This invention relates to a loader or conveyor and an object thereof is to provide improved mechanism for preventing the accumulation of undue slack in a conveyor draft chain as articulated parts of the conveyor frame are adjusted while at the same time eliminating the use of energy storing springs.

A further object of the invention is to provide improved shaft takeup mechanism preferably of the hydraulic type for use in an articulated conveyor.

Another object of the invention is to provide an improved hydraulic system designed particularly for automatically adjusting the takeup shaft of a conveyor system.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 is a plan view of an underground coal loading machine incorporating the features of my invention;

Fig. 2 is a side view of the machine of Fig. 1;

Fig. 3 is an enlarged detail plan view of a portion of the discharge conveyor of the loader of Figs. 1 and 2;

Fig. 4 is a side elevational view taken on the line 4—4 of Fig. 3, looking in the direction of the arrows;

Fig. 5 is a sectional view through one of the pumps of the conveyor or loader; and

Fig. 6 is a schematic piping diagram of the hydraulic system which I preferably employ which in combination and per se constitute features of my invention.

The loader and/or conveyor herein disclosed follows in general design that disclosed in the patent to Nils D. Levin, No. 2,553,052, dated July 4, 1944, to which my improvements have been added, and except for my improvements, unless a contrary fact is indicated by the drawings or specification it is to be understood that the loader of my invention follows said patent.

Briefly described, the principal structure of the loader includes a main frame 10 which is illustrated as provided with wheels 11 so that it may run on the rails 12 of a mine track, though the loader may be mounted on any other transportation mechanism. Mounted on the forward end of the main frame 10 for swinging movement about an upright axis as well as for vertical adjustment of its front end is a gathering boom 13 which includes a pair of motor driven endless flight carrying gathering mechanisms 14 which gather the loose or semi-compact coal in front of the machine and convey it rearwardly along a central trough or way 15 and discharge it into a receiving hopper 16 of a receiving and discharge conveyor 17 which includes trough forming frame members 18 and 19. The frame members 18 and 19 are mounted for swinging movement about an upright axis with respect to the frame member 18 and preferably the frame 10 is articulated about a horizontal axis, as disclosed in the above-mentioned patent. The frame members 18 and 19 are constructed to provide a continuous trough, as disclosed more completely in the above-mentioned patent, said trough having effectively continuous side walls for each of the various relative positions of adjustment between them provided by the swinging movement of the frame member 18.

This swinging movement of the frame member 18 is provided by mechanism disclosed in some detail in Fig. 3 of the drawings which shall now be described.

Extending laterally from each side of the frame member 18 is an arm 20 to which a flexible steel cable 21 is anchored which is reeved over a wheel or pulley 22 carried by a bracket on the frame member 18. From said wheel 22 the cable 21 extends over a pulley 23 journaled to a head 24 of a piston 25 of a hydraulic piston motor, there being two such piston motors designated 26 and 27, respectively, one being on the other side of the frame or boom 18, the other on the other side thereof, as clearly illustrated in Fig. 3 of the drawings. These two piston motors 26 and 27 are of similar construction, one being a right hand motor, the other a left hand motor. Each is of the single acting type. As hereinafter described more completely, by supplying hydraulic fluid under pressure to one of the motors 26 or 27 while the other is connected to drain or tank, the boom or frame 18 may be swung in one direction and a reverse connection of the piston motor 26 and 27 to pressure and tank respectively will reverse its movement. By trapping the fluid in the two motors 26 and 27 the boom or frame 18 will be locked in adjusted position.

Traveling through the continuous trough of the receiving and discharge conveyor 17 formed by the trough-like frame members 18 and 19 is a universally articulated endless chain and flight conveyor mechanism 28. Said conveyor mechanism 28 includes an endless chain 29 and flights 30 which scrape over the bottom of the conveyor 11 and convey material from the hopper 16 rearwardly along said continuous trough and discharge it over a tail or discharge shaft 31 into a receiving receptacle such as a mine car 32. The
shaft 31 is preferably provided at its center with a chain receiving wheel or pulley 33 over which the chain 29 travels, said pulley or 33 being centrally mounted on the shaft 3. The upper or working run of the conveyor mechanism 28 is guided through the conveyor frame or section 16 by spaced guide members 34 carried on top of the bottom portion of the trough formed thereunder. As illustrated in Fig. 3, the guide members 34 will change its direction in case the boom 19 is swung from its rectilinear rearward position to either side, as clearly illustrated in Fig. 3 of the drawings, and will be guided by segmental guide members 35 which are mounted on a pivoted plate on frame 16.

It is a known fact that in an articulated conveyor of the type above described the slack or tension of the chain 29 will vary as the swinging boom, such as the boom 19, swings laterally to either side of a rectilinear position. For example, this lateral swinging movement will decrease the tension on the chain 29 unless mechanism is provided to compensate for the apparent increase in length of the chain 29 which progresses as the boom is progressively swung outward from the rectilinear or aligned position. In prior devices one method of compensating for this is to spring mount the shaft, equivalent to the shaft 31. This construction has two very definite disadvantages. In the first place it is dangerous because of the following conditions which is sometimes encountered. If coal is being conveyed rearward along the trough formed by frames 18 and 19 by the rearward travel of the chain 29 and flights 30, a large lump of coal may strike the mine roof and stop the chain 29 and flights 30. However, since the chain 29 is power driven by a large electric motor, as by driving gear disclosed in detail in the above mentioned patent, there will be a strong pull on the shaft 31 and if the shaft 31 is spring mounted the springs will be compressed completely whereupon if the motor attempts to move the lower or return run of the chain while the upper run in anchored as aforestated, either the chain will break or it will jerk loose from the coal and in either case the energy which is stored up by compression of the springs will be released and the energy stored in the springs will throw pieces of coal in the manner of a catapult and throw the broken upper run portion of the chain with considerable force. On the other hand, if the chain pulls the coal loose from its temporary anchorage, the energy stored in the springs will cause the chain to reverse its direction and this is with considerable speed and thus very dangerous.

There is another objection to this spring loading of the chain. Because of it there is always, or substantially always, a certain amount of compression on the chain as determined by the spring compression. In other words, there is never a condition in which the chain is absolutely slack on the roller, such as the roller 33, though it is desirable that there be no real tension whatever on the chain 29 during most working conditions and there should be a certain amount of slack between the chain and the roller 33 under substantially all working conditions. These undesirable characteristics of said prior known devices have been completely overcome while at the same time automatic compensation for the apparent length of chain 29 is provided for by the structure of my invention.

As clearly illustrated particularly in Fig. 4 of the drawings, opposite ends of the shaft 31 are grooved on the top and bottom so that said shaft 31 rides in slide guideways 35 formed adjacent the discharge or rear end of the conveyer 31. Cooperating with opposite ends of the shaft 31 are single acting hydraulic piston motors or jacks 37 and 38, the free or exposed ends of the pistons of which act as abutments and are preferably received in recesses in the ends of the shaft 31. As illustrated in Fig. 4, a piston 31a has a curved head 40 which is received in a recess in the end of the shaft 31. Preferably this abutting but non-positive connection is provided between piston 39 and shaft 31 since the force transmitted to the chain 29 to cause its upper run to travel rearwardly will provide a force on the shaft 31, tending to move it to the right or forwardly, as viewed in Figs. 3 and 4 of the drawings, when it is in operation. At the same time whenever the chain 29 is not driven or is idle, definite slack may exist between it and the roller 33. It is thus seen that a springless and positive or non- resilient but adjustable abutment is provided for the opposite ends of the shaft 31, restricting its movement in one direction.

To provide a lateral swinging movement of the boom 19 and also to effect adjustment of the shaft 31 to compensate for the apparent change in the length of chain 25, I preferably provide a hydraulic system, though it is to be understood that my invention in its broad aspects embraces other types of swinging and compensating mechanisms.

As hereinbefore described more completely, the compensating arrangement as illustrated, is in effect merely a hydraulic type of linkage. As best seen in Figs. 3, 5 and 6 of the drawings, attached to each of the piston motors 25 and 27 is a piston type pump, the pump associated with piston motor 26 being designated 41 and that associated with piston motor 27 being designated 42. The pumps 41 and 42 are of similar structure and pump 41 is disclosed in detail in Fig. 5 of the drawings. Each of said pumps includes a cylinder 43 within which there is a piston 44 which has a rounded head 45 on the projecting end thereof which abuts a wear block on a bracket 46 which is rigidly attached, as by welding, to the head 24 of the piston 25 of the associated piston motor 26 or 27, as the case may be. The pumps 41 and 42 are single acting and as clearly illustrated in Fig. 6 of the drawings they are connected in a hydraulic series circuit with the two parallel connected hydraulic piston motors 37 and 38 by way of a hydraulic coupling including a conduit 47 extending from pump 41 to motor 37, thence from motor 37 to motor 38 and from motor 38 to pump 42.

As illustrated in Fig. 6 of the drawings, when the boom 19 has its longitudinal axis in alignment with the frame 18 or, in other words, when it extends longitudinally rearward or is in its central or neutral position, the two pistons 25 on the swinging boom motors 26 and 27 will be in the full line positions. Under these conditions the pistons 44 of both the pumps 41 and 42 will be extended the maximum amount but their length is such that their heads 45 will not contact the brackets 46. A limited amount of swinging movement of the boom 19 in either of its reverse directions will not effect any adjustment of the shaft 31. This swinging movement may, for example, be approximately fifteen degrees on either side of the aligned position. However, when this fifteen degree position is encountered, for example as illustrated in Fig. 3
of the drawings, the bracket 46 will abut the head 45 of piston 44 of pump 41 and any further swinging movement of the boom 19 in a clockwise direction will produce depression of the piston 41 and hydraulic fluid will be forced from it through the conduit 47 and through the two hydraulic piston motors 37 and 38 associated with the shaft 31, thereby to expand them and force the shaft 31 outwardly progressive amounts as the boom is progressively swung in a clockwise direction until it reaches the maximum angle to which it can be swung. During this operation it is obvious that pump 42 is essentially idle since its piston 44 is in its greatest position of expansion throughout the entire travel of the boom 19. If the boom 19 is thereafter swung back toward its neutral or aligned position the chain 29, as it progressively decreases its apparent length, will apply force to the shaft 31 and the two motors 37 and 38 will act as pumps and force the hydraulic fluid back into the expanding pump 41 which is acting something in the nature of a motor but actually it is not doing any particular work since it merely pushes its piston 44 outwardly against no load as permitted by the recoiling bracket 46. If the boom 19 is swung in a counter-clockwise position from its neutral position the above described action will be substantially repeated except that the pump 42 will be the active pump and pump 41 will be inactive. It is thus evident that the two pumps 41 and 42 act alternatively for reverse swinging movement of the boom 19 to expand the two motors 37 and 38 together. Said motors 37 and 38 are connected in parallel. This arrangement of hydraulic pumps 41 and 42 and motors 37 and 38 with the hydraulic connections provided is in effect a hydraulic linkage which automatically adjusts the shaft 31 as the boom is swung counter-clockwise. Within the broad aspects of my invention other types of linkages such as mechanical linkage might be employed to effect a similar result.

The hydraulic system for operating the two boom motors 26 and 27 is per se of conventional design and may follow that described in the above mentioned Patent No. 2,353,653. However, there is a novel relation between this power system and the hydraulic linkage system just described which constitutes an important contribution of my invention and which shall be described hereinafter.

Referring first to the hydraulic system for adjusting the motors 26 and 27, it includes a tank 31 for the hydraulic fluid or oil from which oil is derived by a pump 40, the output line or conduit 50 from which leads to a bank of four-way valves 51. A pressure relief valve 52 is provided in the conduit 50 so that on occurrence of excessive pressure therein the outlet flow will be by-passed to the tank 48 by a conduit. The pressure relief valve 52 may be set at any selected value, for example, 800 pounds per square inch. From one of the bank of four-way valves 51 a pair of feed conduits 54 and 55 extend to the single acting piston motors 26 and 27, respectively. Between the conduit 55 and the conduit 47 and adjacent the motor 26 and pump 41 I provide a conduit having a manually operable valve 56 connected therein so that conduits 55 and 47 may be selectively connected or disconnected. Also between the conduit 54 and the conduit 47 adjacent the motor 26 and pump 41 I provide a conduit having therein an adjustable pressure relief valve 57. The pressure relief valve 57 is set to open at a lower pressure than that at which pressure relief valve 52 opens. For example, it may be set to open at 600 pounds per square inch. It controls the flow of hydraulic fluid from the conduit 54 to conduit 47. A reverse flow therethrough is not possible.

The function particularly of the valves 55 and 57 is as follows in connection with the complete hydraulic system. Obviously as is well understood in this art by controlling the valve lever of the four-way valve 51 which controls the two motors 26 and 27 pressure from the pump 41 may be applied selectively to the conduits 55 and 56, the other conduit being connected to drain through the valve of bank 51 and drain conduit 55. When the lever of the control valve of bank 51 is in its neutral position, hydraulic fluid will be sealed in the motors 26 and 27 and in the conduits 54 and 56 and thus the boom 19 will be locked in position. Assuming that the lever of the control valve of bank 51 is actuated to apply pressure to conduit 54 and connect conduit 55 to drain, the boom 19 will be swung in a counter-clockwise direction and if this movement is permitted to continue until said boom 19 has swung the maximum amount provided by its mechanical construction and thus strikes mechanical abutments which are provided, the pressure in the conduits 55 and 56 will increase and as relief valve 57 is set to open at a lower pressure, as for example 600 pounds per square inch, than relief valve 52, the former will open and hydraulic fluid under pressure in conduit 54 will flow into conduit 47 and expand the two pumps 41 and 42 as well as the two motors 37 and 38 and the maximum amount permitted by their pistons or abutments which they encounter. In the case of the motors 37 and 38 it means they will be expanded the maximum amount permitted by the chain 29. In other words, a predetermined tension will be thrown on the chain 29 and the hydraulic linkage system will be filled with oil. As soon as these pistons are all at the ends of their strokes as permitted by the mechanical conditions, the hydraulic pressure will increase until relief valve 52 operates whereupon the manual valve 51 will be released to neutral. If desired, pressure relief valve 52 may be a fixed pressure valve and opened at the will of the operator whenever pressure is in conduit 54 to tension the chain 29 by expanding the motors 37 and 38. The function of the manually operable valve 56 is to drain hydraulic fluid from the above described hydraulic linkage system. For example, if the lever of control valve 51 is actuated to provide pressure to conduit 54, the boom 19 will be swung in a counter-clockwise direction and after a predetermined swinging movement thereof from its normal position the bracket 46 of motor 27 will strike the head of piston 45. Under normal operation the hydraulic fluid thus forced from the cylinder of pump 42 will be delivered to the conduit 47 to expand the motors 37 and 38. Normally, of course, valve 56 is closed under these conditions. If, however, valve 56 is open under the described conditions, the hydraulic fluid delivered to conduit 47 will expand the motors 37 and 38 but will flow through the conduit 55 to drain 59 since conduit 58 is so connected under the conditions described.

It is thus evident that I have provided means to introduce hydraulic fluid under pressure from the pressure system which includes the pump 41 and the motors 26 and 27 to the hydraulic cou-
7. A plugging system which includes the pumps 41 and 42 and the motors 31 and 38 and also means to drain said hydraulic coupling system by way of the hydraulic pressure system.

8. Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended and I wish therefore not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a loading machine, the combination with a main frame, of an articulated conveyor mounted thereon including trough forming conveyor frame members mounted for relative swinging movement about an axis, endless draft conveyor mechanism adapted to travel through said conveyor trough, an adjustable shaft over which said draft mechanism travels, and hydraulic means operated by swinging movement of one of said frame members to adjust the position of said shaft, said hydraulic means including hydraulic piston abutments adjacent said shaft, and feed means for expanding them as said swinging movement takes place.

2. In a loading machine, the combination with a main frame, of an articulated conveyor mounted thereon including trough forming conveyor frame members mounted for relative swinging movement about an axis, endless draft conveyor mechanism adapted to travel through said conveyor trough, an adjustable shaft over which said draft mechanism travels, and means operative in response to swinging movement of one of said frame members to adjust the position of said shaft, said means including mechanism to adjust said shaft in one direction independently of the tension of said chain and operative to provide slack in said chain in at least one of the positions of said conveyor frames.

3. A conveyor including a trough having two articulated frame parts, an endless chain conveyor mechanism adapted to travel through said trough, a shaft over which said chain conveyor mechanism travels, said chain when driven tending to pull said shaft in one direction, abutment means adapted to limit the movement of said shaft under the influence of said chain, means for swinging one of said frames relative to the other including hydraulic motor means, hydraulic motor means operating automatically by said swinging movement to adjust said abutment means, and means for introducing make-up fluid in the system of said abutment adjusting motors.

4. A conveyor including a trough having two articulated frame parts, an endless chain conveyor mechanism adapted to travel through said trough, a shaft over which said chain conveyor mechanism travels, said chain when driven tending to pull said shaft in one direction, abutment means adapted to limit the movement of said shaft under the influence of said chain, means for swinging one of said frames relative to the other including hydraulic motor means, hydraulic motor means operating automatically by said swinging movement to adjust said abutment means, and means for introducing make-up fluid in the system of said abutment adjusting motors.

5. A conveyor including articulated frame members, endless conveyor mechanism adapted to travel over said frame members, means for swinging one of said frame members relative to the other, a shaft on one of said frame members over which said endless conveyor mechanism runs, a hydraulic linkage for adjusting said shaft in response to swinging movement of said one frame member, said linkage including a pair of hydraulic piston motors having adjustable abutments for said shaft, a pair of pumps having abutments operable selectively on reverse movements of said one frame, and means interconnecting said piston motors and pumps whereby the first named abutments will both be moved whenever either of said second named abutments is moved.

6. A conveyor including articulated frame members, endless conveyor mechanism adapted to travel over said frame members, means for swinging one of said frame members relative to the other, a shaft on one of said frame members over which said endless conveyor mechanism runs, means forming a linkage for adjusting said shaft in response to swinging movement of said one frame member, said linkage means including a pair of adjustable abutments abutting said shaft, a second pair of abutments, means associated with the other of said frame members for operating said second abutments selectively on reverse movements of said one frame, and means interconnecting said abutments whereby the first named pair will both be moved whenever either of said second pair of abutments is moved.

7. In a loading machine, the combination with a main frame, of an articulated conveyor mounted thereon including trough forming conveyor frame members mounted for relative swinging movement about an axis, endless draft conveyor mechanism adapted to travel through said conveyor trough, an adjustable shaft over which said draft mechanism travels, and means operative in response to swinging movement of one of said frame members to adjust the position of said shaft, said means including mechanism to adjust said shaft in one direction independently of the tension of said chain and operative to provide slack in said chain in substantially all of the positions of said conveyor frames.

WILLIAM P. ROSE.

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