

PATENT SPECIFICATION

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(54) STEERING CLUTCH AND BRAKE CONTROL SYSTEM

(71) We, CATERPILLAR TRACTOR CO., a corporation organised and existing under the laws of the State of California, United States of America, of 100 N.E. Adams Street, Peoria, State of Illinois 61602, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the steering of tractors, and more particularly, to the steering of tractors which include steering clutches and steering brakes.

In track-type tractors steering is accomplished by interrupting the drive to the drive wheel or sprocket on one side or the other of the tractor, and may be assisted by applying a brake selectively to the right or left drive components. In the past, control systems for steering through such means have been proposed in an effort to provide complete steering control through a single manual control element associated with each track. See, for example, U.S. Patent Nos. 2,941,639, 3,262,525 and 3,374,846 and British Specifications Nos. 1,170,034 and 1,218,526. Generally, each of these systems includes means for providing, through the movement of a single actuator member, the initial disengagement of a clutch and subsequent engagement of a brake associated therewith. In the case of U.S. Patent No. 2,941,639, U.S. Patent No. 3,374,846, and British Specification No. 1,218,526, valve means are included to provide such sequential operation of the steering clutch and steering brake, while in the case of U.S. Patent No. 3,262,525 and British Specification No. 1,170,034, a lost-motion system is provided for achieving such sequential operation. Some of these systems also include a purely mechanical system for actuating the brakes thereof in-

dependently of the actuator member system just described. There is, however, no teaching in any of these references of an independent system for applying brakes through the application of fluid pressure to means associated with the brakes. Rather, as pointed out above, each independent system disclosed in the above-mentioned patents relies on purely mechanical linkage means or the like to accomplish this result.

Of more general interest in this area are U.S. Patent Nos. 2,845,818, 2,876,657; 2,876,659; 2,981,235; 2,989,986; 3,187,845; 3,305,037; 3,369,460; 3,348,563; and 3,448,841.

According to the invention, there is provided a clutch and brake control system for a vehicle in which driving force is applied to each side thereof through a fluid pressure responsive normally engaged clutch and including a fluid pressure responsive normally disengaged brake for each side, said control system comprising valve means connectable to a source of fluid pressure and to said clutch and to said brake and including a reciprocable valve spool positionable in a first position for preventing fluid pressure from said source from actuating said clutch and said brake and movable sequentially to second and third positions, said spool in said second position in use allowing fluid pressure from said source through said valve means to said clutch for disengaging said clutch, but blocking fluid pressure from said source to said brake, said spool in said third position allowing fluid pressure from said source through said valve means to said clutch to maintain said clutch in its disengaged state and allowing fluid pressure from said source through said valve means to said brake for actuating said brake; means for operatively connecting an actuating member with said valve spool so that movement of the actuating member to first, second and third

sequential positions moves the valve spool to its first, second and third sequential positions respectively; and means operable independently of said valve means 5 for allowing fluid pressure from said fluid pressure source to said brake, so that the brake may be actuated with the clutch in an engaged state.

An embodiment of the invention will now be described, by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a side elevation of a crawler tractor incorporating a clutch and brake 15 control system according to the invention;

Fig. 2 is a schematic view of the clutch and brake control system shown in Fig. 1;

Fig. 3 is a sectional elevation of a portion of the clutch and brake control system, in a neutral position;

Fig. 4 is a sectional elevation of a portion of the clutch and brake control system, wherein the clutch means of the system are in a disengaged state; and

Fig. 5 is a sectional elevation similar to that shown in Fig. 3, wherein the clutch means are in a disengaged state, and wherein the brake means are in an actuated state.

Referring to the drawings, a combined steering clutch and brake control system is generally indicated by the reference numeral 10 as operatively associated with a track-type vehicle generally designated by the reference numeral 12. The vehicle 12 includes an elongate body 14 having an engine compartment 16 and an operator's compartment 18. The body 14 is supported and propelled by a pair of laterally spaced track assemblies 20, respectively disposed on opposite sides of the vehicle body 14. Any suitable power train may drivingly connect the prime mover of the vehicle 12 to the track mechanism for propelling the vehicle 12. Such power train normally includes a crossdrive arrangement having a pair of normally engaged steering clutches and a pair of normally disengaged brakes disposed therein. One of the steering clutches and one of the brakes is provided for independent control of torque to one of the track assemblies 20, whereas the other steering clutch and brake is provided for independently controlling torque to the other track assembly 20. Since the steering clutches and brakes may be of any suitable type, the details of which are not pertinent to the instant invention, the details of the clutches and brakes are not shown herein and no further description is necessary for an understanding of this invention.

The combined steering clutch and brake control system 10 includes a pair of actuating members in the form of hand control

levers, one of which is illustrated at 22, which are respectively connected by suitable actuating linkages such as that indicated generally at 24 to a pair of combined steering clutch and brake control valves, one of which is shown at 26.

A pair of brake pedals 28 are disposed in the operator's compartment 18 and are individually connected by suitable linkages indicated generally at 30 to a pair of brake 75 servo valves, one of which is illustrated at 32. Since the pair of levers, linkages, valves and pedals for the opposite sides of the drive mechanism are substantially identical, only one set of these controls will be described, it being understood that the other set of controls is constructed essentially the same and functions in identical manner thereto.

As is more clearly shown in Fig. 2, the 85 linkage 24 terminates in a bellcrank 34 for actuation of the steering clutch and brake control valve 26. In a similar manner, the linkage 30 associated at one end with pedal 28 terminates at its other end in a bell- 90 crank 36 for actuation of the brake servo valve 32. The output side of the brake servo valve 32 is operatively associated with a bellcrank 38 which acts through a scissors linkage generally indicated at 40, to control 95 engagement and disengagement of a brake 42.

Referring now to Fig. 3, valve 26 includes a body 4 having a longitudinal bore 46 extending therethrough for slidably and 100 reciprocally housing a valving control spool 48. A plurality of longitudinally spaced annular grooves 50, 52, 54, 56 are disposed in bore 46. A brake port 58 communicates between annular groove 50 and 105 a line 60 communicating with the brake servo valve 32 for a purpose to be hereinafter described. An inlet port 62 communicates between annular groove 52 and a line 64 for communication between a suitable 110 source of fluid under pressure and the bore 46 in the valve body 44. A clutch port 66 communicates between annular groove 54 and a line 68 for selective communication of pressurized fluid to a clutch actuator, 115 not shown. A passage 70 communicates between annular groove 56 and a chamber 72 defined in part by one end of valve body 44 and a valve actuator housing 74 which encloses the output end of the bellcrank 120 36. A hollow standpipe 76 is secured in the lower wall of housing 74 and extends upwardly in chamber 72 to a level above the valve elements.

An annular groove 78 is disposed in the 125 bore 46 adjacent an outer end thereof and communicates by way of a drain port 80 and a line 82 with an oil storage reservoir (not shown). The outer end of bore 46 adjacent annular groove 78 is closed and 130

sealed by a plug 84 which is retained by a snap ring 86.

The opposite end of bore 46 coaxially connects with an enlarged bore 88 to define a shoulder 90 therebetween. Spool 48 includes a reduced diameter extension 92 which is concentrically coextensive with enlarged bore 88. A snap ring 94 is provided adjacent the outer free end of extension 92. An actuating plunger 96 having a stepped bore 98 therein defining a shoulder 100 is disposed in telescoping relation over the extension 92 of the spool 48. A spool biasing spring 102 is disposed in telescoping relation over the extension 92 so as to have load bearing engagement between the end of the larger portion of the spool 48 and a washer 104 which engages the shoulder 100.

An adaptor sleeve 106 includes a reduced diameter annular extension 108 defining a shoulder 110. The adaptor sleeve 106 is slidably mounted in the enlarged bore 88 in telescoping concentric relation to the actuating plunger 96. A brake feel spring 112 is disposed between the shoulder 110 and a spring retaining washer 114 which engages the shoulder 90 defining the intersection of bore 46 with enlarged bore 88.

A snap ring 116 engages a suitable groove in the outer diameter of actuating plunger 96 and is adapted for selective engagement with the outer end of adaptor sleeve 106 to cause inward movement of the adaptor sleeve 106 and compression of spring 112 as the actuating plunger 96 is moved inwardly past a predetermined point.

A spring 188 is disposed between the plug 84 and the end of the spool 48 opposite extension 92 to provide a biasing force in opposition to the spring 102.

Spool 48 includes a pair of annular grooves 120, 122 defining a plurality of lands 124, 126, 128 which cooperate with the annular grooves 50, 52, 54, 56 to control the flow of pressurized oil through the valve 26. The lands 124, 126, 128 respectively include metering slots 130, 132, 134, 136. The end of the spool 48 adjacent the plug 84 includes a relatively large bore 138 opening to the outer end of the spool 48, with the inner end of the bore 138 joining a coaxial, relatively small diameter blind bore 140 which terminates in generally radial alignment with the annular groove 122. A passage 142 communicates between the outer surface of the land 124 and the inner end of the bore 138. A passage 144 communicates between annular groove 122 and the inner end of bore 140, with a passage 146 communicating between annular groove 120 and the intermediate portion of bore 140.

A relatively large diameter spool or piston 148 is sealingly, reciprocally and

slidably fitted in the bore 138 for abutment at its outer end with the plug 84. A smaller diameter spool or piston 150 is sealingly, reciprocally and slidably fitted in bore 140 in abutting relation with the inner end of piston 148.

As previously described, the line 60 communicates annular groove 50 of valve 26 with the brake servo valve 32. The brake servo valve 32 includes a body or cylinder 152 having a plurality of coaxial bores 154, 156, 158, 160, 162 coaxially aligned and serially connected therethrough. Bellcrank 36 has its output arm extending upwardly into the chamber formed by the bore 156 for engagement with a plunger 164. The plunger 164 is slidably mounted in a bore 166 of an adaptor sleeve 168 which is rigidly mounted in the bore 158. The sleeve 168 includes an external annular groove 170 which communicates through a plurality of radial ports 172 with an annular groove 174 formed in the bore 166. The groove 170 also communicates with an inlet port 176 which communicates via a line 178 with a suitable source of fluid pressure.

A valve spool 180 is slidably mounted in a bore 182 of plunger 164 and is biased outwardly thereof by a spring 184 into contact with a snap ring 186. A plurality of radial ports 188 communicate between a bore 190 of spool 180 and the outer periphery of the spool 180 for selective communication with a plurality of radial ports 192 which communicate with a plurality of radial ports 192 which communicate with the bore 182 of plunger 164. The inner end of the bore 182 communicates with a cross-passage 194 in the plunger 164.

The plunger 164 is biased to the left as viewed in the drawings by a pair of springs 196, which engage at one end a spring retaining washer 198 and at the other end a spring retainer 200 secured to the leftward end of plunger 164 by a snap ring 202. A stop member 204 is slidably disposed in the bore 154 and is biased by a spring 206 for resilient engagement with the output end of bellcrank 36 to absorb rebound energy as it returns to a brake release position as shown in Fig. 3.

A brake actuating servo piston 208 is reciprocally and slidably disposed in the bore 162 and has one end projecting outwardly therefrom for engagement with the free end of bellcrank 36 for selective actuation of the brake 42. The piston 208 includes an annular groove 210 around the outer periphery thereof with passages 212, 213 communicating between the annular groove 210 and a variable column chamber 214 defined by the piston 208, cylinder 152, and the brake servo valve. Groove 210 is disposed on piston 208 so as to be in constant communication with an

inlet port 216 to which the line 60 is connected to provide fluid communication from the valve 26 to the annular groove 210 and thence to chamber 214. A spring 218 is provided in the chamber 214 to bias the piston 208 outwardly to balance forces in the system urging the piston inwardly to minimize fill time for chamber 214 and improve control response.

10 In operation, fluid under pressure is supplied through line 64 and port 62 to the annular groove 52 in body 44 of the valve 26. When spool 48 is in a neutral or first position, the fluid pressure in groove 52 is communicated by way of annular groove 15 120, passage 146, bore 140, passage 144, and metering slots 136 to groove 56 where it is communicated by way of passage 70 to the chamber 72. This is effective to fill 20 the chamber 72 to the top of the standpipe 76 so that the oil supplied to the chamber 72 is communicated through the standpipe 76 to a bevel gear case, not shown, for lubrication of the bevel gear 25 shaft bearings during operation. With the spool 48 in this first position, communication between the inlet port 62 and the clutch port 66 occurs only via the narrow passage 146 and there is no communication between 30 the inlet port 62 and the brake port 58. The clutch port 66 also communicates by way of the slots 136 and the passage 70 with the chamber 72 to ensure that the clutch actuator is not pressurized. The brake port 35 58 communicates by way of the annular groove 50, bore 46 and annular groove 78 to drain port 80, and thence to tank by way of line 82 to ensure complete release of the brake 42.

40 Operation of hand control lever 22 to a second sequential or clutch disengaging position is effective to move the plunger 96 leftward as viewed in the drawings to urge spool 48 to a respective second or clutch 45 disengaging position as best illustrated in Fig. 4. With the spool in this position, the clutch port 66 is isolated from the annular groove 56 and passage 70 to permit fluid pressure to be applied to the clutch actuator. For this purpose, inlet port 62 communicates by way of the slots 134 to the 50 groove 54 and then the port 66 and the line 68 to the clutch for release thereof. At this time, communication between the inlet port 62 and the brake port 58 is still 55 blocked with the metering slots 130 maintaining communication between the brake port 58 and the drain port 80.

This permits the operator to relieve the clutch on one side of the vehicle without engagement of the brake to provide a gradual turn of the vehicle 10 by interrupting the drive to that respective track 20. The pressure in the clutch is modulated 65 by communication of the actuating pressure

to the bore 140 through the passages 144 and 146. The pressure in the bore 140 acts between the piston 150 and the end of the bore 140 in opposition to spring 102 for positioning spool 48 and controlling the 70 clutch pressure in proportion to the compression of the spring 102.

When it is desired to reduce the turn radius for a sharper turn of the vehicle 10, the control lever 22 is moved to a third 75 sequential or brake engaged position which urges the plunger 96 farther to the left at which point the snap ring 116 will engage the end of the adaptor sleeve 106 to provide additional resistance to movement of the control lever 22 and signal the operator 80 that he is going into the brake engaging position. Thus, the movement of the actuating member 22 from its first to its second position is resisted at a first spring rate, 85 and the movement of the actuating member 22 from its second to its third position is resisted at a second spring rate higher than the first spring rate.

Upon further compression of the spring 90 102 the spool 48 is urged leftward to a respective third position for disengagement of the clutch and engagement of the brake which is more clearly shown in Fig. 5. This is accomplished by maintaining the 95 previously described communication between the inlet port 62 and the clutch port 66 to maintain the clutch in a disengaged position. In this position of spool 48 the inlet port 62 communicates by way of the 100 annular groove 120 and the slots 132 with the annular groove 50, brake port 58, and line 60 to communicate fluid pressure to the inlet port 216 of the brake servo valve 32. The pressure in the port 105 216 communicates through annular groove 210 and passages 212 and 213 with chamber 214. Since the spool 180 is in a closed position, the pressurization of chamber 214 urges the piston 208 rightwardly as shown 110 in the drawings to actuate bellcrank 38 toward a brake-engaged position. This engages the brake 42 to retard rotation of the drive to that respective track 20 and thus decrease the turning radius of the vehicle 115 12. Communication of pressure to bore 140 by way of the passage 142 for action on piston 148 controls the spool position to modulate brake pressure in proportion to compression of the spring 102. 120

When it is desired that the vehicle 10 again travel in a straight line, the control lever 22 is released, whereby the spool 48 will return to the neutral position to re-engage the clutch and disengage brake. The communication of lubricating oil to the chamber 72 is again provided as previously described. The brake actuating chamber 214 again communicates with the reservoir by way of the line 60, annular grooves 50, 78, 130 125

and line 82, as previously described. The spring 218 allows the piston 208 to return only the amount necessary for full release of the brakes 42, thus avoiding excessive cavitation of the chamber 214 and ensuring immediate response on brake engagement.

Should the operator desire to engage one or both of the brakes without disengaging the clutch, this is accomplished by actuating bellcrank 36 in a clockwise direction in response to actuation of the foot pedal 28. This rotation of the bellcrank 36 moves the plunger 164 to the right to engage the outer end of the spool 180 with the inner face of the piston 208. This blocks the passage 213 and stops the spool 180. Contained movement of the plunger 164 communicates fluid pressure from the inlet port 176 through the adaptor sleeve 168, to the passage 194 in the plunger 164, the bore 190, the radial ports 188 in spool 180, and the ports 192 in the plunger 164 to the chamber 214 within the cylinder 152 to urge the piston 208 rightwardly and as previously described to engage the brake 42. Release of the foot pedal 28 allows the springs 196 to urge the bellcrank 36 in a counterclockwise direction and thus permit the plunger 146 to return to the position shown. This communicates the chamber 214 to the tank port 80 in the valve 26 by way of passages 213, 212, the groove 210 and line 60 to vent the pressure from the brake-actuating cylinder. Operation of both pedals 28 is effective to operate both brakes as described above.

Thus it may be seen that the invention, at least in the preferred embodiment, provides a simple clutch and brake control system having an actuator member, movement of which effects sequentially disengagement of a steering clutch and the actuation of an associated steering brake. The steering brake may also be actuated through independent means when the steering clutch is still engaged.

WHAT WE CLAIM IS:—

1. A clutch and brake control system for a vehicle in which driving force is applied to each side thereof through a fluid pressure responsive normally engaged clutch and including a fluid pressure responsive normally disengaged brake for each side, said control system comprising valve means connectable to a source of fluid pressure and to said clutch and to said brake and including a reciprocable valve spool positionable in a first position for preventing fluid pressure from said source from actuating said clutch and said brake and movable

sequentially to second and third positions, said spool in said second position in use allowing fluid pressure from said source through said valve means to said clutch for disengaging said clutch, but blocking fluid pressure from said source to said brake, said spool in said third position allowing fluid pressure from said source through said valve means to said clutch to maintain said clutch in its disengaged state and allowing fluid pressure from said source through said valve means to said brake for actuating said brake; means for operatively connecting an actuating member with said valve spool so that movement of the actuating member to the first, second and third sequential positions moves the valve spool to its first, second and third sequential positions respectively; and means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake, so that the brake may be actuated with the clutch in an engaged state.

2. A control system as claimed in claim 1 including first resilient means for resisting the movement of the actuating member from its first position to its second position at a first spring rate, and second resilient means for resisting the movement of the actuating member from its second to its third position at a second spring rate higher than said first spring rate.

3. A control system as claimed in claim 1 or 2 including a cylinder having a piston reciprocable therein and arranged so that application of fluid pressure within the cylinder can move the piston for applying the brake.

4. A control system as claimed in claim 3 wherein the means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake comprise means for allowing fluid pressure from said source to the piston within the cylinder.

5. A control system as claimed in any preceding claim wherein the means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake is adapted to be operated by a foot pedal.

6. A clutch and brake control system substantially as hereinbefore described with reference to the accompanying drawings.

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and line 82, as previously described. The spring 218 allows the piston 208 to return only the amount necessary for full release of the brakes 42, thus avoiding excessive cavitation of the chamber 214 and ensuring immediate response on brake engagement.

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Thus it may be seen that the invention, at least in the preferred embodiment, provides a simple clutch and brake control system having an actuator member, movement of which effects sequentially disengagement of a steering clutch and the actuation of an associated steering brake. The steering brake may also be actuated through independent means when the steering clutch is still engaged.

WHAT WE CLAIM IS:—

1. A clutch and brake control system for a vehicle in which driving force is applied to each side thereof through a fluid pressure responsive normally engaged clutch and including a fluid pressure responsive normally disengaged brake to reach side, said control system comprising valve means connectable to a source of fluid pressure and to said clutch and to said brake and including a reciprocable valve spool positionable in a first position for preventing fluid pressure from said source from actuating said clutch and said brake and movable

sequentially to second and third portions, said spool in said second position in use allowing fluid pressure from said source through said valve means to said clutch for disengaging said clutch, but blocking fluid pressure from said source to said brake, said spool in said third position allowing fluid pressure from said source through said valve means to said clutch to maintain said clutch in its disengaged state and allowing fluid pressure from said source through said valve means to said brake for actuating said brake; means for operatively connecting an actuating member with said valve spool so that movement of the actuating member to the first, second and third sequential positions moves the valve spool to its first, second and third sequential positions respectively; and means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake, so that the brake may be actuated with the clutch in an engaged state.

2. A control system as claimed in claim 1 including first resilient means for resisting the movement of the actuating member from its first position to its second position at a first spring rate, and second resilient means for resisting the movement of the actuating member from its second to its third position at a second spring rate higher than said first spring rate.

3. A control system as claimed in claim 1 or 2 including a cylinder having a piston reciprocable therein and arranged so that application of fluid pressure within the cylinder can move the piston for applying the brake.

4. A control system as claimed in claim 3 wherein the means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake comprise means for allowing fluid pressure from said source to the piston within the cylinder.

5. A control system as claimed in any preceding claim wherein the means operable independently of said valve means for allowing fluid pressure from said fluid pressure source to said brake is adapted to be operated by a foot pedal.

6. A clutch and brake control system substantially as hereinbefore described with reference to the accompanying drawings.

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