BOOM CONTROL MECHANISM FOR TRACTORS OR THE LIKE

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ABSTRACT
A pair of winch drums mounted on a shaft receive the load cable and boom cable of a tractor side boom for pipe laying operations and the like. Simplified, rapid and versatile control of the two winch drums is effected by coupling the shaft to the power takeoff of the tractor through a power shift drive transmission providing a plurality of drive ratios including at least one reverse drive and by transmitting drive from the shaft to each drum through planetary gearing means having fluid pressure operated drive establishing devices for causing drive to be transmitted from the shaft to one or both drums as necessary including counter rotation of one drum relative to the other to enable power driven lowering movement as well as raising motion. Normally applied brake means at each drum are released by the fluid pressure signals which actuate the drive establishing devices of the planetary gearing thereby providing fail safety. The system requires fewer control levers than prior mechanism for a similar purpose and responds more rapidly to control lever manipulations.

5 Claims, 3 Drawing Figures
BOOM CONTROL MECHANISM FOR TRACTORS OR THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to hoist devices for disposition on tractor vehicles and the like and more particularly to winch systems for manipulating the boom of such attachments as well as the load supported thereby.

Tractors or the like are frequently equipped with attachments which include a boom having a lower end pivoted to the vehicle and which has a pulley at the upper end over which a cable extends to connect with a hook or other means for holding a load. Such mechanisms are often referred to as pipe laying attachments since this constitutes one of the principal usages of such mechanisms. For maximum usefulness, winch means are provided for drawing in and feeding out the cable which supports the load and additional winch means are provided for drawing in and feeding out a second cable which attaches to the boom itself whereby the load may be moved towards the vehicle and away therefrom as well as being raised and lowered.

Customarily, both winch means include drums supported for rotation about separate portions of a common axle. To provide for a variety of speeds both of the load and the boom, the axle is connected to a power takeoff on the vehicle through a drive transmission of a form providing a plurality of drive ratios and clutch means are provided between each winch drum and the supporting axle.

The task of operating a vehicle equipped with prior boom attachments is difficult and fatiguing and such operation is usually slow. Basically, this results from the fact that the operator must manipulate a large number of separate control levers in addition to the various controls of the tractor itself. A typical system employs a lay-shaft transmission which, in addition to a shift lever, requires a clutch lever for decoupling from the power take off in the course of a shift and further requires a load cable winch brake lever, a boom cable winch brake lever, a boom drum Pawl lever, a load cable winch clutch lever, a boom cable winch clutch lever and still another control lever for positioning a counterweight that balances the forces on the vehicle to avoid vehicle instability.

Thus a typical prior system requires that the operator manipulate seven control levers additional to the control levers and pedals needed for driving the tractor itself. This creates an extremely demanding and taxing situation for the operator who must have a high degree of skill, experience and stamina in order to function efficiently. Moreover, safety is adversely affected because of the possibility of confusion of control levers and the probability of operator fatigue after a period of operation. Still further, the large number of control levers and associated mechanisms results in congestion and obstruction of the operator's position on the tractor. Taken together, these factors detract from the general working efficiency of the tractor and boom mechanism.

Still another characteristic of prior boom attachment control mechanisms, is that downward and outward movement of the load may be dependent on gravity. Further the winch which controls the boom line and the winch which controls the load may not be simultaneously operable in opposite directions so that a load can be moved outward from the vehicle or inward toward the vehicle without simultaneously raising or lowering the load. The capability of a strictly horizontal movement of the load would be a highly desirable aid in pipelaying operations as well as other uses of a boom attachment.

SUMMARY OF THE INVENTION

The present invention provides for greatly simplifying the control manipulations required of the operator of a boom attachment for a tractor or the like while providing for rapidity of load movement and versatility in the variety of load motions which can be realized. In part, this is accomplished by coupling the load winch and boom winch axle to the power take off of a tractor or the like through a power shift transmission of the form controlled through fluid pressure signals and by selectively transmitting drive from the axle to the winches through planetary gearings also controlled by fluid pressure signals. In a preferred form, fail safety is provided by utilizing a normally applied brake at each winch which is released in response to the fluid signals which actuate the planetary gearing. Also in the preferred form, the planetary gearings associated with at least one of the winches provides for rotation of that winch in the same direction as the other winch or in a reverse direction whereby a load may readily be moved horizontally without necessarily being accompanied by vertical movement and whereby powering down is more readily accomplished. In a typical system in accordance with the invention, the operator need manipulate only four control levers aside from the controls required for operation of the vehicle itself.

Accordingly it is an object of this invention to provide for simplified and more rapid control of a boom attachment for a tractor vehicle or the like. Further objects of the invention are to provide for increased safety, less operator fatigue, less congestion of the operator's station and greater versatility of load manipulation in the operation of boom attachments on tractor vehicles.

The invention together with further objects and advantages thereof will best be understood by reference to the following specification in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:
FIG. 1 is a front elevation view of a crawler-tractor equipped with a side boom attachment embodying the invention,
FIG. 2 is a plan view of a portion of the tractor vehicle of FIG. 1 taken along line II—II thereof, and
FIG. 3 is a schematic diagram showing internal details of the winch drum structure and controls of the side boom attachment.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring initially to FIG. 1 of the drawing, a side boom attachment 11 suitable for pipe laying operations and the like is shown disposed on a crawler tractor 12 which may be of conventional construction except insofar as elements of the present invention are added thereto. Side boom attachment 11 includes a boom 13 having a lower end coupled to one side of the tractor 12 by pivot means 14 which provides for pivoting motion of the boom in a plane normal to the direction of
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3 travel of the tractor. A block and tackle assembly 16 is coupled to the upper end of boom 13 through a pivot 17 and includes a hook 18 for supporting a load.

A load line cable 19 extends from block and tackle assembly 16 under a pulley 21 mounted on tractor 12 at the side thereof at which boom 13 is disposed and extends to a winch drum assembly 22 which is secured to the opposite side of the tractor and which will hereinafter be described in more detail. Winding of the load line cable 19 onto winch mechanism 22 thus raises the hook 18 while feeding out of the load line cable from the winch mechanism lowers the hook 18 to provide for raising and lowering of a load.

To shift hook 18 outward from tractor 12 or inward toward the tractor, boom 13 is pivoted about pivot means 14. Referring now to FIGS. 1 and 2 in conjunction, this is accomplished by means of a boom line cable 23 extending from winch mechanism 22 around a pulley 24 pivoted to the upper end of boom 13 and which extends back around a pulley 26 secured to tractor 12 near the winch mechanism and then again extends to the top of the boom and is fastened thereto. Thus winding of boom line cable 23 onto winch mechanism 22 raises the boom 13 while feeding out of the boom line cable from the winch mechanism lowers the boom.

As heavy loads supported at one side of a tractor 12 by means such as hook 18 may tend to make the tractor unstable, a counterweight 27 is secured to an arm 28 at the opposite side of the tractor from boom 13. Arm 28 is pivoted to the tractor by suitable means 29 which couples the arm to a support 31 secured to the side of the tractor. Thus counterweight 27 may be selectively swung outward as indicated by dashed outline 27' in FIG. 1 to provide a counterbalance for a load supported on hook 18. Control of the position of counterweight 27 is provided for by a hydraulic jack 32 connected between support member 31 and the counterweight.

The structure of the side boom attachment 11 as described to this point is essentially conventional. Hereinafter the operation of a tractor and side boom attachment of this kind has been a complex and fatiguing task. In addition to manipulating the various controls of the tractor 12 itself the operator must manipulate a control lever which operates the jack 32 that positions the counterweight and it has been necessary to operate an undesirably large number of additional control levers for the complex winch mechanism 22 which must be capable of feeding out or drawing in two cables and which should be provided with brakes, several speed ranges and the capability of reversing.

The present invention provides a means for driving the winch mechanism which simplifies and expedites the operator's control functions. Referring now to FIG. 2, winch drum mechanism 22 is secured to a tractor frame element 33 by spaced apart members 34 which extend sidewardly therefrom and includes an axle 36 having a load line cable drum 37 and boom line cable drum 38 disposed thereon for rotation thereabout. A load drum planetary gearing housing 39 is secured to one support member 34 adjacent the end of drum 37 and a boom line planetary gearing housing 41 is secured to the other support member 34 adjacent the boom line drum 38.

The winch drum mechanism 22 is driven from a power takeoff sprocket 42 which is generally a pre-existing component of crawler tractors. A chain 43 couples sprocket 42 to the drive input gear 44 of a multi-speed drive transmission 46 while an additional chain 47 couples the output gear 48 of the transmission with a sprocket gear 49 mounted on the end of winch mechanism shaft 36.

A control console housing 51 is situated adjacent an arm rest 52 of the operator's seat 53 and supports a four position load line control lever 54, a four position boom line control lever 56 and a five position transmission control lever 57 movable in an H pattern. Operator's controls for the side boom attachment are completed by a conventional double pedal 58 for selectively retracted and extending the hydraulic cylinder 32 of FIG. 1 which positions the counterweight 27.

Referring now to FIG. 3, the drive transmission 46 is of the power shift form for ease and speed of control and in this example has an input shaft 61 driven by a multi-speed sprocket 44 and which turns a sun gear 62 and a rotating clutch member 63. Planet gears 64 are arranged to orbit about sun gear 62 and drive a planetary carrier 66 which turns an input gear 67 of a reduction gear set 68 wherein gear 67 drives a larger gear 69 that in turn drives the previously described transmission output gear 48. Planet gears 64 also engage a ring gear 71 which may be stopped by actuation of a fluid pressure operated brake 72. A second sun gear 73 is disposed coaxially with respect to input shaft 61 and is engaged by second planet gears 74 supported on the same carrier 66 that supports the first planet gears 64. Second planet gears 74 engage a ring gear 76 which may be stopped by actuation of an additional fluid pressure operated brake 77. A rotating clutch 78 of the form engagable by a fluid pressure signal provides for coupling clutch member 63, and thus input shaft 61, to second sun gear 73 through an annular hub 79. Hub 79 may in turn be braked by actuation of still another fluid pressure operated brake 81.

Analysis of the above described structure of transmission 46 will show that a low range forward drive is realized by application of fluid pressure to brake 72 through a conduit 82 while an intermediate drive ratio is provided by applying fluid pressure to brake 81 through an additional conduit 83. A higher drive ratio is provided by applying pressurized fluid to rotating clutch 78 through conduit 84 while reverse drive is effected by pressurizing brake 77 through a suitable conduit 86. With all brakes and clutches unpressurized, a neutral condition of the transmission is realized.

Transmission 46 is therefore coupled to a suitable control circuit 87 of the form which pressurizes conduit 82, 83, 84 or 86 respectively in response to movement of the operator's shift lever 57 to the low, intermediate, high and reverse settings. Circuit 87 receives fluid through an inlet conduit 88 connected with a pump 89 that draws from a reservoir 91, a relief valve 92 being connected between conduit 88 and the reservoir to maintain a predetermined maximum pressure, such fluid supply means being a pre-existing component of many tractors. While in practice the valving functions performed by manipulation of the shift lever 57, through linkages 93, may be embodied in one or two complex selector valve spools, a separate valve 94 is shown schematically in FIG. 3 for each function to facilitate understanding of the circuit, suitable detailed constructions for transmission control circuits of this kind being known to the art. Such circuits usually in-
clude pressure modulating means 96 to smooth shifting of the transmission by slowing the pressure rise at the selected ones of the transmission brakes or clutches following movement of the shift lever 57, the detailed construction of such means being known to the art and examples being described in U.S. Pat. Nos. 3,481,435 and 3,386,540.

Accordingly by manipulation of control lever 57, the operator may cause drive to be transmitted from tractor power take off gear 42 to axle 36 of winch drum assembly 22 at any of three forward drive ratios or one reverse drive ratio. This is accomplished rapidly and easily and does not require manual operation of a clutch for the purpose of facilitating the shift.

Considering now the drive structure within the winch drum assembly 22, load line drum 37 and boom line drum 38 have flanges 98 and 99 respectively at the adjacent ends to retain the cables 19 and 23 respectively thereon and have flanges 101 and 102 respectively at the opposite ends which are integral with annular brake hubs 103 and 104 respectively. Brake bands 106 and 107 are disposed coaxially around hubs 103 and 104 respectively and each such brake is normally applied by one of a pair of actuators 108 each of which includes a spring 109 acting on a piston 111 which connects with the associated brake band to apply the brake and thus clamp the associated one of the winch drums 37 or 38 against rotary movement about shaft 39. Brakes 106 and 107 are released by fluid pressure received through conduits 110 and 112 respectively which pressure acts against the pistons 111 in opposition to springs 109, when rotation of one or both of the drums is necessary as will be hereinafter discussed in more detail.

To transmit drive from shaft 36 to the load line drum 37 a sun gear 113 is disposed coaxially on the shaft within planetary gearing housing 39 and planet gears 114 engage therewith for orbital motion therearound. Planet gears 114 are rotatably supported on a carrier 116 coupled to flange 101 whereby the orbital motion of the planet gears results in rotation of the load line drum 37. Planet gears 114 in turn engage a ring gear 117. A brake 118 of the form which is applied by application of a fluid pressure through a conduit 119 is disposed in planetary gearing housing 29 to selectively clamp the ring gear against rotation. Thus when brake 118 is not applied the ring gear 117 may rotate freely and drive is not transferred from shaft 36 to load line drum 37. Upon application of brake 118 ring gear 117 is clamped against rotation forcing the planetary gears 114 to orbit about sun gear 113 as shaft 36 turns and thereby drive the load line drum.

At various times during the operation of the side boom it may be desired that the boom line drum 38 be operated simultaneously with operation of load line drum 37 or that it be operated while the load line drum is stopped further, in the case of simultaneous operation, it may be desired that the boom line drum either operate in the same direction as the load line drum or in a counter rotating manner. To provide for the several modes of operation a more complex planetary gearing system is disposed within the housing 41 at the opposite end of the winch drum mechanism 22. In particular an additional sun gear 121 is disposed coaxially on shaft 36 within housing 41 and additional planet gears 122 are engaged therewith for orbiting motion thereabout, the additional planet gears being mounted on a carrier 123 which connects to flange 102 of the boom line drum 38. Planet gears 122 in turn engage a ring gear 124. An additional brake 126, which may be applied by application of fluid pressure through a conduit 127, is situated between ring gear 124 and housing 41.

Thus when the brake 126 is applied stopping ring gear 124, planet gears 122 are constrained to orbit sun gear 121 and thereby rotate the boom line drum 38 in the same direction that load line drum 37 turns if the brake 118 is pressurized at that time. To provide for counter rotation of the boom line drum 38 relative to the load line drum 37, still another sun gear 128 is disposed on shaft 36 in housing 41 and planet gears 129 are engaged therewith for orbiting motion therearound. Planet gears 129 engage a ring gear 131 which is attached to an extension 132 of the carrier 123 of planet gears 122 whereby rotational motion of the ring gear 131 turns boom line drum 38. The planet gears 129 are supported on a carrier 133 which may be selectively stopped by application of fluid pressure to a brake 133 through a conduit 134. Accordingly when brake 133 is released, the planetary gearing defined by sun gear 128, planet gear 129 and ring gear 131 does not transmit drive in that ring gear 131 is not necessarily constrained to rotate in response to rotation of the sun gear 128. With brake 133 applied to stop orbital motion of the planet gears 129, ring gear 131 and thus boom line drum 38 is forced to rotate in a direction opposite to the rotation provided by actuation of brake 126.

Considering now the hydraulic circuit 136, which transmits control pressures to the winch drum mechanism 22 in response to manual manipulation of the boom line control lever 56 and load line control lever 54, operation of the brakes 106 and 107 of the winch drum mechanism requires higher pressures than operation of the drive establishing brakes 118, 126 and 133 and accordingly two pressure accumulators 137 and 138 are provided to supply the appropriate pressures. To establish and maintain the two different pressures, a two position shuttle valve 139 is connected between the output of pump 89 and each accumulator. Shuttle valve 139 has an unpiolated position at which pump 89 is communicated with the low pressure accumulator 137 through a first check valve 141 and has a piloted position at which the pump communicates with the high pressure accumulator 138 through a second check valve 142, the shuttle valve being spring biased towards the unpiolated position and being piloted by the pressure within the low pressure accumulator 137. Thus initially, the output of pump 89 is communicated with low pressure accumulator 137 which is charged to the desired pressure, 450 psi in one example of the invention. When the pressure in accumulator 137 reaches this desired value, shuttle valve 139 is piloted to block further charging of the low pressure accumulator while charging the high pressure accumulator 138 to the full available pressure which is approximately 1,200 psi in this example. At such times as the charge of low pressure accumulator 137 drops below the desired value, shuttle valve 139 shifts momentarily to restore such pressure.

Load line control lever 54 has four positions designated as Down, Hold, Raise, and Float. Movement of the load line control lever 54 simultaneously pilots a valve 143 which controls brake 118 of the winch drum mechanism 22 and another valve 144 which controls brake 106 thereof. At the Hold position, valve 143
vents brake 118 while valve 114 vents brake 106. Thus at the Hold position there is no driving connection between shaft 36 and the load line drum 37 and the load line drum is held against rotation by brake 106. At the Down setting of load line control lever 54, valve 143 continues to vent brake 118 while valve 144 now pressurizes brake 106 to release such brake. Accordingly, at this setting load line drum 37 is enabled to turn freely and thus the load may descend under the influence of gravity. At the Raise setting of load line control lever 54 valve 143 pressurizes brake 118 from accumulator 137 while valve 144 pressurizes brake 106 from accumulator 138. The resultant stopping of ring gear 117 causes drive to be transmitted from shaft 36 to the load line drum 37 to raise the load. It should be noted at this point that the system provides the capability of powered lowering of the load without reliance on gravity in that operation is obtainable by placing load line control lever at the described Raise position while shifting transmission 46 into reverse. At the Float position of the load line control lever 54, the valves 143 and 144 establish the same fluid connections herebefore described for the Down setting and thus the load may move in response to external forces acting thereon.

The boom line control lever 56 also has four settings which are designated Out, Hold, In, and Float and pilots a four position valve 146 which controls brakes 126 and 133 of the transmission and simultaneously pilots a second four position valve 147 which controls the boom line drum brake 107 of the winch mechanism 22. At the Hold setting of boom line control lever 56, valve 146 vents both of brakes 126 and 133 while valve 147 vents the boom line drum brake 107 causing such brake to be applied. Thus at the Hold setting, no drive is transmitted to boom line drum 38 and the drum is immobilized by brake 107. At all other positions of the boom line control lever 56 valve 147 pressurizes brake 107 to release such brake and enable movement of the boom line drum 38 as determined by valve 146 in conjunction with an additional two position valve 148.

A pair of conduits 149 and 151 are connected between valves 146 and 148 and in an unpiotted first position valve 148 communicates the conduits 149 and 151 with conduits 134 and 127 respectively to brakes 126 and 133 respectively. Valve 148 is piloted to an alternate position by movement of the transmission shift lever 57 into the Reverse setting thereof and with the transmission in reverse valve 148 causes conduits 149 and 151 to be communicated with conduits 127 and 126 respectively to drive establishing brakes 126 and 133 respectively. Thus the effect of valve 148 is to reverse the connections between valve 146 and the boom line drive establishing brakes 126 and 137 when drive through the transmission 46 is itself reversed. This eliminates any effect of reversal of the transmission on the direction of boom line drive as selected by manipulation of boom line control lever 56. In other words if the transmission is reversed to power down the load as herebefore described, valve 148 shifts so that control of the boom line drum by means of lever 56 is not affected thereby.

At the Out setting of boom line control lever 56 valve 146 pressurizes conduit 149 from accumulator 137 and thus pressurizes either brake 133 or brake 126 according to the position of valve 148 at that time which is itself determined by the position of the transmission shift lever 57 as described above. Thus regardless of the direction of drive being supplied to winch drum shaft 36, the boom line drum 38 is turned to feed out the boom line. At the In setting of boom line control lever 56, valve 146 pressurizes conduit 151 and thus pressurizes either brake 126 or brake 133 as determined by the position of valve 148. Thus regardless of whether the transmission shift lever 57 is in a Forward or Reverse setting, boom line drum 38 is turned to wind in the boom line. At the Float position of boom line control lever 56, valve 146 vents both of conduits 149 and 151 and thus vents both of brakes 126 and 133 regardless of the position of valve 148. Since brake 107 is also released by pressurization at this time through valve 147, the boom line drum may turn freely under the influence of external forces acting thereon.

Accordingly, through the use of three control levers 54, 56 and 57, it may be seen that the load line may be selectively immobilized, allowed to react to external forces, or wound in and may be fed out either under the influence of gravity of forcibly. The boom line may similarly be immobilized or allowed to react to external forces and may be wound in or fed out forcibly and independently of the movement of the load line at that time. This provides the capability of moving the load outward or inward relative to the vehicle in a horizontal manner.

It should also be observed that the drum brakes 106 and 107 are applied in the absence of fluid pressure while drive establishing brakes 118, 126 and 133 are released under that condition. Thus safety is greatly enhanced in that the load and boom are immobilized in the event of failure of system pressure from a ruptured hose or other cause.

While the invention has been described with respect to a preferred embodiment, it will be apparent that many variations are possible and it is not intended to limit the invention except as defined in the following claims.

What is claimed is:

1. Winch mechanism for drawing in and feeding out a boom line cable attached to a boom pivoted to a vehicle and for raising and lowering a load suspended from said boom by a load line cable wherein said vehicle has power take off means, comprising a pair of planetary gear support means having means for attachment to said vehicle, winch shaft means extending within said support means and journaled therein for rotation relative thereto, a boom line drum journaled on a first portion of said shaft means for receiving said boom line cable, a load line drum journaled on a second portion of said shaft means for receiving said load line cable, boom line drum planetary gear means disposed in a first of said support means and having first fluid pressure operated drive establishing means for selectively causing drive to be transmitted from said shaft means to said boom line drum, load line drum planetary gear means disposed in the other of said support means and having second fluid pressure operated drive establishing means for selectively causing drive to be transmitted from said shaft means to said load line drum, said drive establishing means of one of said planetary gearings having means for selectively transmitting drive from said shaft means to the associated one of said drums to rotate said one drum in the same
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direction that the other of said planetary gearings rotates the other of said drums, and having alternate means for selectively transmitting drive to said one drum to rotate said one drum in an opposite direction from said direction that said other of said planetary gearings rotates said other of said drums, drive transmission means for providing a plurality of drive ratios including at least one reverse drive ratio, said drive transmission means having third fluid pressure operated drive establishing means for selecting a drive ratio therein and having a drive input member coupled to said power take off and a drive output member coupled to said shaft means, and

manually shiftable control means for selectively transmitting said fluid pressures to said drive establishing means of said planetary gearings and said drive transmission.

2. The combination defined in claim 1 wherein said control means has a valve which transmits said fluid pressures to said drive establishing means of said one planetary gearing and further has means for shifting said valve to an alternate position in response to shifting of said transmission to a reverse drive ratio at which alternate position said fluid pressures are transmitted to said alternate means.

3. The combination defined in claim 1 wherein each of said planetary gearings comprises a sun gear disposed coaxially on said shaft means for rotation therewith, at least one planet gear engaged with said sun gear for orbital motion therearound, a planet gear carrier coupling said planet gear to the associated with one of said drums, and a ring gear engaged by said planet gear, and wherein said drive establishing means of each of said planetary gearings comprises a fluid pressure operated brake for stopping rotation of the associated one of said ring gears.

4. The combination defined in claim 3 wherein one of said planetary gearings further comprises an additional sun gear disposed on said shaft means for rotation therewith, at least one additional planet gear engaged with said additional sun gear for orbital motion therearound, an additional ring gear engaged by said additional planet gear, means coupling said additional ring gear to said planet carrier of said one planetary gearing which is coupled to said associated one of said drums, and wherein said drive establishing means of said one planetary gearing further comprises an additional fluid pressure operated brake for stopping orbital motion of said additional planet gear.

5. The combination defined in claim 1 further comprises a pair of brake means each being operative to stop rotation of a separate one of said drums, means holding said brake means in a normally applied condition, fluid pressure operated means for releasing said brake means in response to transmission of said fluid pressures to said drive establishing means of said planetary gearing means, and wherein said control means is manually shiftable to a position which releases at least one of said brake means while blocking said fluid pressures from said drive establishing means of the planetary gearing which drives the one of said drums acted on by said one of said brakes.

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