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REGULATING APPARATUS FOR A HYDRAULIC TRACK SPREADER

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FIG.4





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3,360,063 **REGULATING APPARATUS FOR A HYDRAULIC** TRACK SPREADER

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6 Claims. (Cl. 180-9.2)

This invention relates to a regulating apparatus for, and method for regulating, a track adjuster used on a tracked vehicle.

In one known construction of hydraulic track adjusters 15 for a tracked vehicle, the force with which the reversing roller is urged against the track is maintained at a constant value, independent of the position of the reversing roller and also of the track adjuster, by means of a regulating system for maintaining a constant pressure of the 20 being so constructed that the following correlation is hydraulic fluid in the track adjuster cylinder. This has the disadvantage that, during particular driving conditions which require a low advancing force or power in the more tightly stretched portions of the track between the driving sprocket and that portion of the track rest-25ing on the surface of the road or other surface, the track is stretched or tightened excessively. On the other hand, driving conditions also may occur, for example over mountainous terrain, which require such a great advancing force that the track adjuster force being regu-30 lated in this manner does not suffice to prevent the track adjuster from running into the innermost position thereof due to the longitudinal track forces acting on the reversing roller.

In another known construction of hydraulic track ad- 35 justers, the supply of the hydraulic fluid to and from the track adjuster cylinder is controlled by appropriate valves or slides, or by a combined valve and slide, in such a manner that the hydraulic fluid can flow to the track adjuster under the predetermined line feed pressure 40 if the forces exerted by the track on the reversing roller are small. If the longitudinal track tension or force increases beyond the value corresponding to the hydraulic line feed pressure, the inflow of the hydraulic fluid is blocked but no outlet is opened. The pressure of the hydraulic in the track adjuster then will increase corresponding to the longitudinal track force until a predetermined upper safety limiting value has been attained, at which point an outlet will be opened. The disadvantage of this particular construction is that, after the longitudinal track force corresponding to the feed pressure has been exceeded, the track adjuster can not start but will, instead, move slightly inwardly due to the compressibility of the hydraulic fluid. This disadvantage becomes particularly evident if the traveling or driving direction is such that the more strongly tightened or stretched track portion between the driving sprocket and the track part resting on the surface of the road runs over the reversing roller.

An excessive tension in the track results in excessively high losses of the driving force or propulsive output, whereas a tension which is too low may, under certain circumstances, produce a breaking of the track. In general, therefore, it is desirable to tighten or spread the track in each case to such an extent that neither of these two difficulties will result. Thus, it is desired to correlate the force with which the reversing roller is urged against the track in each case to the advancing or driving force required by the vehicle at the particular track. It is known to achieve this in an approximate manner in which the theoretical value of the hydraulic

fluid pressure which should exist in the track adjuster cylinder is manually adjustable in either two or more stages. It also has been proposed to measure the torque in the track drive, which is proportional to the advancing force of the track, i.e., to measure it in the elements for the transmission of power connected to the trackdriving sprocket and to determine therefrom the reference input, i.e., the theoretical value, for the aforementioned hydraulic pressure.

The present invention utilizes in a particularly ad-10 vantageous manner the latter regulation of hydraulic pressure within the track adjuster cylinder. For this purpose, the present invention utilizes known transmitting elements, for example, those of electrical, electronic, hydraulic, or purely mechanical types, which transform or convert the torque measured at the track-driving sprocket into the reference input for the hydraulic pressure in the track adjuster cylinder, and transmit the same to the corresponding cylinder, the transmitting element produced between the driving torque and the reference input for the aforementioned hydraulic pressure: (a) In the case of driving conditions in which that portion of the track over-running the reversing roller participates in the transmission of the tractive force from the driving sprocket to the road surface, the reference input of the hydraulic pressure in the track adjuster cylinder results in a longitudinal track force within the two parts of the track running off the reversing roller which is at all times by a precisely constant or substantially constant value above the advancing force or power transmitted by the respective track to the road surface and,

(b) In driving conditions in which that portion of the track over-running the reversing roller does not participate in the transmission of the tractive force from the track-driving sprocket to the road surface, the reference input of the hydraulic pressure in the track adjuster cylinder results in a precisely constant or substantially constant longitudinal track force in the two parts of the

track running off the reversing roller which is preferably equal to the constant excess value referred to under (a)above.

The measurement of the driving torque, supplied to the driving sprocket which is necessary for the regulation of the hydraulic pressure in the track adjuster cyl-45inder, may be performed particularly favorably if the track drive is equipped, in known manner, with a planetary-type reduction gear. In such case, it is preferred that the supporting or bearing moment of the station-

- 50 ary part of the planetary gear, generally the outer ring, be measured with known means.
 - One embodiment of the present invention is illustrated in the accompanying drawings in which:
- FIGURE 1 is a schematic view showing the principle 55 of a track with the ratios of forces prevailing therein in one driving direction,
 - FIGURE 2 is a corresponding schematic view for the opposite driving direction.
- FIGURE 3 is a diagram of the ratios of forces pre-60 vailing at the reversing roller,
 - FIGURE 4 is a flow diagram of the signal arrangement employed in the present invention,
- FIGURE 5 is a graphic representation of the dependence of the track adjuster force on the advancing force 65 which the track transmits to the road,
 - FIGURE 6 is a diagram of a track drive with a sun and planet gear,
- FIGURE 7 is a schematic top plan view of the sun and planet gear of the track drive with means for measure-70 ment of the torque, and

FIGURE 8 is a schematic view of a measuring member for measurement of the torque.

In FIGURES 1 and 2, reference numerals 1_{I} to 1_{IV} designate the road wheels, reference numeral 2 identifies the driving sprocket, reference numeral 3 identifies the reversing roller, and reference numeral 4 identifies the track. Reference numeral 5 identifies the piston, reference numeral 6 designates the piston rod, and reference numeral 7 represents the cylinder of the hydraulic track adjuster in which force is produced by the pressure of the hydraulic fluid within the cylinder space 8. The longitudinal forces in the track for the driving direction according to the arrow 9_{I} have been indicated in FIGURE 1 and for the driving direction according to the arrow 9_{II} in FIGURE 2 by means of lines applied in each case at a right angle to the track 4. The advancing power or force Z_1 and Z_2 , respectively has been shown therein, 15 in the interest of simiplification, as being transmitted to the track 4 in a uniformly distributed manner to the road surface, not shown. It was further assumed, also in the interest of simplification, that this force is transmitter at the first tooth of the driving sprocket 2 in engagement with the track 4 and is transmitted undiminished. The arrows M_1 in FIGURE 1 and M_2 in FIGURE 2 indicate the direction of the torque at the driving sprocket. The slack strand of the track must not be completely without tension but should have a slight pretensioning force P_{v1} and P_{v2} , respectively, in order to ensure a faultless running-off of the track. Accordingly, the strand of the track revolving around the reversing roller has, in FIG-URE 1, the longitudinal track force $P_{g1} = Z_1 + P_{v1}$ and, in FIGURE 2, the longitudinal track force P_{v2} . From these longitudinal track forces, which have been generally designated by P in FIGURE 3, results, in known manner, the track adjuster force Pk which is required to counteract the track force, note FIGURE 3. In this instance, only the simple case was assumed where the track adjuster is positioned precisely in the direction of the resultant P_k . Otherwise, P_k must be determined from P using the known laws of mechanics, for example, if the reversing roller is mounted on a crank arm, by means of the equations of moments.

In the signal flow diagram of FIGURE 4, reference numeral 11 represents the device for measuring the torque applied to the driving sprocket 2, reference numeral 12 identifies the converter, which may be electronically operated for example, for producing the reference input 45 for the hydraulic pressure within the cylinder space 8 of the track adjuster cylinder 7; reference numeral 13 identifies the regulator of this hydraulic pressure, and reference numeral 14 represents the control element, e.g., 50a distributing slide valve for the hydraulic fluid. Reference numeral 15 represents the cylinder space 8 of the track adjuster cylinder 7.

The supply of hydraulic fluid to the control element 14 is effected at 16 from a supply system, not shown, and the discharge from the element 14 is effected at 55 17 to a reservoir, not shown. Transmitted at 18 are the measured values for the driving torque M1 and M2, respectively, according to value and sign, at 19 the reference input for the hydraulic pressure in the track adjuster cylinder 15, being formed in 12, at 20 the displacing movement of the control element 14, and at 21 the hydraulic fluid flow either to or from the track adjuster cylinder 15. The repeating or answering signal of the actual value of the hydraulic pressure in 15 to the regulator 13 is effected at 22.

FIGURE 5 illustrates the characteristics 24 and 25 of the member 12. The advancing forces Z_1 and Z_2 , respectively, being transmitted by the track to the road are shown as the abscissa for the driving directions according to FIGURES 1 and 2, respectively. The instrument 12 indicates the forces Z_1 and Z_2 from the measured values for the driving torque M1 and M2, respectively, by multiplication with the corresponding constant. The ordinate is the track adjuster force P_k and 75

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also the hydraulic pressure in the track adjuster cylinder, which is proportional thereto. The track adjuster force portion P_{k2} and also the dashed line 23 correspond to the driving condition of FIGURE 1, but for the undesirable case where $P_{v1}=0$. The angle β of this line is found by means of known correlations from the angle α of FIGURE 3. In order to obtain the desired finite value of P_{v1} , the characteristic 24 is positioned over the line 23 by a corresponding value P_{k1} so that for the driving conditions of FIGURE 1, the hydraulic pressure in the track adjuster cylinder is regulated in accordance with the track adjuster force Pk. For the driving conditions according to FIGURE 2, there results from the requirement of the specific value for P_{v2} the track adjuster force P_k^* .

In the track drive according to FIGURES 6 and 7, reference numeral 30 designates the drive shaft originating from the steering mechanism, reference numeral 31 identifies the sun gear rigidly secured thereto and reference numerals 32_{I} to 32_{III} represent the planet gears 20 which are mounted on the planet carrier 33, the latter being connected to the track-driving sprocket 35 by means of the shaft 34. Reference numeral 36 identifies the outer gear ring of the planetary gear, which is secured against rotation by means of the measuring members, preferably 25three, 37_{III} to 37_{IIII} connected to the vehicle hull at 38_{III} to 38₁₁₁, respectively. The measuring members 37 which measure the moment of the outer ring 36, which moment is proportional to the torque at the driving sprocket 35, may be constructed, for example, according to FIGURE 30 8. As shown in the latter figure, they may consist of a slightly resilient ring 40 with two straps 41 and 42, with the aid of which the measuring members are secured to the gear ring 36 and also to the vehicle hull. The force 35 measurement is effected by determining the deformation of the ring 40 by means, for example, of an inductive path recorder 43 which is responsive to the change of the ring diameter between the straps 41 and 42. Other constructions of the measuring member which may be employed 40 are traction-compression rods with extension measuring strips secured thereto, or hydraulic cylinders, the pressure of the hydraulic fluid serving as an indication of the bearing power or force.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. An apparatus for regulating a hydraulic track adjuster for a tracked vehicle which comprises means for measuring the driving torque applied to the track, and converter means connected thereto for producing a reference input for the regulation of the hydraulic pressure in the adjuster cylinder in accordance with a characteristic wherein (a) for driving conditions in which the track part over-running the reversing roller participates in the transmission of the tractive force from the track drive to the road surface, the reference input corresponds to a longitudinal force within the two parts of the track running off the reversing roller which is at all times in ex-60 cess of, by an at least substantialy constant value, the driving force transmitted to the road by the track; and (b) for driving conditions in which the track part overrunning the reversing roller does not participate in the transmission of the tractive force from the track drive 65 to the road surface, the reference input corresponds to an at least substantially constant longitudinal force in the two parts of the track running off the reversing roller which is substantially equal to the aforementioned excess value. 70

2. An apparatus according to claim 1 in which the means for measuring the driving torques applied to the track measure the retaining torques of the stationary gear of a planetary gear system, which latter are part of driving means for a track-driving sprocket.

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3. An apparatus according to claim 2 in which the measuring means connected to the stationary gear, comprises respectively at least one resilient ring means having means connected thereto for measuring differences in the resilient ring diameter.

4. An apparatus according to claim 2 in which the measuring means connected to the stationary gear ring comprises respectively at least one traction-compression rod containing strain gauges.

5. An apparatus according to claim 2 in which the 10 measuring means connected to the stationary gear ring comprises at least one hydraulic cylinder containing measuring means for measuring the hydraulic pressure therein.

6. A method for regulating a hydraulic track adjuster 15 for a tracked vehicle which comprises measuring the driving torque applied to the track and converting the obtained measurement into a reference input for the regulation of the hydraulic pressure in the adjuster cylinder in accordance with a characteristic wherein (a) for driving 20 conditions in which the track part over-running the reversing roller participates in the transmission of the tractive force from the track drive to a road surface, the ref-

erence input corresponds to a longitudinal force within the two parts of the track running off the reversing roller which is at all times in excess of, by an at least substantially constant value, the advancing force transmitted to the road by the track; and (b) for driving conditions in which the track part over-running the reversing roller does not participate in the transmission of the tractive force from the track drive to the road surface, the reference input corresponds to an at least substantially constant longitudinal force in the two parts of the track running off the reversing roller which is substantially equal to the aforementioned excess value.

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