# United States Patent

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[54] **BELT-TRAINING APPARATUS**
**11 Claims, 9 Drawing Figs.**


[52] **U.S. Cl.** ..... **198/202,** 198/20
[51] **Int. Cl.** ..... **B65g 27/00**
[50] **Field of Search** ..... 226/23, 20; 198/202



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,108,232 | 2/1938 | Nash | 226/23 X |
| 2,914,957 | 12/1959 | Johnson | 226/23 X |
| 3,278,002 | 10/1966 | Robins | 198/202 |

FOREIGN PATENTS

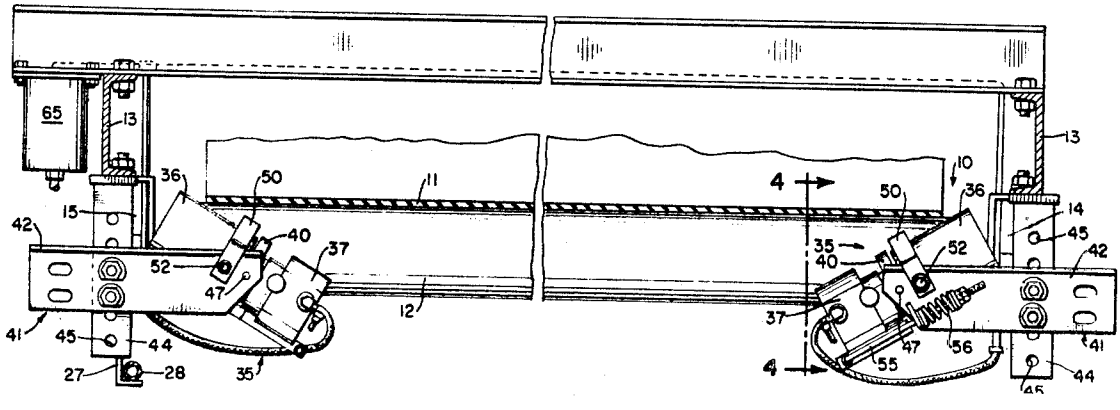
| | | | |
|---|---|---|---|
| 1,070,095 | 11/1959 | Germany | 198/202 |
| 1,102,647 | 3/1961 | Germany | 198/202 |



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**ABSTRACT:** The belt-training apparatus of the present invention includes two sensing units on opposite sides of a belt run, which is to be maintained in properly centered or trained position in relation to a conveyor-supporting frame, and which is supported on idler rollers. At least one of these belt supporting rollers is angularly adjustable to veer the belt run in properly trained position by the action of these sensing units. When the belt run is properly trained, the belt run does not activate the sensing units. Each sensing unit comprises a sensing roller adapted to be engaged by and frictionally driven by the adjacent edge of the belt run, when the belt run strays laterally from properly trained position, and a hydraulic pump coupled to the sensing roller. A hydraulic circuit includes the two pumps of the two sensing units interconnected by pipe connections, through which hydraulic liquid flows from a pump activated by sensing to an idle pump, and tends thereby to operate the latter pump as a motor. In accordance with the present invention, means are provided for preventing such interplay between the pumps.

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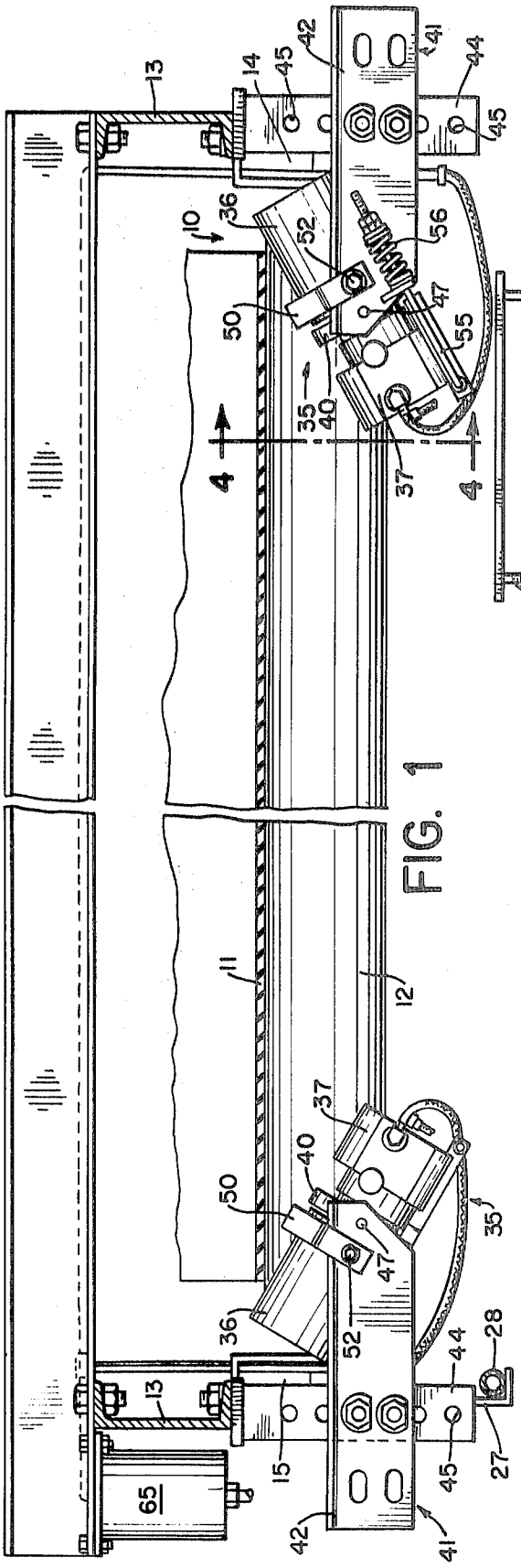


FIG. 1

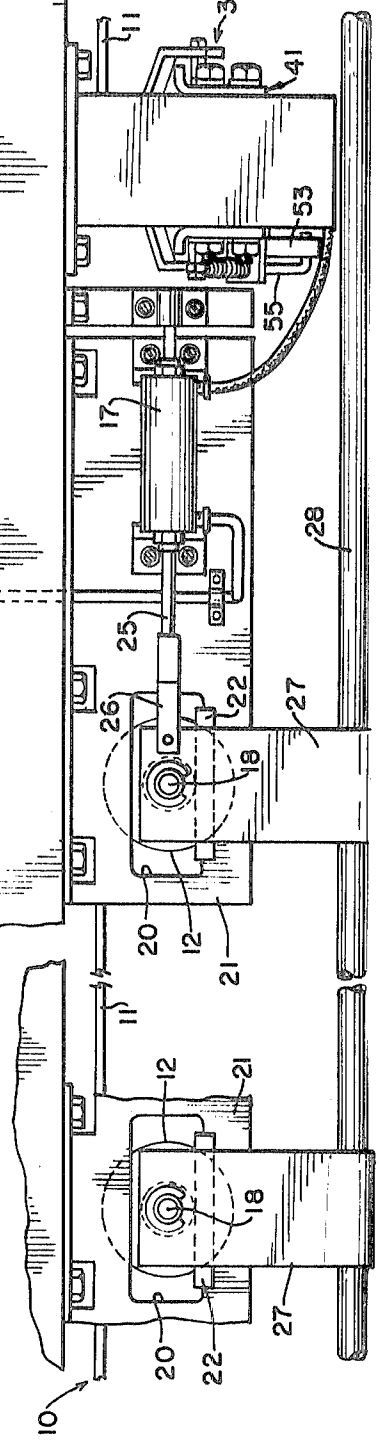


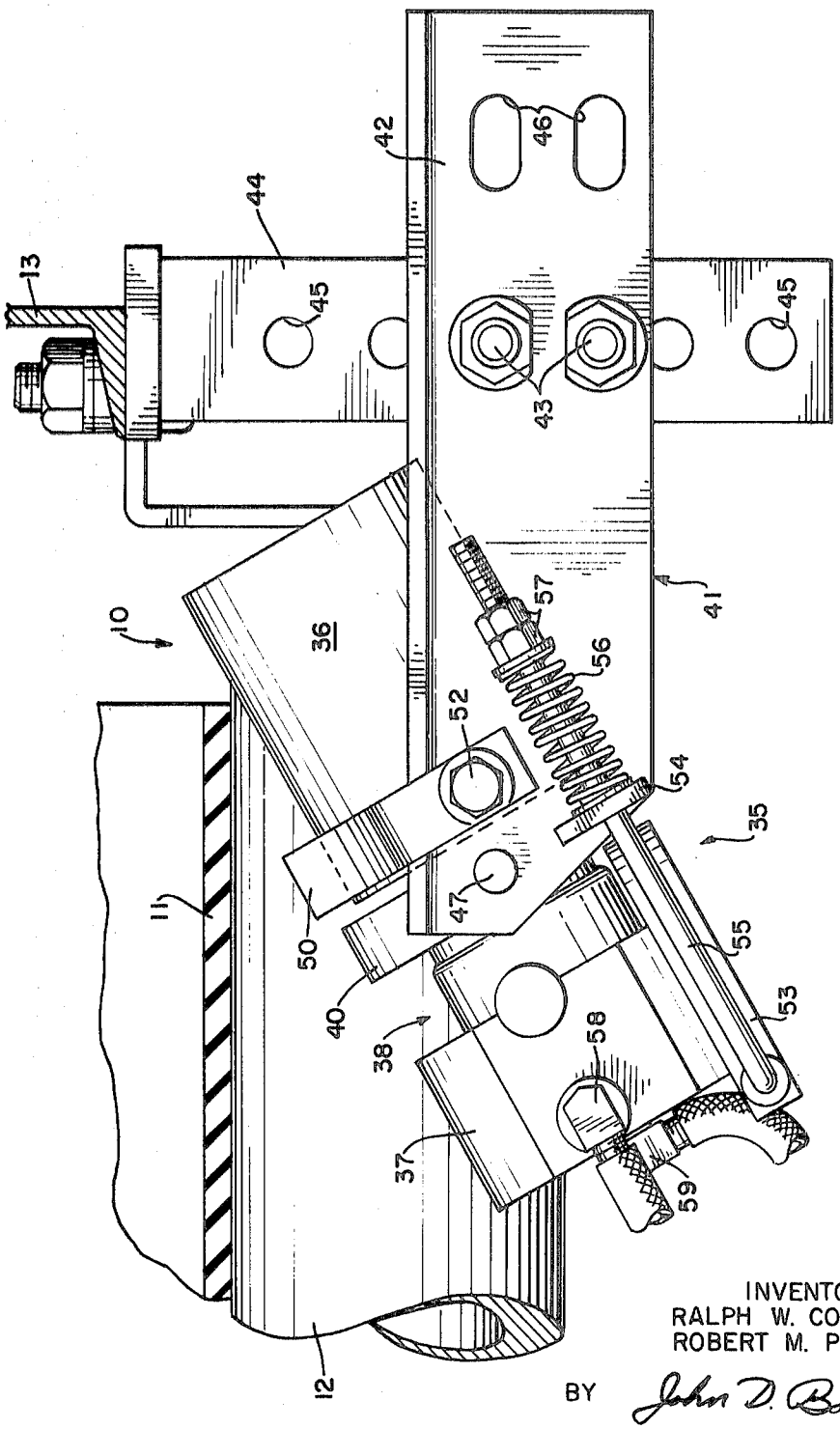
FIG. 2


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FIG. 3

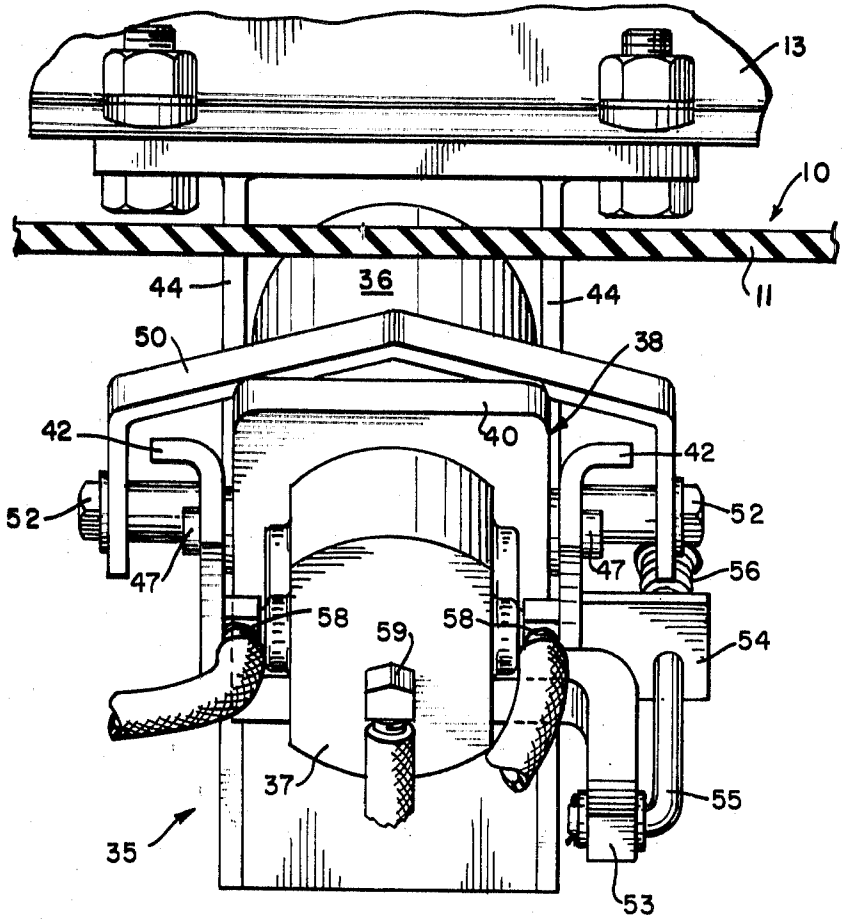



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FIG. 4




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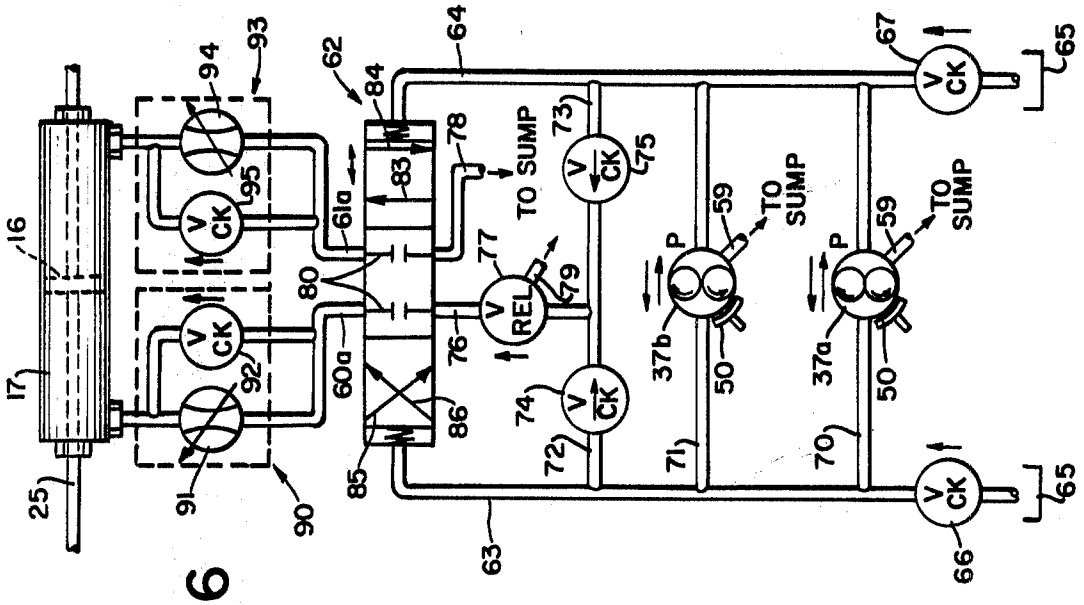
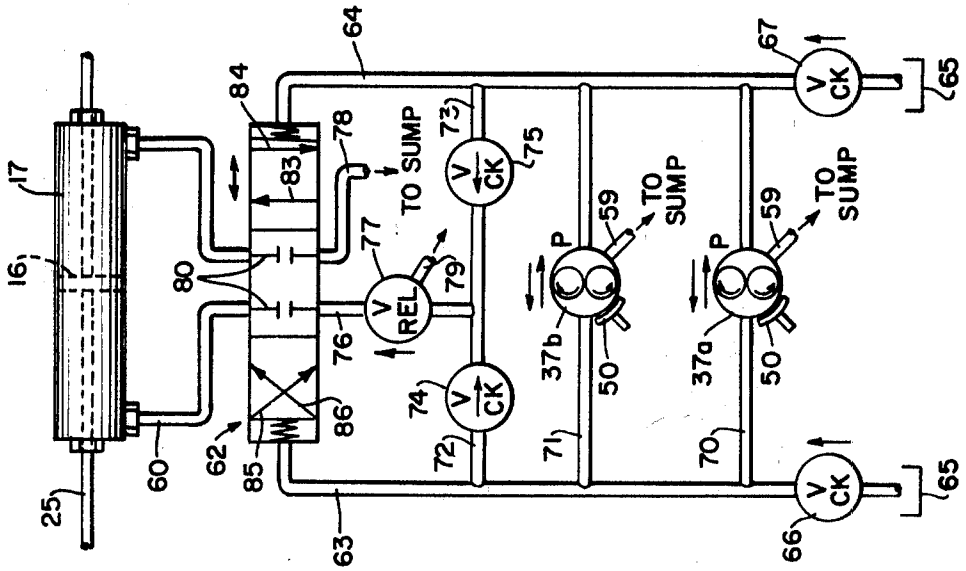



FIG. 6

FIG. 5




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FIG. 7

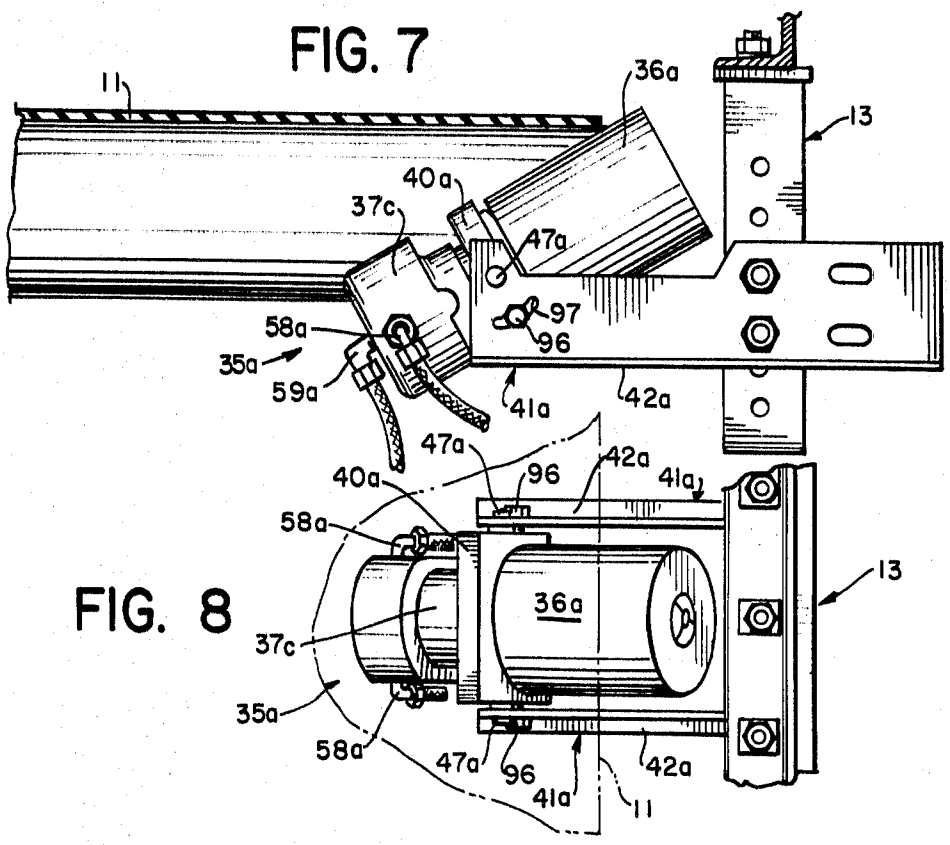
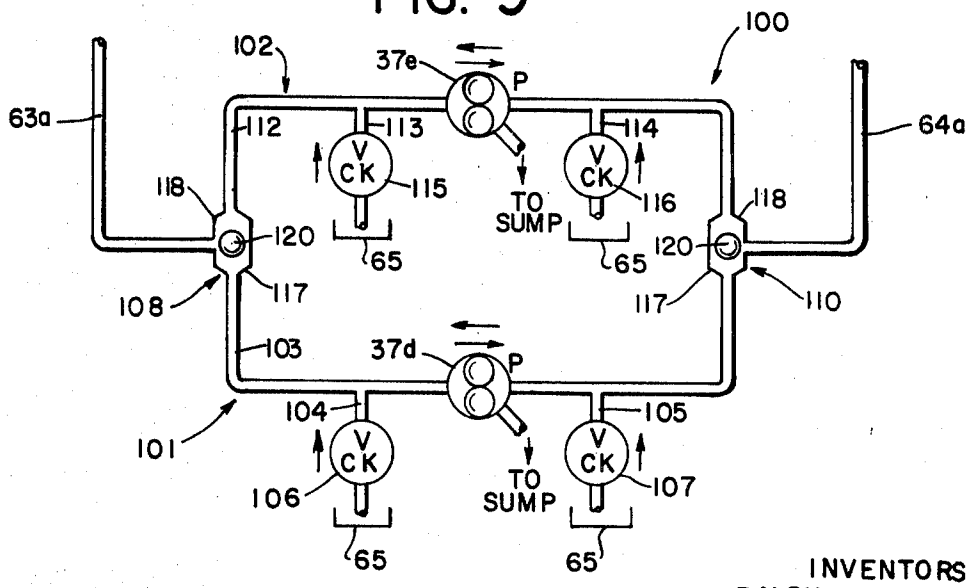



FIG. 8

FIG. 9




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# BELT-TRAINING APPARATUS

The invention also comprises a valve, which is movable by the hydraulic pressures created by the pumps when activated, into one of two positions, from a neutral position, and which according to its position, controls flow to and from hydraulic cylinder, designed to adjustably move the belt-supporting roller for belt centering or retraining operation. In neutral position, the valve blocks flow to and from the hydraulic cylinder.

The invention also comprises means by which the rate of travel of the piston in the hydraulic cylinder can be adjusted, so that the rate of adjustment of the belt-supporting roller for belt-retraining purposes can be correspondingly regulated.

The present invention relates to a belt training apparatus and is an improvement over the apparatus described in the Robins U.S. Pat. No. 3,278,002 issued Oct. 11, 1966.

A long endless belt employed as part of a conveyor system, for example, of the type used in connection with the handling of ore, if improperly trained, may wear rapidly and may consequently require expensive replacement or repair. The patent referred to discloses an apparatus for maintaining a belt centered with respect to the conveyor supporting frame structure by the use of sensing means positioned in proximity to each of the longitudinal edges of a conveyor belt run and actuated when the belt run is moved laterally off center. The actuation of either sensing means moves a transverse idler roller, on which the belt run is supported, angularly in a plane parallel to that of the belt run and in a direction to recenter the belt.

The apparatus of the present invention is of the general type described, and includes a double acting hydraulic cylinder with a piston connected to the angularly adjustable idler roller, and the two sensing means on opposite sides of the belt run to be trained comprise respective sensing rollers, adapted to be rotated when the adjacent side edges of a detrained moving belt run come into contact with the corresponding sensing rollers. The rotation of either sensing roller by this contacting action drives a corresponding hydraulic pump, which in turn pumps fluid to either side of the cylinder to move the idler roller angularly in the proper direction to retrain the belt run supported on said idler roller.

The different hydraulic units of the hydraulic system or circuit are so integrated, that the operation of either pump tends to operate the other pump as a motor. One way to avoid this adverse condition is to provide inefficient pumps having high internal friction. However, with such pumps, the tolerances are comparatively low and this tends to create undesirable leakages in the pumps.

One object of the present invention is to provide a new and improved belt-training apparatus of the general type described, which permits the use of efficient high precision pumps, and which avoids the interplay of pump and motor action between the pump units under the conditions described.

In accordance with one embodiment of the present invention, the objective described is attained by mechanical brake means provided in connection with each sensing roller to immobilize the roller when out of contact with the adjacent edge of the belt run under training control; this brake means is automatically releasable by the action of the adjacent edge of the offset belt run moving into driving contact with the sensing roller.

In accordance with another embodiment of the present invention, the interplay of pump and motor action between the pumps under the conditions described is prevented by valve means, which block the flow of hydraulic liquid from the activated pump to the idle pump, and which thereby prevent the latter pump from being operated as a motor.

Another problem is posed by a belt-training hydraulic system 64 the general type described when the conveyor belt run to be trained is inclined in a longitudinal direction. Under these conditions, the weight of the correspondingly inclined angularly adjustable supporting idler roller tends to move the piston in the double-acting hydraulic cylinder, thereby forcing fluid through one or both pumps. This allows the training idler roller to move angularly in a direction to detrain the belt.

Another object of the present invention is to provide a new and improved belt-training apparatus of the general type described, which avoids the adverse conditions described resulting from an inclination of the conveyor installation. For that purpose, the hydraulic system comprises a hydraulic actuated slide valve, which controls flow into and out of the hydraulic cylinder and which is operated through a system of check valves operating to prevent fluid from flowing back through the pumps. This slide valve also serves to direct hydraulic liquid from the nonpressured end of the hydraulic cylinder to a pump. This will aid in clearing out the air in initial assembly and in preventing air accumulation in the system during operation.

A further object of the present invention is to provide a belt-training system having the advantages of the present invention described and having a sensitivity which may be selectively varied by varying the rate of adjusting travel of its different control units, such as the angularly adjustable idler rollers.

Various other objects, features and advantages of the present invention are apparent from the following description and from the accompanying drawings, in which

FIG. 1 is a transverse vertical cross section through a conveyor installation showing a return belt run under the control of a belt-training apparatus which is provided with pump brake means and which constitutes one embodiment of the present invention;

FIG. 2 is an end view of the conveyor installation shown in FIG. 1;

FIG. 3 is a front view of one of the belt-sensing means forming part of the belt training apparatus shown in FIG. 1;

FIG. 4 is a side view of the belt-sensing means shown in FIG. 3;

FIG. 5 shows diagrammatically a hydraulic circuit adapted for use with the belt-training apparatus shown in FIG. 1, and constituting one embodiment of the present invention;

FIG. 6 shows a hydraulic circuit adapted for use with the belt-training apparatus shown in FIG. 2, and constituting still another embodiment of the present invention to provide control of the rate of travel of different movable control parts of the system;

FIG. 7 is a transverse vertical cross section through a part of a conveyor installation showing a return belt run under the control of a belt-training apparatus, which has no pump brake means but instead valve means for preventing an idle pump unit from being operated as a motor by the activated pump unit, and which forms part of a belt-training system constituting still another embodiment of the present invention;

FIG. 8 is a top plan view of the part of the conveyor installation shown in FIG. 7; and

FIG. 9 shows a part of a hydraulic circuit adapted in conjunction with part of the circuit shown in FIGS. 5 or 6, for use with the belt-training apparatus shown in FIGS. 7 and 8, and employing valve means instead of mechanical brake means for preventing the operation of the idle pump unit as a motor.

Referring to FIGS. 1 and 2 of the drawings, there is shown an endless conveyor belt 10, comprising an upper load carrying run, which is not shown, but which can be of the type shown in the aforesaid U.S. Pat. No. 3,278,002, and a lower return belt run 11, supported by a plurality of transverse substantially parallel idler rollers 12. These idler rollers 12 have end journals supported in suitable bearings.

A section of the belt run 11, which is to be train-controlled, may be supported on a plurality of adjustable retaining idler rollers 12, two of such rollers being shown in FIG. 2. Each of these adjustable rollers 12 is pivotally mounted at one end 14 to the frame structure 13, while the other end 15 is supported for arcuate movement through the action of a piston 16 (FIG. 5) in a double-acting hydraulic cylinder 17. In the specific form shown, each adjustable idler roller 12 at its movable end 15 has its journal 18 in a bearing, which passes through a horizontal slot 20 in a bearing plate 21 rigidly secured to the

frame structure 13, and which is supported for slide movement on a bearing block 22 secured to the bearing plate at the bottom of the slot. This construction permits the skewing motion of the idler roller 12 in a plane parallel to the plane of the belt run 11.

The hydraulic cylinder 17 is supported on the bearing plate 21, and has a piston rod 25 connected to the piston 16 (FIG. 5) in said cylinder, and connected at one end to a link 26 secured to a plate 27 supporting the bearing for the journal 18 of the roller 12. When the belt run 11 strays from its centered position, the piston 16 in the cylinder 17 is moved in a manner to be described, causing the plate 27 to be moved accordingly; this moves the end 15 of the idler roller 12 in the slot 20 of the bearing plate 21 in a direction to recenter the belt run 11.

The belt-training system of the present invention is shown arranged to simultaneously skew a group of two or more idler rollers 12 in either one of two directions. In the specific form shown, two or more of the idler rollers 12 are supported for angular movement, as shown in FIG. 2, and as described, and are provided with plates 27 at the free ends 15 thereof. A connecting rod 28 joins the lower ends of the plates 27, so that when one of the plates is moved by the piston rod 25 directly connected thereto, the other plates are moved at the same time through the connecting rod 28, thereby causing all of the idler rollers 12 controlled from the hydraulic cylinder 17 to be retrained into centered position.

The construction so far described is similar to that shown and described in the aforesaid patent.

A pair of sensing means 35 are positioned on opposite sides of the longitudinal edges of the belt run 11. Each of these sensing means 35 comprises a sensing roller 36 (FIGS. 1-4) coupled to a rotary pump 37 of the reversible gear type, having fluid flow communication with the hydraulic cylinder 17 in a manner to be disclosed, to move the piston 16 therein, when said pump is driven by driving contact of the sensing roller with an adjacent detrained edge of the belt run 11. The sensing roller 36 and the pump 37 are supported as a unit on a frame 38, which includes a bearing block 40 between the roller and the pump for the shaft coupling the pump and the roller. The sensing roller 36, the pump 37 and the frame 38 form a unit pivoted to a bracket 41 adjustably secured to the frame structure 13 of the conveying system. In the specific form shown, the bracket 41 comprises two parallel angle bars 42 flanking the sensing unit 35 and secured by means of bolts 43 to a pair of parallel depending legs 44 forming part of said frame structure 13. The legs 44 forming part of said frame structure 13 have a number of holes 45 and the angle bars 42 have elongated holes 46, to permit horizontal and vertical adjustment of the angle bars 42 in relation to the fixed frame structure 13.

For mounting a sensing unit 35 to the corresponding bracket 41, the bearing block 40 in said unit is pivotally secured to said bracket by means of pivot pins 47.

In the embodiment of the invention shown in FIGS. 1–4, the sensing rollers 36 are controlled by mechanical brake means for preventing the idle pump 37 from being operated as a motor by the action of the other pump 37, which has been activated by the engagement between its corresponding sensing rollers 36 and the adjacent edge of the detrained belt run 11. In this embodiment of the invention, each sensing unit 35 is spring biased into contact with a brake device 50, when not angularly depressed about the axes of the pivot pins 47 by contact with the adjacent longitudinal edge of the belt run 11. This brake device 50 is in the form of a yoke straddling the sensing roller 36 and rigidly affixed to the bracket bars 42 by means of studs 52.

The spring-biasing means comprises an arm 53 extending alongside of the pump 37 and rigid with the frame 38 of the sensing unit 35, a lug 54 integral or otherwise rigidly secured to one of the bracket bars 42, a rod 55 pivotally connected at one end to the arm 53 and passing with a slide fit through the lug 54, a coil spring 56 encircling the rod 55 beyond the lug and bearing at one end against said lug and bearing at the other end against a nut 57 threaded onto the outer end of said rod.

The spring-biasing means described maintains the sensing unit 35 slopingly in position with the sensing roller 36 yieldably pressed against the fixed brake 50, when the sensing roller 36 is not contacted by the adjacent edge of the belt run 11. This immobilizes the pump 37 in this sensing unit 35, so that this pump cannot be operated as a motor by the pumping action of the pump 37 in the other sensing unit 35, in case said other sensing unit has been activated by the lateral straying of the belt run 11. The angularities of the sensing units 35 in relation to the belt run 11 are adjusted by adjusting the angularity of the brakes 50 through the studs 52.

Two sensing units 35 of the general type described are slopingly positioned underneath the longitudinal edges of the belt run 11. When the belt run 11 is properly centered with respect to the fixed conveyor support frame structure 13, the two sensing rollers 36 in said sensing units 35 are out of engagement with the belt edges and immobilized by the brakes 50. However, when the belt run 11 strays laterally, for example, under the influence of uneven loading of the upper belt run, one longitudinally moving edge of the belt run 11 will frictionally engage the sensing roller 36 in the adjacent sensing unit 35, and at the same time, will tilt the sensing unit 35 about the axes of the pivot pins 47 against the action of the spring 56, so that the sensing roller is freed from engagement with the brake 50 and will be frictionally driven by the moving contacting belt edge. This will drive the pump 37 connected to the driven sensing roller 36 in the activated sensing unit 35 and will introduce hydraulic fluid into one end of the hydraulic cylinder 17, causing the idler roller or rollers 12 to be displaced angularly in the appropriate direction to recenter the belt run 11. At the same time, the pump 37 in the other sensing unit 35 will be immobilized by the action of the brake 50 on the sensing roller 36 in said sensing unit.

Each pump 37 has two connections 58, serving as inlet and outlet therefor, leading to and from the hydraulic cylinder 17, and operable as such, when the pump is released from the brake 50 and is operating for belt retrainment. Each of the pumps 37 has a pump drain line 59 to prevent internal leakage from building pressure on the shaft seals of the pump.

In the hydraulic circuit of FIG. 5 to be described, the two pumps 37 are interconnected through the connections 58, and when one pump 37 is operating, some of the hydraulic fluid flowing in the circuit by the action of this pump moves to the other immobilized pump through one of the connections 58 of the latter pump. The hydraulic fluid for the operation of the hydraulic circuit may be oil.

In the specific embodiment of the invention shown in FIGS. 1–4, the sensing rollers 36 are cylindrical, and the rate or rotation of a roller contacting an adjacent longitudinal edge of a detrained belt run 11 will be constant, depending on the rate of travel of the belt, regardless of the extent to which the belt run 11 has strayed from centered position. The corresponding pumps 37*a* and 37*b*, therefore, will rotate at a corresponding constant rate.

The sensing rollers 36, instead of being cylindrical, may be conical and taper towards their outer ends, causing thereby the pumps 37 to be driven at varying speeds depending upon the laterally strayed position of the belt run 11, i.e., the amount that the belt is detrained. If the belt run 11, for example, is only slightly detrained, it will contact the outside of a conical sensing roller 36 near its inner end where its diameter is comparatively large, and will frictionally drive the roller and the related pump 37 at a rate depending on this diameter, and if the belt run is offset laterally to a greater extent, the edge of the belt run will contact the adjacent sensing roller nearer its outer end where the diameter is smaller, and will drive the roller and, in turn, the pump at a correspondingly greater speed.

FIG. 5 shows diagrammatically a hydraulic circuit, which can be employed to control the belt-training apparatus of FIGS. 1–4 described, and which is also designed to avoid the

adverse effect of gravity on the idler rollers 12 due to possible inclination of the belt run 11. In this circuit, the hydraulic cylinder 17 has an inlet and outlet connection line 60 at one end of the cylinder and an inlet and outlet connection line 61 at the opposite end. Flow of hydraulic fluid through these lines 60 and 61 is controlled by means of a directional control slide valve 62 according to the axial position of said valve. The valve 62 is moved into any one of two operative positions against the action of spring means (not shown) normally biasing the slide valve in the neutral position shown in FIG. 5. For that purpose, two hydraulic lines 63 and 64 are connected to the ends of the control valve 62 to move said valve axially from neutral position. These hydraulic lines 63 and 64 lead from a hydraulic fluid reservoir 65 through check valves 66 and 67. Although the diagram of FIG. 5 shows two reservoirs 65 for simplicity in illustration, actually, the system would have a single hydraulic liquid supply reservoir.

Shunted across the two hydraulic lines 63 and 64 beyond the check valves 66 and 67 are two hydraulic flow lines 70 and 71 containing the two pumps 37 respectively of the two sensing units 35. These pumps are designated in FIG. 5 as pumps 37*a* and 37*b* respectively, for the purpose of facilitating description of the hydraulic circuit and its operation.

Shunted across the two hydraulic lines 63 and 64 is a third line divided into two parts 72 and 73 and containing respective check valves 74 and 75. These check valves 74 and 75 are sprung, so that they will open only when the hydraulic pressure acting thereon is developed to a predetermined level above atmospheric, as for example, 15 p.s.i. gauge.

A pressure connection line 76 joins the juncture between the lines 72 and 73 to one side of the directional control valve 62 and contains a pressure relief valve 77, with a relief connection line 79 to a sump, which may be the reservoir 65 supplying hydraulic fluid to the system, or may be connected to said reservoir for fluid return purposes. Also connected to this side of the directional control valve 62 is an exhaust connection line 78 leading to the sump.

Connected to one side of the slide valve 62 are the two connection lines 60 and 61 from the ends of the hydraulic cylinder 17, and connected to the other side of the slide valve are the two connection lines 76 and 78. Flow between the connection lines 60 and 61 on one side of the slide valve 62 and the connection lines 76 and 78 on the opposite side is effected or controlled through ducts and passageways in said slide valve, was will be described.

FIG. 5 shows the hydraulic circuit in neutral condition when the belt run 11 is centered and inactive. Under these conditions, the piston 16 in the hydraulic cylinder 17 is in centered position, the sensing rollers 36 of the two sensing units 35 are out of contact with both edges of the trained belt run and are immobilized by the brakes 50, and the pumps 37*a* and 37*b* are correspondingly immobilized. Under these conditions, flow through the slide valve 62 between the connection lines 60 and 61 on one side of the valve and the connection lines 76 and 78 on the opposite sides is blocked.

The slide valve 62 is movable into any one of three axial positions including the center neutral position shown, and has three sets of flow controls for the three positions indicated. In the center neutral position shown, two parallel passageways 80 in the slide valve 62 in registry with the pair of connection lines 60 and 61 and with the pair of connection lines 76 and 78 are plugged, so that flow between these two pairs of connection lines through the valve is completely blocked. With this arrangement, any gravity action by the idler rollers 12 on the piston 16, due to the inclination of the belt run 11, and in turn due to the corresponding inclination of the idler rollers, would apply pressure to the piston 16 in the hydraulic cylinder 17 through the piston rod 25. However, since fluid flow on either side of the piston is blocked by the slide valve 62 in neutral position shown, the piston is held in this position, and the idler rollers 12 remain in proper position to maintain the belt run 11 in centered position.

Besides the center neutral position shown in FIG. 5, the slide valve 62 has two operative positions. For operation in one of these other positions, the slide valve 62 has two parallel ducts 83 and 84 for registry with the connection lines 60 and 61 respectively and connection lines 76 and 78 respectively, to permit hydraulic flow through these connections 60 and 61, in one direction. For operation in the other of these operative positions, the slide valve 62 has two crossing ducts 85 and 86 for registry with the connection lines 60 and 61 respectively, and with connection lines 78 and 76 respectively, to permit hydraulic flow through these connections 60 and 61 in an opposite direction. Assuming that the belt run 11 strays laterally in position to cause one of its longitudinal edges to engage the sensing roller 36 on one of the sensing units 35, this depresses the sensing unit angularly about the axes of its pivot support pins 47, and this operation releases the sensing roller from the corresponding brake 50, and at the same time, frictionally drives the sensing roller 36. Assuming that the sensing unit 35 so activated is the one containing the reversible pump 37*a*, this pump will be driven to cause the hydraulic fluid to be drawn from the reservoir 65 through either check valve 66 or check valve 67, according to the direction of movement of the belt run 11. It is assumed for the purpose of illustration that the belt run 11 is operated in a direction to cause the pump 37*a* to rotate in a direction to cause the hydraulic liquid to be drawn from the reservoir 65 through the check valve 66, so that the hydraulic line 64 becomes the pressure line. This operation builds up pressure in the line 64.

The slide valve 62 is spring pressed into the neutral position shown in FIG. 5, and the spring is biased to require a hydraulic pressure in the lines 63 or 64 corresponding at least to that which will open the check valves 74 and 75 (i.e., at least 15 p.s.i. in the embodiment illustrated) to move the slide valve in either of the two operative positions described.

In the operation of the hydraulic circuit so far described, the build up of pressure in the line 64 to at least 15 p.s.i. will slide the valve 62 towards the left against its biasing spring to bring the two ducts 83 and 84 into registry with the connection lines 60 and 61 respectively on one side of the slide valve 62 and in registry with the connection lines 76 and 78 respectively on the opposite side of the valve. With the slide valve 62 in this operative position, and the pressure in the lines 64 and 73 at least 15 p.s.i., the check valve 75 will open, causing the hydraulic liquid to pass through the line 76 and through the pressure relief valve 77. The hydraulic liquid will pass from the line 76 through the duct 83 in the slide valve 62, through the connection line 60 and into the hydraulic cylinder 17 on the left side of the piston 16, causing the piston to move to the right. The hydraulic liquid on the right side of the piston 16 will pass out of the cylinder 17 through the line 61, through the duct 84 in the slide valve 62 and through the the sump line 78 for return to the reservoir 65. During this operation, the pump 37*b* will be immobilized by the corresponding brake 50 acting on the corresponding sensing roller 36. The pump 37*a*, thereby, will not operate the pump 37*b* as a motor during this operation.

During the operation described, should the piston 16 reach the end of its stroke in the cylinder 17, and the pump 37*a* continue to operate, the pressure in the line 76 will increase until the relief valve 77 opens, allowing hydraulic liquid to return to the reservoir 65 through the exhaust 79. The relief valve 77 under these conditions acts as a safety valve.

The operation described will continue until the belt run 11 is retrained by the swinging of the idler rollers 12 angularly in appropriate directions, into centered position out of contact with both of the sensing units 35. Under these conditions, the spring means acting on the slide valve 62 will restore the slide valve into the neutral position shown in FIG. 5.

In case the belt run 11 moving in the direction described, strays laterally in the direction opposite to that described, the pump 37*b* is released from the action of its corresponding brake 50 and the hydraulic line 63 becomes the pressure line, and when the pressure builds up to at least 15 p.s.i. in said line

63, the slide valve 62 moves toward the right, until the crossing ducts 85 and 86 register with the connection lines 60 and 61 respectively on one side of the slide valve and with the connection lines 78 and 76 respectively on the opposite side of the slide valve. Under these conditions, the hydraulic liquid under pressure of at least 15 p.s.i., flows from hydraulic line 63 into line 72 through check valve 74, through line 76 and pressure relief valve 77, along the duct 86 in the slide valve 62 in the direction indicated, to the connection line 61 and into the hydraulic cylinder 17 on the right hand side of the piston 16 therein, causing said piston to move towards the left. The hydraulic liquid in the hydraulic cylinder 17 on the left side of the piston 16 is exhausted through line 60, through the duct 85 in the slide valve 12, and through the line 78 to the sump or reservoir 65. The movement of the piston rod 25 effected by this operation swings the idler rollers 12 angularly into position to center the belt run 11 out of contact with both sensing units 35.

In case the belt run 11 moves longitudinally in a direction opposite to that described, then the operations described due to the lateral straying of the belt run 11 are reversed, since the turning of the sensing rollers 36, and therefore the pumps 37*a* and 37*b*, will be in directions opposite to those described.

There may be cases where it is desired to regulate the rate of angular adjusting movements of the idler rollers 12 in their belt-retraining operations. For example, where the belt run 11 is steeply inclined, the rate of adjusting movements of the idler rollers 12 to recenter the belt run may be too slow for efficient correction, or there may be cases, as for example, on short high speed belts, where faster or different travel rate of adjustment of the idler rollers 12 is desired.

The hydraulic circuit of FIG. 6 is similar to that of FIG. 5, but provides in addition, mans for adjusting the rate of travel of the piston 16 in the hydraulic cylinder 17 in each direction, and thereby means for adjusting the rate of angular adjustment of the idler rollers 12.

In the embodiment of the invention shown in FIG. 6, the connection line 60*a*, corresponding to the connection line 60 of FIG. 5, has connected in series therewith a loop assembly 90, comprising a variable orifice valve 91 and a check valve 92 connected in parallel, and the connection line 61*a*, corresponding to the connection line 61 of FIG. 5, has similarly connected in series therewith a loop assembly 93, comprising a variable orifice valve 94 and a check valve 95 connected in parallel. The valves 92 and 95 operate as check valves to permit full flow to the hydraulic cylinder 17, without hindrance from the corresponding variable orifice valves 91 and 94, regardless of the settings of said valves 91 and 94. By adjusting the variable orifice valves 91 and 94, the rate of exhaust flow from the cylinder 16 is adjusted, and the rate of travel of the piston 16 in the cylinder 17 can thereby be selectively adjusted to regulate the rate of angular adjustment of the belt run 11 in recentering said belt run from offset position.

FIGS. 7 and 8 show a modified form of sensing means 35*a* on one longitudinal side of the lower return belt run 11 of an endless conveyor belt, it being understood that there is a similar sensing means 35*a* on the opposite longitudinal side of said belt run. This sensing means 35*a* does not include a mechanical brake mans as in the embodiment of FIGS. 1–6, but is incorporated in a hydraulic circuit shown in FIG. 9 having valve means for blocking flow of hydraulic liquid from a pump activated by the sensing contact of one side of a detrained belt run 11, to the other idle pump on the other side of aid belt run. These blocking valve means thereby prevent the idle pump from being operated as a motor.

Each of the modified sensing device 35*a* of FIGS. 7 and 8 referred to comprises a sensing roller 36*a*, which may be cylindrical as shown, or conical as described, coupled to a rotary pump 37*c*, similar to the pumps 37 in the construction of FIGS. 1–4. The sensing roller 36*a* and the pump 37*c* are supported as a unit on a frame which includes the bearing block 40*a* between the roller and the pump for the shaft, coupling the pump and the roller. The sensing roller 36*a*, the pump 37*c*, and the frame including the block 40*a* form a unit mounted on the bracket 41*a* through pivot pins 47*a* passing through the arms 42*a* of said bracket and into the respective sides of said bearing block 40*a*. This bracket 41*a* is similar to the bracket 41 in the construction of FIGS. 1–4 and is similarly adjustably secured to the frame structure 13 of the conveying system.

The angularity of the sensing unit 35*a* in relation to the belt run 11 is adjusted by rotating the unit about the axes of the pivot pins 47*a*, and the sensing unit 35*a* is locked in angularly adjusted operative position by clamping means, such as a headed clamping screw 96, threaded into one side of the bearing block 40*a* and passing through an elongated arcuate slot 97 in a bracket arm 42*a* concentric with the axes of the pivot pins 47*a*. Similar clamping means may be provided on the other side of the bearing block 40*a* to attain symmetry and balance.

Each pump 37*c* has two connections 58*a*, serving as inlet and outlet therefor, and has a pump drain line 59*a*, as in the construction of FIGS. 1–4, serving the purposes described in connection with said construction.

FIG. 9 shows part of a hydraulic circuit, which can be used with the brakeless sensing units 35*a* of FIGS. 7 and 8, and which replaces the part of the circuits of FIG. 5 or FIG. 6, just below the lines 72 and 73 in the latter circuits. This lower part of the circuit shown in FIG. 9 comprises a loop assembly 100 shunted across the two hydraulic lines 63*a* and 64*a* corresponding to the hydraulic lines 63 and 64 in FIGS. 5 and 6. This loop assembly 100 comprises two similar flow legs 101 and 102 connected together in parallel. EAch of the flow legs 101 102 includes a pump 37*c*; the two pumps 37*c* are designated in FIG. 9 as pumps 37*d* and 37*e* respectively, for the purpose of facilitating description of the hydraulic circuit and its operation.

The flow leg 101 includes a flow line 103 containing the pump 37*d*. Connected to the flow line 103 on the opposite sides of the pump 37*d* are two branch flow lines 104 and 105 leading from the hydraulic fluid reservoir 65 through check valves 106 and 107, blocking return flow towards said reservoir.

The flow leg 101 also includes two shuttle values 108 and 110 in the flow line 103 near opposite ends thereof respectively, blocking flow towards the pump 37*d*.

The flow leg 102 includes a flow line 112 containing the pump 37*e*. Connected to the flow line 112 on the opposite sides of the pump 37*e* are two branch flow lines 113 and 114 leading from the hydraulic fluid reservoir 65 through check valves 115 and 116, blocking return flow towards said reservoir. The flow leg 102 also includes the two shuttle valves 108 and 110 in the flow line 112 near opposite ends thereof respectively, blocking flow towards the pump 37*e*.

One end of the hydraulic line 63*a* is connected to the juncture between the flow lines 103 and 112 through the shuttle valve 108, and the other end is connected to one of the directional control slide valve corresponding to the directional control slide valve 62 in FIGS. 5 and 6. One end of the hydraulic line 64*a* is connected to the juncture between the flow lines 103 and 112 through the shuttle valve 110 and the other end is connected to the other end of the directional control slide valve.

The shuttle valve 108 is of known conventional construction, and for that reason, it is shown only diagrammatically. The shuttle valve 108 is located in the juncture between hydraulic line 63*a* and the flow lines 103 and 112 and is shown consisting essentially of two opposed valve seats 117 and 118 around valve openings, communicating with the flow lines 103 and 112 respectively and a valve member 120, shown in the form of a ball, confineably movable between these valve seats by the pressure in these flow lines 103 and 112, to open and close these openings. When, for example, the pump 37*d* is activated in a direction to pump liquid towards the left (FIG. () in the flow line 103, the hydraulic pressure in said line moves the valve member 120 in the shuttle valve 108 against the valve seat 118, and blocks flow into the flow line 112 toward

the inactive pump 37*e*, while permitting flow into the hydraulic line 63*a*. Similarly when the pump 37*e* is activated in the direction to pump liquid towards the left (FIG. 9) in the flow line 112, the valve member 120 in the shuttle cock 108 is moved by the hydraulic pressure in said line against the valve seat 117 in said shuttle cock, thereby blocking flow into the flow line 103 towards the inactive pump 37*d*, while permitting flow of the pumped liquid into the hydraulic line 63*a*.

The shuttle valve 110 is located in the juncture between the hydraulic line 64*a* and the flow lines 103 and 112, is similar to the shuttle valve 108 and is similarly operated to prevent liquid pumped from either activated pump 37*d* or activated pump 37*e* from flowing towards the other inactivated pump 37*d* or 37*e*, while permitting flow into the hydraulic line 64*a*.

In the operation of the hydraulic circuit of FIG. 9, the driving of the pump 37*d*, for example, in a direction according to the direction of the belt run 11 to cause the hydraulic liquid under pressure to flow towards the left in the line 103, will draw hydraulic liquid into the inlet of said pump from the reservoir 65 through the branch line 105 and through the check valve 107. The liquid under pressure from the flow line 103 passes through the shuttle valve 108 and into the hydraulic line 63*a*, where it acts to shift towards the right the directional control slide valve corresponding to the directional control slide valve 62 in FIGS. 5 and 6. The operation from then on is the same as described in connection with FIG. 5 or FIG. 6. During the operation of the pump 37*d* on one side of the belt run 11, flow of liquid from the line 103 to the idle pump 37*e* on the other side of the belt run is blocked by the shuttle valve 108. The pump 37*e* is thereby immobilized against operation as a motor.

The flow of the hydraulic liquid under pressure from the activated pump 37*d* will be towards the right in the line 103 if the belt run 11 is operating in a direction opposite from that indicated above, in which case, the liquid to the inlet of the pump 37*d* is drawn from the reservoir 65 through the branch line 104 and through the check valve 106. Under these conditions the shuttle valve 110 blocks flow of liquid to the idle pump 37*e*.

The pump 37*e*, when activated by contact of its sensing roller 36*a* with one side of the strayed belt run 11, will similarly be operated to draw liquid from the reservoir through either the branch line 113 or 114 and through check valves 115 or 116, according to the direction of movement of the strayed belt run, and the shuttle valves 108 and 110 will block flow to the idle pump 37*d* and thereby will prevent operation of the latter pump as a motor.

The operation of the rest of the circuit of FIG. 9 is similar to that of Fig. 5 or FIG. 6. Where, for example, the belt run 11 is horizontal or is not steeply inclined, the rest of the circuit shown in FIG. 9 may be similar to that shown in FIG. 5. Where this belt run 11 is steeply inclined, and the training idler rollers are consequently apt to move more slowly in one direction and faster in the other direction, the valve arrangements 91, 92, 94 and 95 of FIG. 6 may be used in conjunction with the circuit of FIG. 9 to permit movements of these training idler rollers to be adjusted and made uniform.

What is claimed is:

1. A belt-training apparatus comprising two sensing devices adapted to be placed on opposite sides of and in proximity to a conveyor belt run to be controlled against lateral straying and in position to be free from engagement with sides of the belt run when the belt run is properly trained, and to be engaged separately by the adjacent sides of the belt run when the belt run is detrained laterally while operating, each of said sensing devices comprising a hydraulic liquid pump, and means for driving said pump automatically when the corresponding sensing device has been engaged by the adjacent side of the detrained belt run, hydraulic circuit means responsive to the liquid pressure created by the driving of either one of said pumps for retraining the detrained belt run and comprising two hydraulic lines, one or the other becoming a pressure line according to the pump operating, the pumps of the two sensing devices being connected in parallel between said hydraulic lines, means for blocking the operation of each of the idle pumps said blocking means comprising brake means for each of said pumps, and means for automatically releasing said brake means associated with the driven pump when the detrained belt run engages the sensing device containing the latter pump, while the pump in the other sensing device is maintained idle by the brake means associated with the idle pump, each of said sensing devices comprising a sensing roller coupled to the corresponding pump and adapted to be engaged and frictionally driven by the adjacent side of the detrained belt run to drive said pump, said blocking means further comprising means mounting each of said brake means for direct action on the corresponding sensing roller.

2. A belt-training apparatus as described in claim 1, wherein the sensing roller and the pump in each sensing device are integrated into a unit, said apparatus comprising means for supporting said unit for movement relative to a frame structure supporting a conveyor system of which said belt run is a part, from a pump-braking position in which it is free from engagement with the adjacent side of the trained belt run, to a brake-releasing position when said sensing roller is engaged by the adjacent side of the detrained belt run and is moved thereby, and means for yieldably urging said unit towards said pump braking position.

3. A belt-training apparatus as described in claim 1, wherein said brake mans comprises a brake band around at least a part of the circumference of said sensing roller adapted to be rigidly secured to the frame structure supporting a conveyor system of which said belt run is a part, means pivotally supporting said sensing device in relation to said brake band to cause the sensing device to be tilted about its pivotal support and away from braking action by said brake band, when the sensing roller is engaged and is moved about its pivotal support by the adjacent side of the detrained belt run, and spring means urging said sensing device about its pivotal support into braking engagement with said brake band.

4. A belt-training apparatus as described in claim 3, comprising a frame structure integrating the sensing roller and the pump into a unit, and bracket means for pivotally supporting said unit and adapted to be secured to the conveyor support frame structure, said brake band being in the form of a yoke straddling said sensing roller and rigidly secured to said bracket means, said spring means comprising a rod pivotally connected to said integrating frame structure and extending along said unit, a lug secured to said bracket means, said rod passing through said lug with a slide fit, and a coil spring encircling said rod outwardly beyond said lug, and bearing against said lug, said coil spring being held under compression to maintain the sensing unit against the brake band under spring pressure.

5. An apparatus for training a belt run in a conveyor when the belt run strays laterally from a trained position, comprising an idler roller for supporting said belt run, means pivotally supporting said idler roller for angular movement, substantially in the plane of said belt run, a hydraulic cylinder having a piston therein, means connecting said piston to the idler roller for effecting said angular movement as said piston moves in said cylinder, a directional control valve, a hydraulic pressure line connecting into said valve, an exhaust line leading from said valve, a first connection line and a second connection line connecting into said cylinder at opposite sides of the piston and connecting into said valve, means for sensing the straying of said belt run laterally from trained position, means automatically responsive to the sensing action of said sensing means when the belt run strays laterally from trained position for creating hydraulic pressure in said pressure line, said valve being movable into any one of three positions, said valve in a first of said positions having means establishing communication therethrough from said pressure line to said first connection line and from the second connection line to said exhaust line to move said piston in one direction in said cylinder, said valve in a second of said positions having means

establishing communication therethrough from said pressure line to said second connection line and from said first connection line to said exhaust line, to move said piston in the opposite direction in said cylinder, said valve in a third of said positions blocking passage between said pressure line and both connection lines and between both connection lines and said exhaust line, means automatically operable while said belt run is in trained position for moving said valve into said third position and for maintaining it in said third position while said belt run is in trained position, means automatically operable when said belt runs strays laterally in one direction for moving said valve into said first position, and means automatically operable when said belt run strays laterally in the opposite direction for moving said valve into said second position, said means for moving said directional control valve comprising two hydraulic lines leading from a supply of hydraulic liquid to said directional control valve, and means for creating hydraulic pressure in one or the other of said hydraulic lines automatically when said belt run strays laterally from trained position, the hydraulic line in which hydraulic pressure is created depending on the straying direction of the belt run, the movement of said directional control valve into said first and second positions being effected by the hydraulic pressure applied to said valve by the hydraulic line under hydraulic pressure.

6. A belt training apparatus as described in claim 5, said means for creating hydraulic pressure in said pressure line comprising a third line shunted across said two hydraulic lines, said third line being divided into two parts and having a check valve in each of said line parts, said pressure line being connected to said third line between said check valves, and said check valves permitting hydraulic flow towards said pressure line but blocking flow in the opposite direction.

7. A belt training apparatus as described in claim 6, said check valves being sprung open only when the hydraulic pressures in the corresponding line parts attain a predetermined value substantially above atmosphere.

8. A belt-training apparatus as described in claim 6, said means for creating hydraulic pressure in said pressure line also including two pumps shunted across said hydraulic lines, and means operating one or the other of said pumps in accordance with the activation of said sensing means according to the lateral direction of straying of the belt run.

9. An apparatus for training a belt run in a conveyor when the belt run strays laterally from a trained position, comprising an idler roller for supporting said belt run, means pivotally supporting said idler roller for angular movement, substantially in plane of said belt run, a hydraulic cylinder having a piston therein, means connecting said piston to the idler roller for effecting said angular movement as said piston moves in said cylinder, a directional control valve, a hydraulic pressure line connecting into said valve, an exhaust line leading from said valve, a first connection line and a second connection line connecting into said cylinder at opposite sides of the piston and connecting into said valve, means for sensing the straying of said belt run laterally from trained position, means automatically responsive to the sensing action of said sensing means when the belt run strays laterally from trained position for creating hydraulic pressure in said pressure line, said valve being movable into any one of three positions, said valve in a first of said positions having means establishing communication therethrough from said pressure line to said first connection line and from the second connection line to said exhaust line to move said piston in one direction in said cylinder, said valve in a second of said positions having means establishing communication therethrough from said pressure line to said second connection line and from said first connection line to said exhaust line, to move said piston in the opposite direction in said cylinder, said valve in a third of said positions blocking passage between said pressure line and both connection lines and between both connection lines and said exhaust line, means automatically operable while said belt run is in trained position for moving said valve into said third position and for maintaining it in said third position while said belt run is in trained position, means automatically operable when said belt run strays laterally in one direction for moving said valve into said first position, and means automatically operable when said belt run strays laterally in the opposite direction for moving said valve into said second position, and means for selectively controlling the rate of travel of the piston in said hydraulic cylinder.

10. A belt-training apparatus as described in claim 9, wherein said means for selectively controlling the rate of travel of the piston in said hydraulic cylinder comprises manually controllable valve means in each of said connection lines for controlling the hydraulic pressure in said connecting lines applied to said hydraulic cylinder.

11. A belt-training apparatus as described in claim 9, wherein said means for selectively controlling the rate of travel of the piston in said hydraulic cylinder comprises a valve assembly in each of said connection lines, each of said assemblies comprising a variable valve for regulating the flow away from the hydraulic cylinder and a check valve connected in parallel with said variable valve for allowing flow to the hydraulic cylinder and for blocking flow away from the hydraulic cylinder so that the flow away from the hydraulic cylinder passes through said variable valve.