciprocating conveyer mechanism including a conveying element, supporting means having sufficient inherent rigidity to support the conveying element while permitting very short stroke but rapid reciprocation thereof as herein described, a piston and cylinder device one element of which is connected with the conveying element to move therewith and the other of which is stationary, a reservoir of operating liquid, a pumping unit for delivering liquid from the reservoir to said piston and cylinder device under pressure and with sufficient suddenness to slip the conveying element beneath the material being conveyed, and means for venting the liquid to said reservoir so as to relieve the pressure prior to the commencement of the return or conveying stroke of the conveying element, the duration of the stroke in said slipping direction being less than the duration of the stroke in the conveying direction.

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