DAVID BROWN

IMPLEMATIC

HYDRAULIC SYSTEM

FILE IN REPAIR MANUAL FOLDER

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IMPLEMATIC HYDRAULIC SYSTEM

The hydraulic lift systems on all Implematic type tractors are of the same basic construction and operate in exactly the same manner. For servicing purposes however it is possible to separate the systems into two types according to the tractor model.

The first 850 and 950 models Implematic tractors have serial numbers in the following range.

Tractor Model	*Serial Number*
850 Implematic	2B/850/300 001 to 306 350
850 Implematic Livedrive	2A/850/30 001 to 306 350
950 Implematic	W/950/63 001 to 81 850
950 Implematic Livedrive	V/950/63 001 to 81 850

These tractors, which will be referred to as early model tractors, have a 3½ in. (88·9 mm) diameter ram cylinder with a linkage locking bolt on the cylinder cover. As the hydraulic valve is set to deliver 2 000 lb/in² (140 kg/cm²), for operating external equipment, but the ram cylinder only requires 1 500 lb/in² (105·6 kg/cm²), a relief valve is fitted into the ram cylinder to prevent the linkage from being overloaded. BSF threads are used throughout and the appropriate parts catalogues are DBT471 (850) and DBT464 (950).

Tractors referred to as later models have serial numbers as follows:

Tractor Model	*Serial Number*
850 Implematic	850/D/310 001 onward
850 Implematic Livedrive	850/C/310 001 onward
880 Implematic	880/D/350 001 onward
880 Implematic Livedrive	880/C/350 001 onward
950 Implematic	950/3B/400 001 onward
950 Implematic Livedrive	950/3A/400 001 onward
990 Implematic	990/B/440 001 onward
990 Implematic Livedrive	990/A/440 001 onward

The hydraulic system on these tractors incorporates a 3⅛ in. (79·37 mm) diameter ram cylinder with an automatic locking catch mounted in the cylinder cover. As the reduced diameter of the ram cylinder allows it to operate at full pump pressure of 2 000 lb/in² (140 kg/cm²) a relief valve is not required in the cylinder. The introduction of unified threads on these tractors has necessitated part number changes for parts which are otherwise unchanged, it should however be noted that the tapped holes in the hydraulic pump body are threaded BSF as on previous series. Parts catalogues for these tractors are DBT494 (990) and DBT.497 (850–880–950).

A further change, to include height control, was introduced at the following serial numbers:

Tractor Model	*Serial Number*
850 Implematic	850/D/313 773
850 Implematic Livedrive	850/C/313 773
880 Implematic	880/D/355 341
880 Implematic Livedrive	880/C/355 341
990 Implematic	990/B/453 124
990 Implematic Livedrive	990/A/453 124

These changes consisted of, the provision of a cable attachment on the right-hand end of the ramshaft, to enable the position of the depth control valve to be controlled by movement of the ramshaft. Alteration in the method of attaching the flexible cable to the top link. A slight change in the shape of the depth control valve spindle. Fitting of a latch stop on the pre-set guide and a clamp bolt to enable the guide to be locked in any set position. Addition of a flow control valve in the ram cylinder banjo bolt, to give a constant lowering rate regardless of implement weight. Also included at the same time was a reshaping of the leak-off control valve to give a more controlled rate of lowering, when using the system with the flexible cable disconnected.

OPERATION OF THE IMPLEMATIC SYSTEM

The Implematic hydraulic system may be used in a number of different ways, depending on the operational requirements of the implement or attachment. All the different methods however require one of four systems and it is convenient to consider these four basic systems separately.

SYSTEM ONE—TRACTION CONTROL

This system is used when operating implements equipped with their own depth wheels and as the operating depth of the implement is not controlled by the tractor, the hydraulic system is not affected by any change in implement depth, or draught.

The flexible cable J is connected to the top link so that when the control lever A is placed in the TCU position the depth control valve F is fully opened and both pump valves D and E are closed. Pump output then flows through the open depth control valve F and is restricted when passing through the spring-loaded TCU valve G. The effect of restricting the flow through the TCU valve is to cause a back pressure to build up on the pump side of the valve and as the ram cylinder is connected to the pump output the back pressure acts against the ram piston K and exerts a lifting force on the linkage. As the force on the linkage is insufficient to raise the implement out of work the linkage does not move but transfers part of the implement weight on to the tractor rear wheels. The TCU valve G is in the form of a spring-loaded pressure relief valve, which opens when the oil pressure reaches a set figure. To enable the amount of back pressure, and therefore the amount of weight transference, to be adjusted to suit various conditions the opening pressure of the TCU valve can be adjusted by means of the hand wheel M.

When the control lever A is moved into the 'lower' position the abutment screw B contacts the push rod C and opens both pump valves D and E, by means of the connecting linkage. Pump output is then returned to the reservoir through valve D and oil in the ram cylinder escapes through valve E. The linkage therefore lowers and as there is no back pressure in the ram cylinder no weight transference takes place.

When the control lever A is moved into the 'raise' position the depth control valve F is closed, pump output therefore flows into the ram cylinder and raises the linkage. As the ramshaft turns into the raised position, the striker arm R contacts the trip lever S and turns the lever until the spring-loaded toggle T snaps the mechanism over and opens the pump valve D. This removes the load from the pump, by returning the pump output to the reservoir, but retains oil in the ram cylinder to support the linkage, due to valve E, O and F remaining closed.

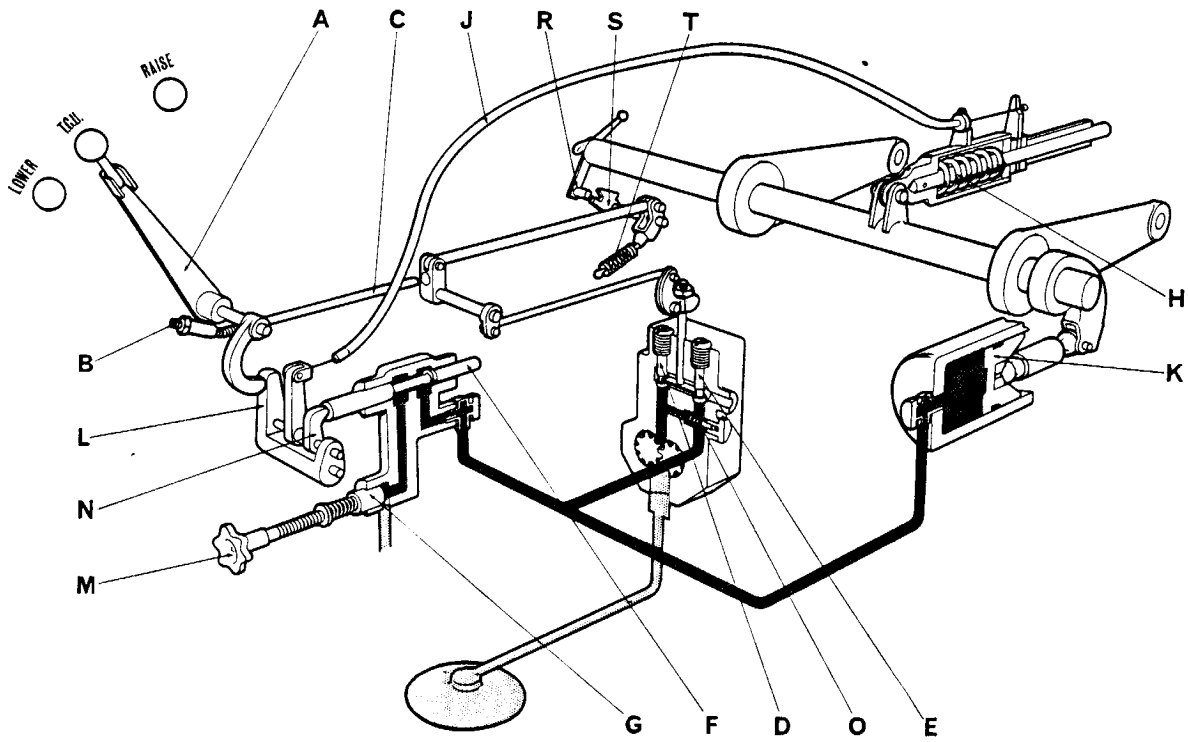

Fig. 1 OPERATION OF THE SYSTEM WHEN USING TRACTION CONTROL

A. Control Lever
B. Abutment Screw
C. Push Rod
D. Control Valve
E. Leak-Off Valve
F. Depth Control Valve
G. Traction Control Valve
K. Ram Piston
M. TCU Hand Wheel
O. Non-Return Valve
R. Striker Arm
S. Trip Lever
T. Toggle

SYSTEM TWO—DRAUGHT CONTROL

This system is used when operating ground-engaging implements that are not equipped with depth wheels. The hydraulic system must, therefore, maintain the implement at the required operating depth and this is achieved by the action of the top link which telescopes against its spring according to the amount of implement draught. As the draught of the implement increases with any increase in the operating depth, any change in implement depth will also make a change in the length of the top link and allow the hydraulic system to make an automatic correction to restore the original depth setting.

When the control lever A is placed in any position within the depth control range, the depth control valve F is opened and as both pump valves D and E are closed pump output flows through the depth control and TCU valves. Since the pressure in the ram cylinder is unable to support the full weight of the implement, the implement is lowered into work. As the implement increases its working depth the draught, and therefore the compression in the top link, will also increase. The spring H will be compressed and the flexible cable J will commence to close the depth control valve F. The depth control valve is not fully closed, as this would raise the implement out of work, but is closed sufficiently to restrict the flow of oil. As any restriction of flow through the valve will cause back pressure to build up in the ram cylinder, closing the depth control valve will exert a lifting force on the linkage. As the operating depth of the implement increases, the back pressure, and therefore the lifting force, will also increase until the lifting force balances the weight of the implement and no further increase in depth takes place. The actual depth at which this balanced condition exists is determined by setting the position of the control lever A, which moves the floating pivot L to give the correct valve opening at the required depth. As any subsequent change in operating depth will make a corresponding change in the amount of compression of the spring H, the valve F will be opened, or closed, and the amount of back pressure reduced, or increased, until the change in depth is corrected.

Due to oil from the depth control valve F also having to pass through the TCU valve G, the minimum back pressure in the ram cylinder is determined by the setting of the hand wheel M. This pressure is insufficient to have any effect on the operating depth of the implement but assists wheel adhesion by transferring part of the implement weight on to the tractor.

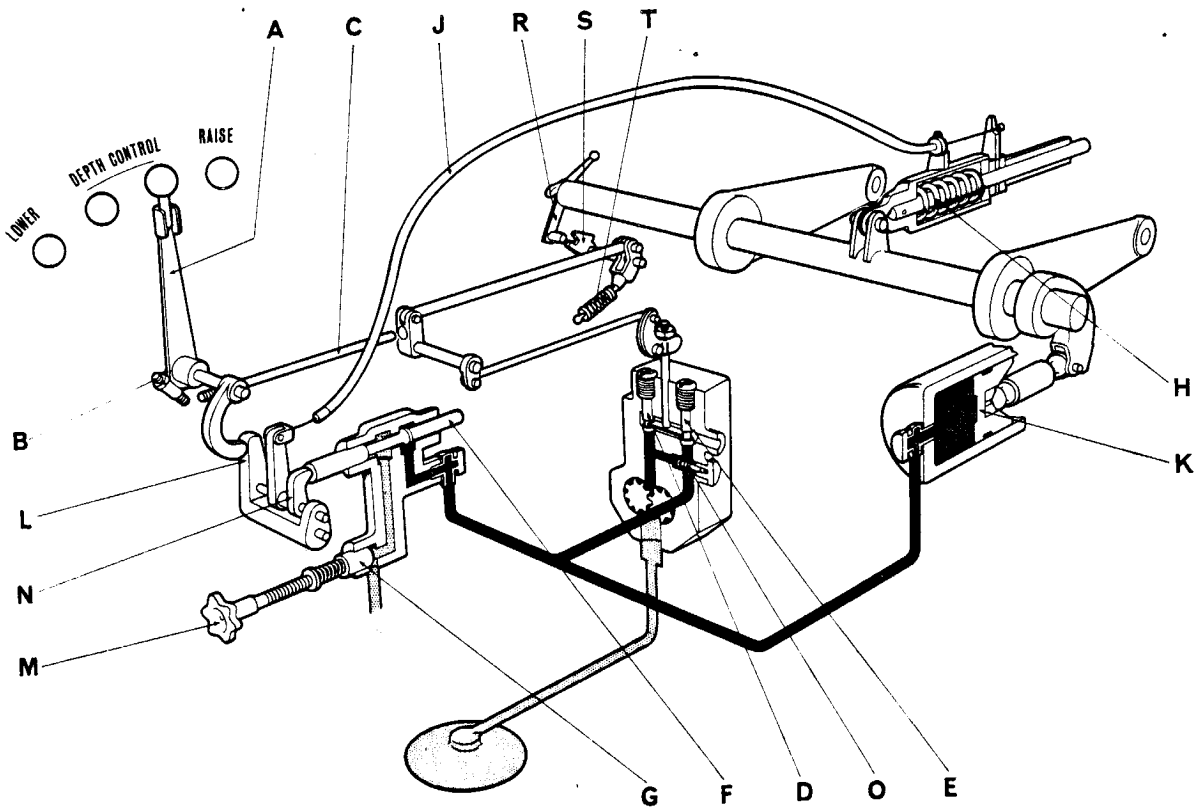

Fig. 2. OPERATION OF THE SYSTEM WHEN USING DEPTH CONTROL

A. Control Lever
D. Control Valve
E. Leak-Off Valve
F. Depth Control Valve
G. TCU Valve
H. Compression Spring
J. Flexible Cable
L. Floating Pivot
M. TCU Hand Wheel

SYSTEM THREE—HEIGHT CONTROL

This system is used when operating non-ground engaging implements that are not equipped with depth wheels. As these implements require to be held at a set height above the ground, changes in draught do not occur and draught control cannot be used. The flexible cable is therefore connected to the ramshaft, so that movement of the ramshaft can be used to control the position of the depth control valve. Any change in position of the linkage thus changes the position of the valve and allows the hydraulic system to make an automatic correction to restore the linkage to its original setting.

When the control lever A is placed in any position in the height control range the depth control valve F is opened and as both pump valves D and E are closed, pump output flows through the depth control and TCU valves. Since the pressure in the ram cylinder is unable to support the weight of the implement the linkage is lowered. As the linkage is lowered the ramshaft turns and the flexible cable J commences to close the depth control valve F. When the depth control valve commences to close, the restriction to the oil flow causes back pressure to build up in the pump outlet and ram cylinder. The effect of the back pressure in the ram cylinder is to exert a lifting force on the linkage and as the further the linkage lowers, the less will be the amount of valve opening, the back pressure will increase as the linkage lowers until a point is reached where the lifting effort on the ram piston K balances the weight of the implement. No further movement will then take place and the implement will be held at this height. The actual position at which this balanced condition will be reached is determined by setting the position of the control lever, A which moves the floating pivot L, to give the correct amount of valve opening at the required height.

When the control lever A is moved fully rearwards, the depth control valve F and both pump valves D and E are closed. Pump output then flows into the ram cylinder and acts on the piston K to raise the linkage. As the linkage is raised the ramshaft turns and the striker arm R contacts the trip lever S and turns the lever until the spring-loaded toggle T snaps over and opens the pump valve D. This removes load from the pump, by returning pump output to the reservoir, but retains the linkage in the raised position due to the valves F, E and O remaining closed.

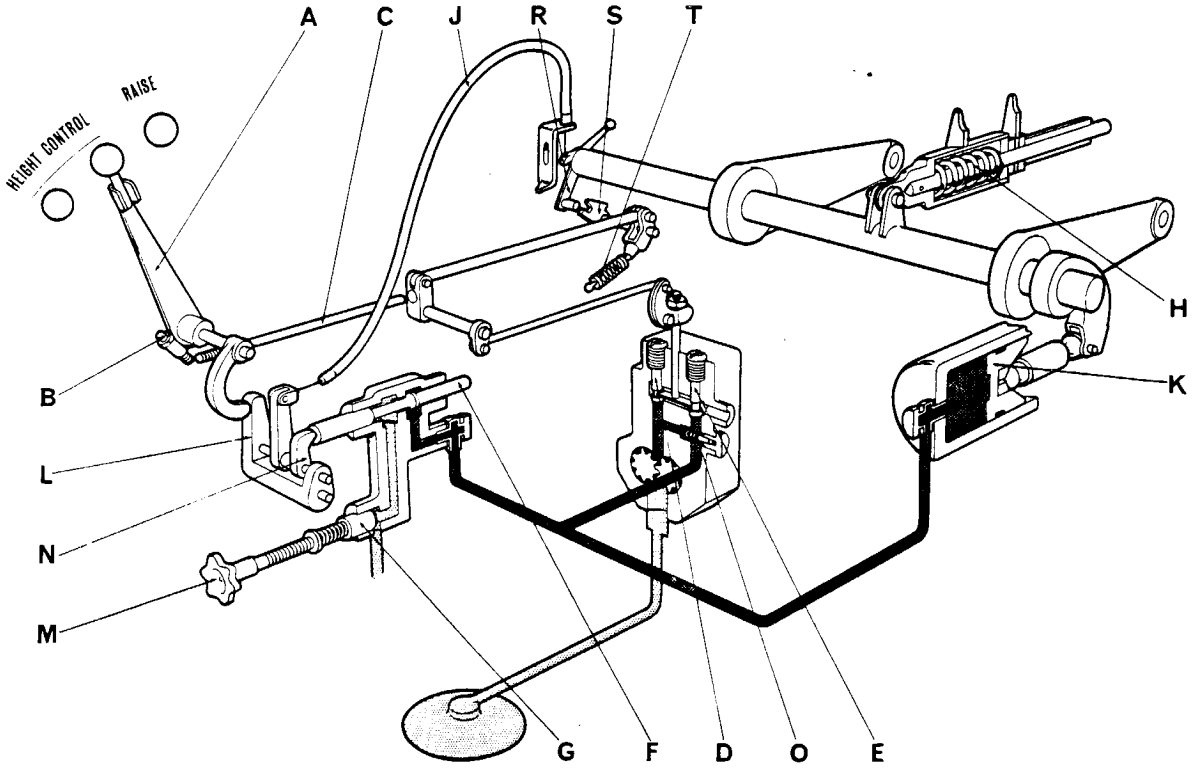

Fig. 3. OPERATION OF THE SYSTEM WHEN USING HEIGHT CONTROL

A. Control Lever
D. Control Valve
E. Leak-Off Valve
F. Depth Control Valve
J. Flexible Cable
K. Ram Piston
L. Floating Pivot
O. Non-Return Valve
R. Striker Arm
S. Trip Lever
T. Toggle

SYSTEM FOUR—EXTERNAL EQUIPMENT

This system is used when the tractor is required to operate external hydraulic rams. As these rams do not require any form of automatic control a raise, hold and lower system is required. This system is obtained by disconnecting the flexible cable, so that the depth control valve is permanently closed, and the system controlled by the two pump valves.

When the flexible cable J is disconnected the operating lever N is released and the depth control valve F is closed. Placing the control lever A in the 'raise' position closes the two pump valves D and E, so that pump output flows through the three-way valve and into the external ram. When the control lever is moved into the 'hold' position the abutment screw B contacts the push rod C and opens the pump valve D. This removes the load on the pump, by allowing pump output to return to the reservoir through valve D but retains oil in the system, to hold the attachment stationary, due to valves E and O being closed.

When the control lever is pushed forward into the 'lower' position, the abutment screw B opens both pump valves D and E. Pump output then returns to the reservoir through valve D and the attachment is lowered, due to oil in the system being returned to the reservoir through valve E.

If the linkage is required to be stowed in the raised position when the external equipment is being operated, the striker arm R must be disconnected from the ramshaft by means of the override control. Otherwise the lever S will be tripped into the hold position as the ramshaft turns into the raised position and valve D will be opened. Pump output will then return to the reservoir through valve D and no pressure will be available to raise the attachment.

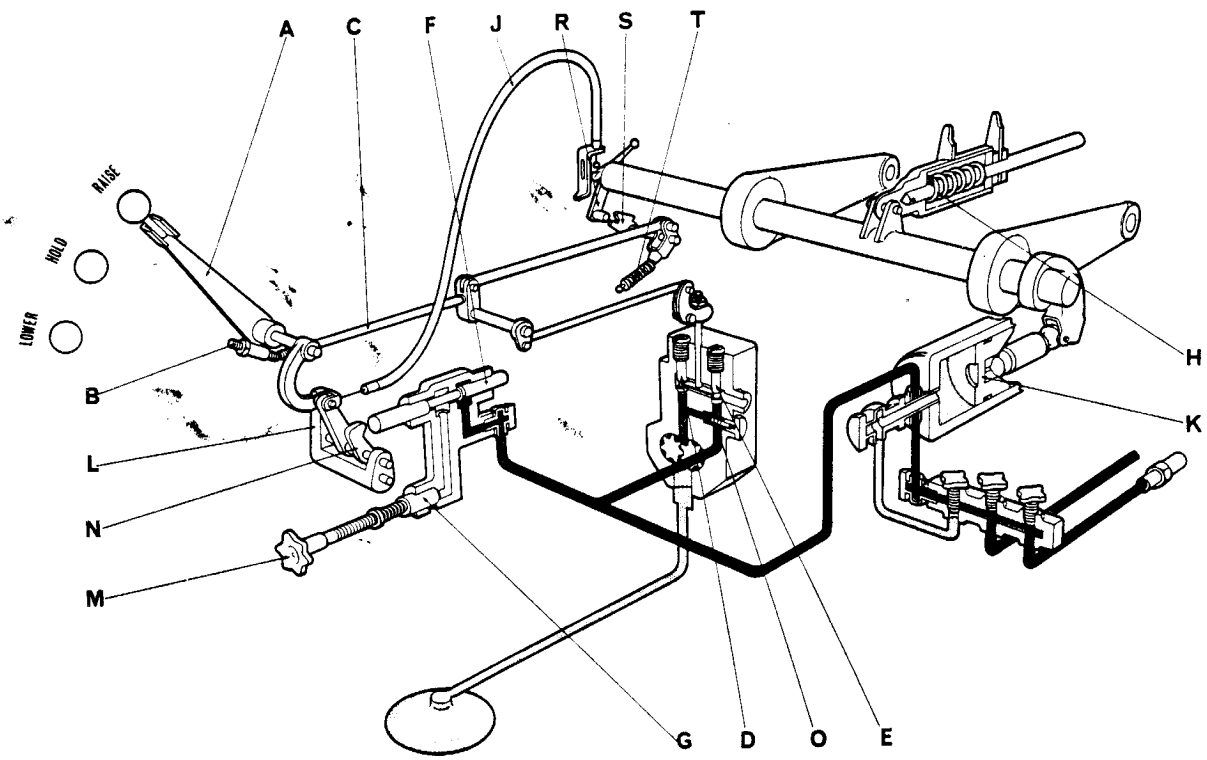

Fig. 4. OPERATION OF THE SYSTEM WHEN USING EXTERNAL HYDRAULIC EQUIPMENT

A. Control Lever
B. Abutment Screw
C. Push Rod
D. Control Valve
E. Leak-Off Valve
F. Depth Control Valve
J. Flexible Cable
N. Operating Lever
O. Non-Return Valve
R. Striker Arm

CHECKING THE SYSTEM FOR FAULTS

Incorrect operation of the system may be due to any of a number of causes, and the exact cause of the faulty operation should first be located before any re-adjustments or dismantling are undertaken.

The following fault finding chart summarises the more common faults and indicates their probable cause. To locate the cause of faulty operation, refer to the symptom applicable then check each cause in turn. The causes are listed in order of probability and where a simple visual check can not be made a test is indicated. These tests are listed at the end of the chart and provide methods of checking adjustments and components with the minimum of dismantling.

Symptom	*Probable Cause*	*Action*
Lift fails to rise or rises very slowly	Override control disengaged and in "hold" position	Check
	Three-way valve closed to ram cylinder	Check
	Relief valve opening due to lift being overloaded	Reduce load
	Shortage of oil in transmission	Check
	Hydraulic pump inlet filter choked	Remove and check
	Incorrect adjustment of pump valve linkage	Test A
	Faulty ram cylinder relief valve	Test B
	Faulty depth control valve or incorrectly adjusted top link cable	Test C
	Leaking oil pipe or union	Test D
	Insufficient pump pressure due to worn pump components	Test D
Lift fails to hold in raised position	Control lever not fully into "raise" position	Check
	Incorrect adjustment of automatic hold mechanism	Test E
	Faulty ram cylinder relief valve	Test B
	Incorrect adjustment of top link cable or faulty depth control valve	Test C
	Oil leakage from faulty pipe or connection	Test D
	Faulty hydraulic pump valves	Test E
	Worn ram cylinder piston or rings	Test F
Lift fails to lower or lowers slowly	Three-way valve not fully open	Check
	Incorrect grade of oil (too heavy) in transmission	Check
	Incorrect adjustment of pump linkage	Re-adjust
Implement fails to operate at depth required	Insufficient tension in control lever pivot allowing lever to move from original setting.	Re-adjust (page 14)
	Implement failing to penetrate due to incorrect setting	Test H
	Incorrect adjustment of top link cable	Test H

Fault Diagnosis

After referring to the fault finding chart to find the possible cause, the next step is to locate the actual fault. The following tests will assist in this by providing a method of checking the operation of the various components.

Test A. To check the pump valve linkage.

Remove the inspection plug from the top of the power take-off housing and check that when the control lever is placed in the "raise" position, and the linkage is lowered, the flat washer on the pump valve spindle is clear of the Nyloc nut. If the washer is not free, the linkage should be re-adjusted (page 12).

Test B. To check the ram cylinder relief valve.
(Early model tractors only)

Remove the cover plate from the front left-hand side of the rear axle case, attach an implement to the linkage then place the control lever into the "raise" position, any leakage of oil from the ram cylinder relief valve can then be observed.

If the tractor is fitted with a three-way isolating valve, remove the union assembly from the front end of the ram cylinder, then temporarily attach the main oil pipe banjo directly to the ram cylinder, using banjo bolt part number 11765, and test as previously.

Test C. To check the depth control valve.

Remove the cover from the right-hand ramshaft bracket and attach an implement to the linkage. Place the control lever into the "raise" position then start the engine. Any discharge of oil from the oil jet on top of the valve body will then indicate that the depth control valve is not fully seated. If a discharge of oil takes place, allow the implement to lower then disconnect the top link cable and re-test. If no oil discharge occurs on the second test, the flexible cable is holding the valve off its seat and requires adjustment (page 14). If the oil discharge still takes place when the cable is disconnected, the valve is not seating and should be removed and examined.

Test D. To check the system for leakage.

Remove the cover plate from the front left-hand side of the axle casing and remove the oil pipe banjo bolt. Temporarily connect the oil pipe to the ram cylinder with a banjo bolt that has been modified, by drilling and tapping $\frac{1}{4}$ in. BSP (Fig. 5). If the tractor is fitted with a three-way isolating valve, remove the banjo bolt on the end of the ram cylinder union and replace this with a bolt that has been modified by drilling and tapping $\frac{1}{4}$ in. BSP.

Connect a pressure gauge calibrated to 3000 lb/in.^{2} (210 kg/cm^2) to the banjo bolt, attach an implement to the linkage and place the control lever into the "raise" position. If the gauge shows a low pressure reading at all engine speeds, this indicates that the pump output is flowing to waste due to a leakage from the system. If the pressure rises slowly as the engine speed is increased, a worn hydraulic pump should be suspected.

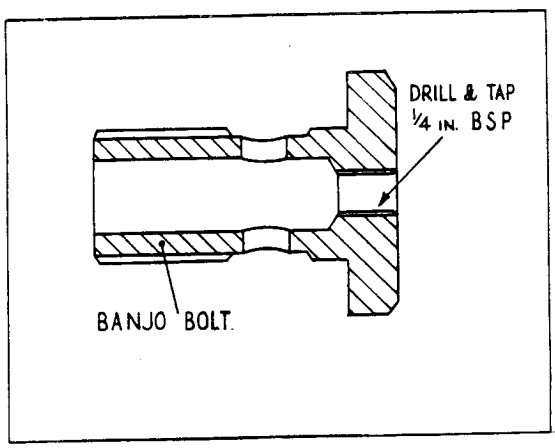

Fig. 5. MODIFICATION TO BANJO BOLT FOR CONNECTION TO PRESSURE GAUGE

Test E. To check the hold mechanism adjustment.

Disconnect the top link cable and disengage the override control. Place the control lever in the "raise" position and allow the implement to reach full height, then stop the engine. Observe that the implement does not creep down, then manually trip the override control into the hold position. If the implement commences to lower immediately the override control is tripped, adjust the hold mechanism, then re-test. If the linkage continues to fall when the hold mechanism is tripped on the second test, the non-return valve in the pump should be examined.

Test F. To check the ram piston for leakage.

If the tractor is fitted with a three-way valve, raise the implement then firmly close the left-hand control on the three-way valve. Closing this valve will prevent oil in the ram cylinder from returning into the system, if the implement, therefore, continues to fall when the valve is closed oil is leaking either through the ram cylinder relief valve or past the ram piston rings.

Remove the cover plate from the left-hand front of the axle case and remove the banjo bolt from the front end of the ram cylinder. If the tractor is fitted with a three-way valve, remove the union assembly from the front end of the ram cylinder. Temporarily attach the main oil pipe to the ram cylinder by means of a banjo bolt which has been modified by fitting a bolt through the centre (Fig. 6). Raise the implement

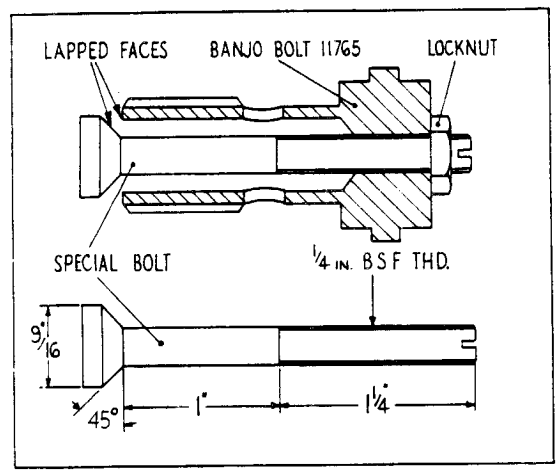

Fig. 6. MODIFICATION TO BANJO BOLT FOR CHECKING RAM CYLINDER

then firmly unscrew the bolt in the banjo bolt, to prevent oil in the ram cylinder from returning into the system, and place the control lever in the "lower" position. If the implement then creeps down and no oil can be observed leaking out of the cylinder relief valve, oil leakage is taking place past the piston rings.

Test G. To check the maximum hydraulic pressure.

If the tractor is not fitted with a three-way take-off valve remove the cover plate from the left-hand front of the rear axle case and connect a pressure gauge into the system by replacing the ram cylinder banjo bolt, part number 11765, with an adaptor (service tool 960620) or by modifying a banjo bolt as shown in Fig. 5.

Attach an implement to the linkage, start the engine and place the lift control lever in the 'raise' position. If a linkage locking bolt is fitted on the left-hand ramshaft bracket engage the bolt into the ramshaft arm when the linkage reaches the hold position ; this will prevent the piston from reaching the end of its stroke and uncovering the ram cylinder spill port. Tractors fitted with an automatic lift catch do not incorporate spill ports in the ram cylinder and this type of catch need not, therefore, be engaged. Operate the override control to trip the hold mechanism out of action, this will bring the pump into operation and enable a pressure reading to be taken. If the ram cylinder incorporates a relief valve this should open at 1 450–1 550 lb/in^2 (101–109 kg/mm^2) though when the engine is running at a fast speed the back pressure in the system may rise above this figure. If the ram cylinder does not incorporate a relief valve the pump relief valve should limit the pressure to 2 000–2 200 lb/in^2 (140–154 kg/cm^2).

If the tractor is fitted with a three-way hydraulic valve, remove the Exactor coupling from the rear of the seat support and connect a pressure gauge to the $\frac{1}{2}$ in. BSP pipe union, using service tool 960646 or any suitable adaptor.

Start the engine, close the ram cylinder oil-supply valve and open the rear take-off valve. Place the lift control lever in the 'raise' position and note the pressure gauge reading, the pump relief valve should limit the maximum pressure to 2 000–2 200 lb/in^2 (140–154 kg/cm^2). If the tractor is fitted with a relief valve in the ram cylinder, first check the pump

pressure then open the ram cylinder valve. Engage the linkage locking bolt into the left-hand ramshaft arm when the implement reaches the hold position then operate the override control to trip the mechanism out of action and observe the gauge reading. The ram cylinder valve should open at 1 450–1 550 lb/in² (101–109 kg/cm²) though when the engine is running at a fast speed the back pressure in the system may rise above this figure.

Test H. To check the operation of the automatic depth control.

If the implement fails to operate at the depth required, and the control lever is in the maximum depth position, place the control lever into the "lower" position. The implement should then rapidly increase its operating depth, failure to do this indicating that the fault is in the setting of the implement and not in the tractor hydraulic system. Either the levelling levers are too short, preventing the implement from being fully lowered, or the top link is too long, giving insufficient pitch on the implement.

If the operating depth of the implement increases immediately the control lever is placed in the "lower" position, the hydraulic system is preventing the implement from attaining sufficient depth. This could be caused by excessive TCU pressure, or incorrect adjustment of the top link cable.

If the implement operates satisfactorily at full depth but will not maintain a consistent shallow depth, check that the compression in the top link is sufficient to operate the control unit. This may be checked by noting the position of the peg in the compression spring housing, if the peg does not move from the end of the slot when the implement is in work the control unit cannot operate correctly.

ADJUSTMENTS AND SETTING INSTRUCTIONS

Adjustment is available at the following points:—

1. Main relief valve pressure setting.
2. Ram cylinder relief valve pressure setting.
3. Pump valve operating rod.
4. Hold mechanism operating rod.
5. Hold mechanism striker arm.
6. Top link compression spring.
7. Top link flexible cable.
8. Control lever abutment screw.
9. Control lever pivot shaft.

The main relief valve (Fig. 18) is set to limit the maximum pump output pressure to 2300 lb/in² (162 kg/cm²) and may be adjusted by removing, or adding, shims between the cap and valve seat, see page 18.

On 990 series tractors from serial number 461135 a second relief valve is fitted over the hold valve. This valve is adjusted to limit the pressure to 2 500 lb/in² (175 kg/cm²) and prevents excessive back pressure building up in the system when travelling over rough ground with a heavy implement or attachment in the 'hold' position.

As the pump relief valve is set to open at 2 000 lb/in² (140 kg/cm²) for operating external equipment, 3½ in. (88·9 mm) diameter ram cylinders are fitted with a relief valve which opens at 1 500 lb/in² (105·6 kg/cm²)

Pump relief valves are set during manufacture and do not normally require subsequent re-adjustment unless new components are fitted. For details of valve adjustments see page 19.

Setting Instructions

If any part of the system has been disturbed, or if faulty operation is experienced, the settings should be checked in the following order.

With the engine stopped, the linkage lowered and the override control in the 'engaged' position. Place the lift control in the 'raise' position and remove the cover from the right-hand ramshaft housing. **Unscrew the nut A on the hold mechanism linkage rod until the nut is level with the end of the rod.** This will ensure that the pump linkage is against the control lever plunger and is not being held out of position by incorrect setting of the hold mechanism.

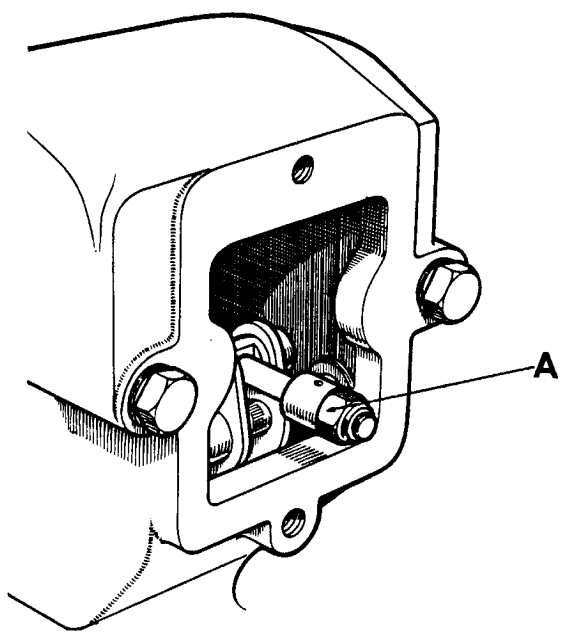

Fig. 7. HOLD MECHANISM LINKAGE ROD

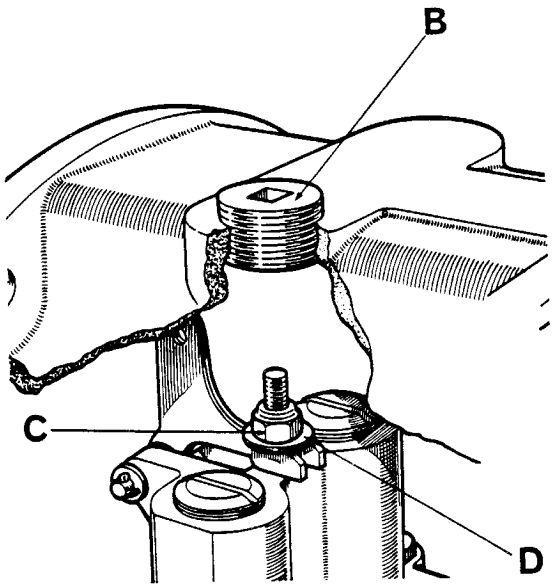

Fig. 8. PUMP CONTROL VALVE

Remove the plug B from the top of the power take-off housing. Insert a suitable box spanner through the plug aperture and on to the nut C on the end of the pump control valve operating lever. Screw the nut down slowly. Remove the spanner after each half turn and check that the washer D under the nut can be turned with the finger. When the nut commences to grip the washer so that it can only just be turned, **unscrew the nut two complete turns if it is UNC thread or two and threequarter turns if it is BSF thread,** to provide the required amount of clearance in the linkage, then replace the plug.

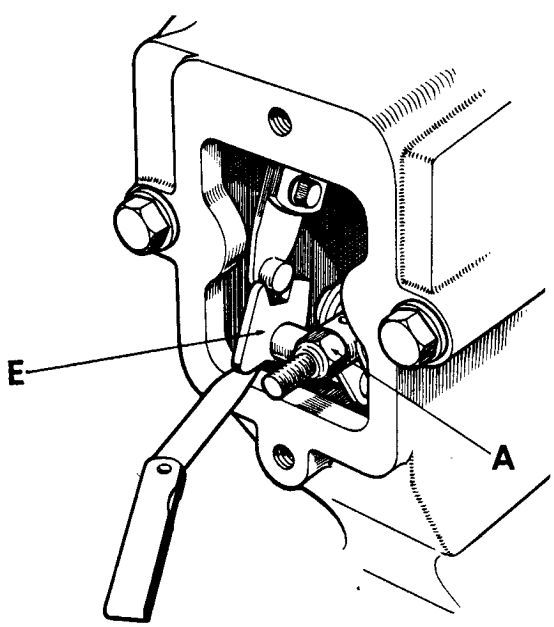

Fig. 9. AUTOMATIC HOLD MECHANISM ADJUSTMENT

Raise the linkage by hand and lock in the raised position by means of the locking latch. The automatic hold mechanism should now have tripped rearwards into the 'hold' position, with the heel of the operating lever E resting against, or close to, the casing. Tighten the nut A on the end of the linkage rod until the operating lever commences to lift away from the casing—this can be checked by inserting a feeler gauge between the heel of the operating lever and the casing—then **unscrew the nut four complete turns.**

Raise the linkage by hand to the highest point of lift and measure the distance from the top corner of the levelling lever to the rear face of the seat support. Lower the linkage, attach a heavy implement and start the engine. Place the control lever in the 'raise' position and allow the linkage to raise until the hold mechanism operates, then take a second measurement from between the same two points as previously. **The distance F,** which is the difference between the two measurements, **should be** $\frac{1}{4}$ - $\frac{3}{8}$ **in.** (6·3–9·5 **mm**) and if outside this limit the clamp bolt G should be released and the striker moved backward, or forward, as required.

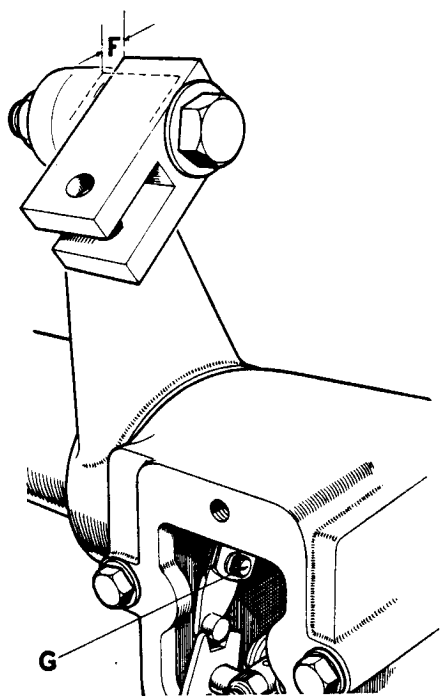

Fig. 10. HOLD MECHANISM TRIP ADJUSTMENT

On early tractors fitted with a linkage locking bolt the hold mechanism should be set in the same manner as with a locking latch but instead of setting the linkage by measuring the distance from the fully raised position, the clamp bolt G should be set so that when an implement is raised the hold mechanism trips when the hole in the left-hand ramshaft arm is opposite the locking bolt. Enabling the locking bolt to be slid into engagement when required.

Repeat the checking procedure after adjusting the striker and when the correct position has been obtained, check the tightness of the clamp bolt and replace the housing cover.

Since any change in distance between the two cable attachment points on the top link will affect the cable adjustment, top links are not interchangeable unless the attachment points are a set distance apart. If it is desired to interchange the top link the distance R between the two cable attachment points should set to 4·300-4·310 in. (109·2-109·5 mm), by fitting shims between the nut I and the inner cable attachment bracket, before adjusting the cable. Any other top link set to the same dimension can then be fitted without it being necessary to re-adjust the cable.

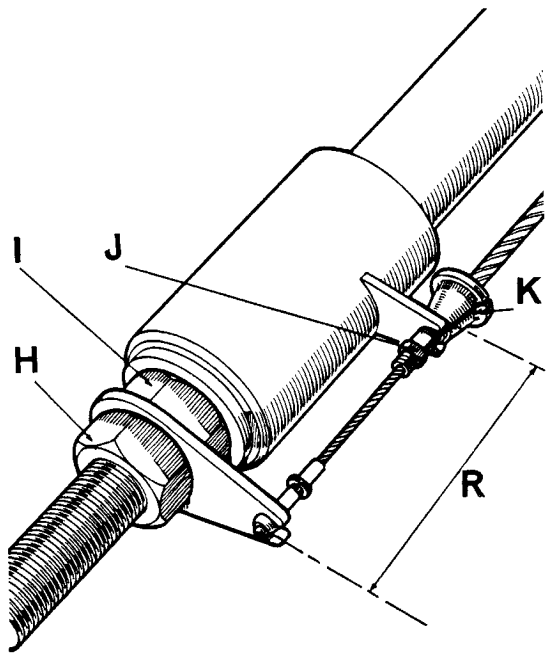

Fig. 11. TOP LINK AND FLEXIBLE CABLE ADJUSTMENT

Disconnect the flexible cable from the top link and release the compression spring locknut H. Unscrew the inner nut I until the screwed shaft has end play then **tighten the nut until all end play is removed** but the spring is not compressed, and tighten the locknut.

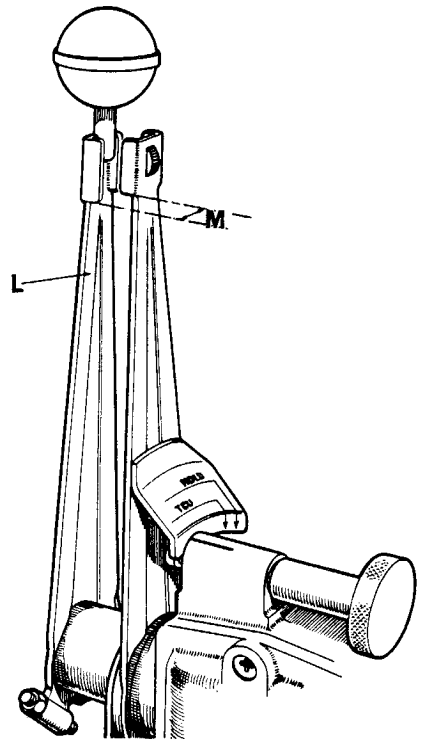

Fig. 13. CONTROL LEVER SETTING

Release the locknut J on the flexible cable adjustment. Hold the nut K stationary, screw the adjuster fully in, to shorten the outer cable, and reconnect the cable on the top link.

Attach a heavy implement on to the linkage. Start the engine, place the control lever L in the 'raise' position and allow the linkage to rise until it trips into the hold position. Stop the engine and move the control lever ½ in. (13 mm) forward from the fully rearward position as at M. Unscrew the adjuster, to lengthen the outer cable, until the implement commences to creep down then **screw the adjuster inwards one full turn** and tighten the locknut J.

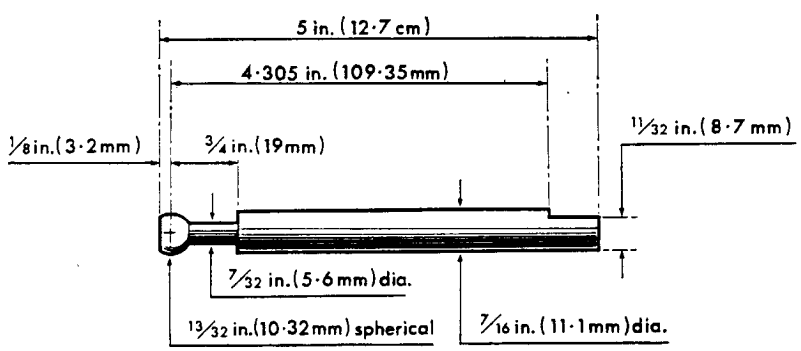

Fig. 12. DETAILS OF GAUGE FOR SETTING TOP LINK AND RAMSHAFT BRACKET

Lower the implement and disconnect the flexible cable from the top link. Push the control lever L fully forward and check that the lever has sufficient resistance to movement to enable it to remain in this position. If the lever requires only a very slight pressure to move it from the forward position, tighten the adjusting nut N in the centre of the lever boss. A single Nyloc nut was fitted on early tractors but later tractors have two locknuts.

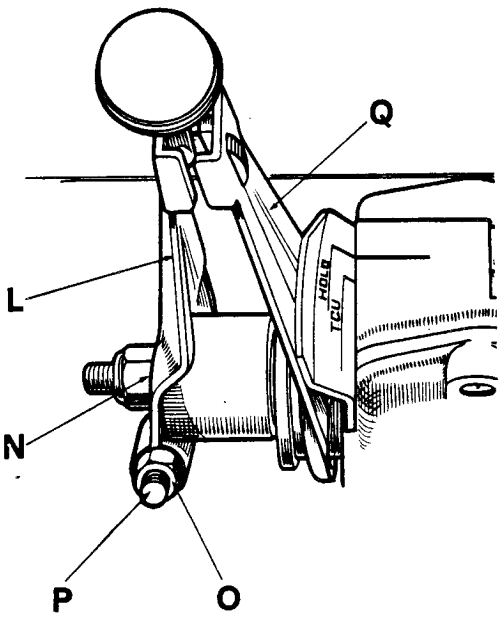

Fig. 14. CONTROL LEVER ADJUSTMENT

Start the engine. Raise the implement until it reaches the hold position and stop the engine. Release the locknut O on the control lever screw P and screw the screw outwards three or four turns. Move the pre-set guide Q until the line marked HOLD on the guide is opposite the line on the housing, then move the control lever forward until it is exactly opposite the pre-set guide. Screw thec ontrol lever screw P slowly inwards until the implement commences to creep down, then **unscrew one full turn** and lock with the locknut.

Lower the implement and reconnect the cable on to the top link.

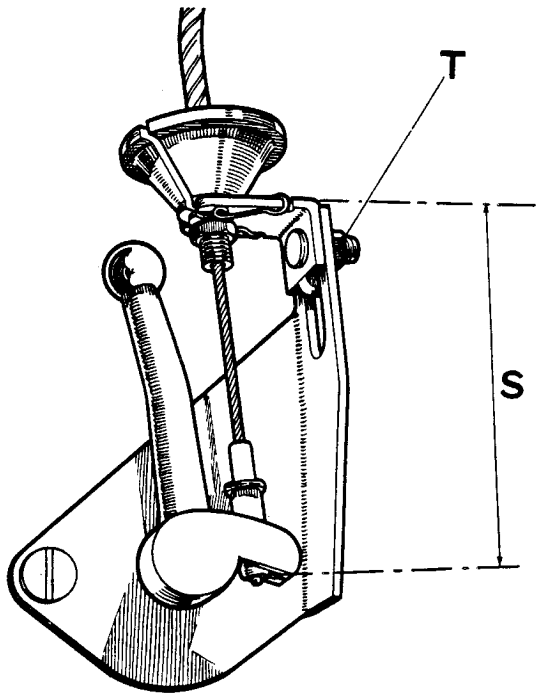

Fig. 15. RAMSHAFT CABLE ATTACHMENT

With the linkage lowered and the top link not attached to an implement, measure the distance R between the inner and outer cable attachment points. This may be done by means of a gauge (Fig. 12), or a pair of callipers. If using callipers it is more convenient to place the top link cable in position and measure from the inner cable nipple.

Raise the linkage, either by hand or power, and engage the linkage locking latch. Check the distance between the inner cable attachment on the override lever and the bracket forming the outer cable attachment. The two measuring points must be in exactly the same places as the two points measured on the top link and the distance S between the points must be equal to the distance R. If the two distances vary more than $\frac{1}{16}$ in. (1·6 mm), **release the clamp bolt T and move the bracket up, or down, on the slide until the required distance is obtained.**

CONTROL VALVE ASSEMBLY

The control valve assembly consists of the depth control valve, traction control valve and operating linkage. No internal adjustments are required, and the mechanism is lubricated by the leak-off oil from the valves forming an oil bath in the housing.

Figure 16 shows a section through the valve assembly. The depth control valve E is operated by the roller H, which is connected to the top link cable and changes position according to the amount of compression in the top link. Since the entire pump output is flowing through the valve any change in the amount of opening of the valve will result in a change in back pressure in the ram cylinder. The change in back pressure thus counteracts the change in depth by raising, or lowering, the linkage as required.

The traction control valve O is a pressure balanced valve, whose operation is identical with the pressure balanced valves in the hydraulic pump. When the depth control valve is open oil flows into the port P, where it exerts pressure against the valve O. This pressure tends to lift the valve O off its seat but is balanced by the oil passing through an orifice in the valve and building up an equal pressure on the opposite side of the valve. The valve, therefore, remains seated until the pressure behind the valve is sufficient to lift the ball M off its seat. This allows surplus oil to flow to waste, thus preventing any further increase in pressure behind the valve, and any increase in pressure in port P will not then be accompanied by a corresponding increase in pressure behind the valve. The higher pressure in port P then opens the valve and allows a controlled flow of oil to be released.

From the above description, it will, therefore, be noted that whilst the main flow of oil from port P passes directly to waste, the maximum pressure in port P is determined by the opening pressure of the ball valve M. The handwheel thus controls the pressure setting of the traction control valve by adjusting the pressure of the ball valve spring L. The ball J locates on to the six flats machined on the handwheel spindle and gives six positive positions during each complete turn of the hand wheel.

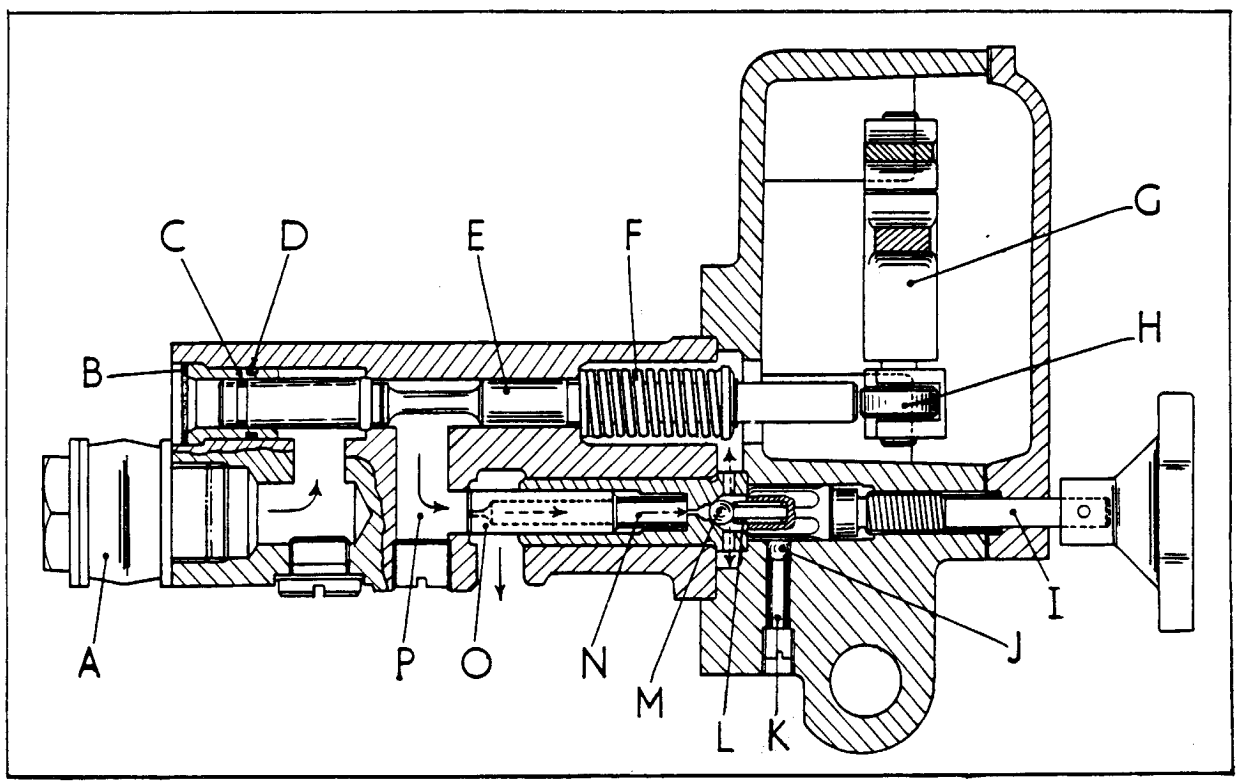

Fig. 16. SECTION THROUGH CONTROL VALVE

A. Inlet Union	B. Circlip
C. 'O' Ring	D. 'O' Ring
E. Depth Control Valve	F. Valve Spring
G. Floating Pivot	H. Roller
I. Handwheel Spindle	J. Detent Ball
K. Detent Spring	L. Ball Valve Spring
M. Ball Valve	N. Cavity
O. Traction Control Valve	P. Port

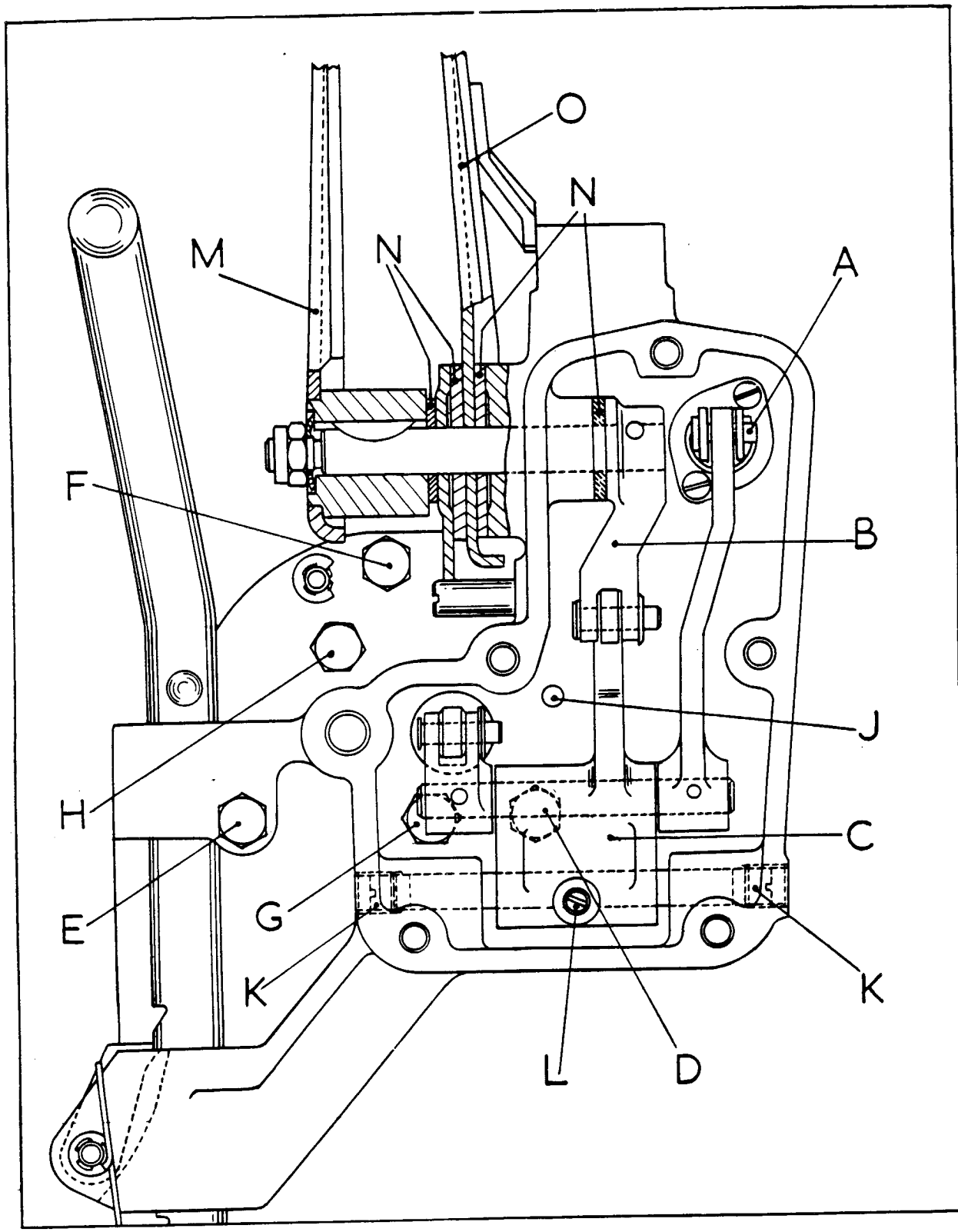

Fig. 17. CONTROL VALVE MECHANISM

A. Cable Attachment Pin
B. Operating Lever
C. Floating Pivot
D. Axle Case Bolt
E. Axle Case Bolt
F. Axle Case Bolt
G. Valve Body Bolt
H. Valve Body Bolt
J. Oil Level Hole
K. Shaft Plug
L. Locating Grub Screw
M. Control Lever
N. Friction Washers
O. Pre-set Guide

Removing the Valve Assembly

Disconnect the linkage and remove the ramshaft complete with its right-hand housing. Remove the banjo bolt connecting the oil feed pipe to the rear of the valve housing, taking care of the two sealing washers. Disconnect the linkage from the lower end of the hand brake lever and remove the traction control handwheel, this is secured to the spindle with a Mills pin. Remove the five cap bolts attaching the cover to the housing then break the joint and withdraw the cover. A quantity of oil will be released when the cover is removed, but this will be replaced automatically when the system is in operation.

Remove the clevis pin (A, Fig. 17) connecting the flexible cable to the depth control valve operating lever and remove the nut from the control lever pivot shaft. Slide the control lever towards the end of the shaft, until it is clear of the key, this will enable the lever B to be pulled forward so that the floating pivot C can be swung downwards to expose the attachment bolt D. Remove the three attachment bolts D, E and F, then withdraw the complete assembly forward out of the axle case.

To replace the unit, reverse the removal procedure, ensuring that all gaskets, sealing washers, etc., are in good condition and taking special care to ensure that the housing to axle case gasket does not obstruct the oil drain hole J. This hole controls the housing oil level and if restricted will allow the housing to fill completely, resulting in oil leakage from the flexible cable aperture.

Check that the control lever pivot shaft is free in the housing and also in the control lever boss. If the shaft is tight in the control lever boss the Belleville washer cannot spring load the friction washers, the lever will then quickly work loose and have insufficient resistance to remain in the 'lower' position. Clean the shaft with abrasive tape, if necessary, and smear the shaft with anti-scuffing paste when assembling into the housing.

When refitting the Nyloc nut onto the control lever pivot shaft, ensure that the Belleville washer is first placed on the shaft and the nut then tightened sufficiently to allow the friction washers to hold the lever in any set position. On later tractors the single Nyloc nut is replaced by two locknuts.

Dismantling the Valve Assembly

After removing the complete assembly from the tractor, remove the two bolts G and H (Fig. 17) and separate the valve body from the linkage housing, taking care of the ball M and spring L (Fig. 16) which will be displaced.

Remove the traction control valve plunger, complete with sleeve and spring, and remove the depth control valve spring F after removing the circlip from the valve spindle. Extract the circlip B from inside the valve body then push the valve spindle and sleeve out of the body.

The drilled plug screwed into the top of the valve body is an oil jet, which lubricates the automatic hold mechanism by spraying oil into the right hand ramshaft bracket housing when the depth control valve is open.

Assembling the Valve Mechanism

After thoroughly cleaning all parts, carefully examine the valves for any sign of wear, paying particular attention to the valve seat faces. It is essential that the valves slide freely in their bores and special care should be taken during assembly to prevent the inclusion of any foreign matter which would affect the movement of the valves. Depth control valves and bodies are selectively paired during assembly and should not, therefore, be interchanged with similar components, from another valve.

TCU valves and sleeves are also selectively assembled and it should be noted that two assemblies are available. These assemblies are identical in appearance but as they give different maximum pressures assembly number 961028 should only be fitted to tractors with a $3\frac{1}{8}$ in. (79·4 mm) diameter ram cylinder and assembly number 88615 fitted to tractors with a $3\frac{1}{2}$ in. (88·9 mm) diameter ram cylinder.

When assembling the valve, replace the parts in the reverse order of dismantling, ensuring that all components are clean and lightly oiled. All gaskets and 'O' rings should be replaced regardless of condition. After assembling the depth control valve, check the valve for freedom of operation. When attaching the valve body to the linkage housing ensure that the traction control valve ball and spring are first placed in position.

HYDRAULIC PUMP UNIT

Description

Figure 19 shows a section through the pump unit. Oil is drawn through the gauze and magnetic filter, situated in the base of the transmission case, into the inlet elbow A from where it is pumped by the rotors Q into the passage B. From there it passes through the non-return valve C into the delivery port D, which is connected to the ram cylinder supply pipe by means of a connector O mounted on the pump support plate P.

The valves E and F control the flow of oil into the port D and are operated by the stirrup G which is connected to the lift control lever. The stirrup has three positions, in the lower position both valves are seated and the oil from the rotors passes through the non-return valve C and into the system through the port D, thus raising the linkage. When the stirrup is in the mid-position valve E remains seated but valve F is opened, oil from the rotors, therefore, passes into the port H from where it is directed to waste. Oil is, however, retained in the system, due to the valve E and the non-return valve C remaining seated, which supports the linkage in the hold position. Further movement of the stirrup into the upper position also opens the valve E, so that oil in the ram cylinder returns into the port D and then passes into the waste port H, allowing the linkage to lower.

It will be noted that the valve F is open whenever the stirrup is in the mid (hold) or upper (lower) position. This allows the pump to idle since it is then only circulating oil into the waste port H, which is piped to the gearbox and power take-off unit for lubrication purposes.

The rotors Q are supported in bushes M which not only provide bearings for the rotor shafts but also seal the side faces of the rotors against leakage. Most of the internal leakage that occurs in gear type pumps is due to the fixed running clearance between the rotors and side-plates. The rotor bushes are therefore pressure loaded by allowing oil pressure from the pump pressure port B to be fed to an annular area outside the front rotor bushes. This area is sealed by means of a sealing ring J and is slightly greater than the pressure area on the gear side of the bush. The difference in pressure area results in the complete rotor and bush assembly being pressed against the pump housing end cover at all pump output pressures, and oil leakage between the rotor side faces is thus reduced to a minimum.

The valves E and F are pressure balanced valves, the oil pressure acting on both sides of the valve. Figure 18 shows a section through valve F. Oil pressure from the underside of the valve passes through the orifice A and into the cavity D. The pressure on the top of the valve is thus able to hold the valve seated against the equal pressure acting against the underside of the valve. The spring C does not therefore control the operation of the valve but only applies a light pressure to give the valve a bias towards its seat. When the pressure in the cavity D is sufficient to overcome the tension of the spring H the ball valve F is raised off its seat and allows oil to leak away faster than it can be replaced by the restricted flow through the orifice A. Any further increase in pressure against the underside of the valve is not then accompanied by a corresponding increase in the cavity D which results in the valve B being raised off its seat and allowing oil to flow to waste. The relief pressure of the valve is therefore controlled by the tension of the spring H which may be adjusted by removing, or adding, shims G between the cap and the valve seat. The operation of the valve E is the same as valve F except that no relief valve is incorporated in the end cap as no maximum pressure control is required.

The valve seats are loose inserts mounted on rubber sealing rings, thus permitting the seats to align themselves with the valves which are mounted in a detachable housing.

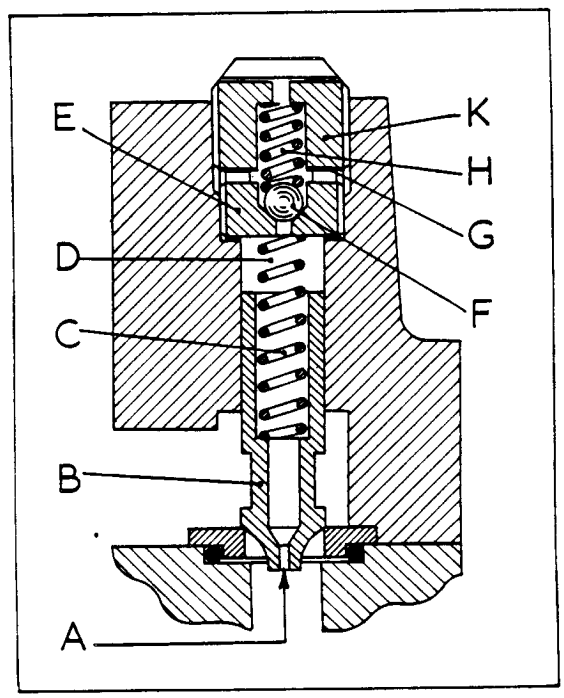

Fig. 18. SECTION THROUGH PUMP RELIEF VALVE

A. Orifice	B. Valve Plunger
C. Plunger Spring	D. Cavity
E. Ball Seat	F. Ball Valve
G. Adjustment Shim	H. Ball Spring
	K. Plug

Removing the Pump Unit

Access to the pump unit is obtained by removing the power take-off and pulley unit after first draining the transmission oil.

The pump is driven from a gear on the power take-off shaft and this is removed with the P.T-O. unit. After removing the P.T-O. unit, remove the four set screws attaching the intake elbow to the base of the pump body and unscrew the union on the gearbox lubricating pipe. Disconnect the valve operating rod from the bell crank lever and remove the two lower attachment bolts. Remove the nut from the upper attachment stud and draw the pump rearwards. The pump outlet port is on the rear face of the pump housing and fits on to a connector mounted on the pump support plate.

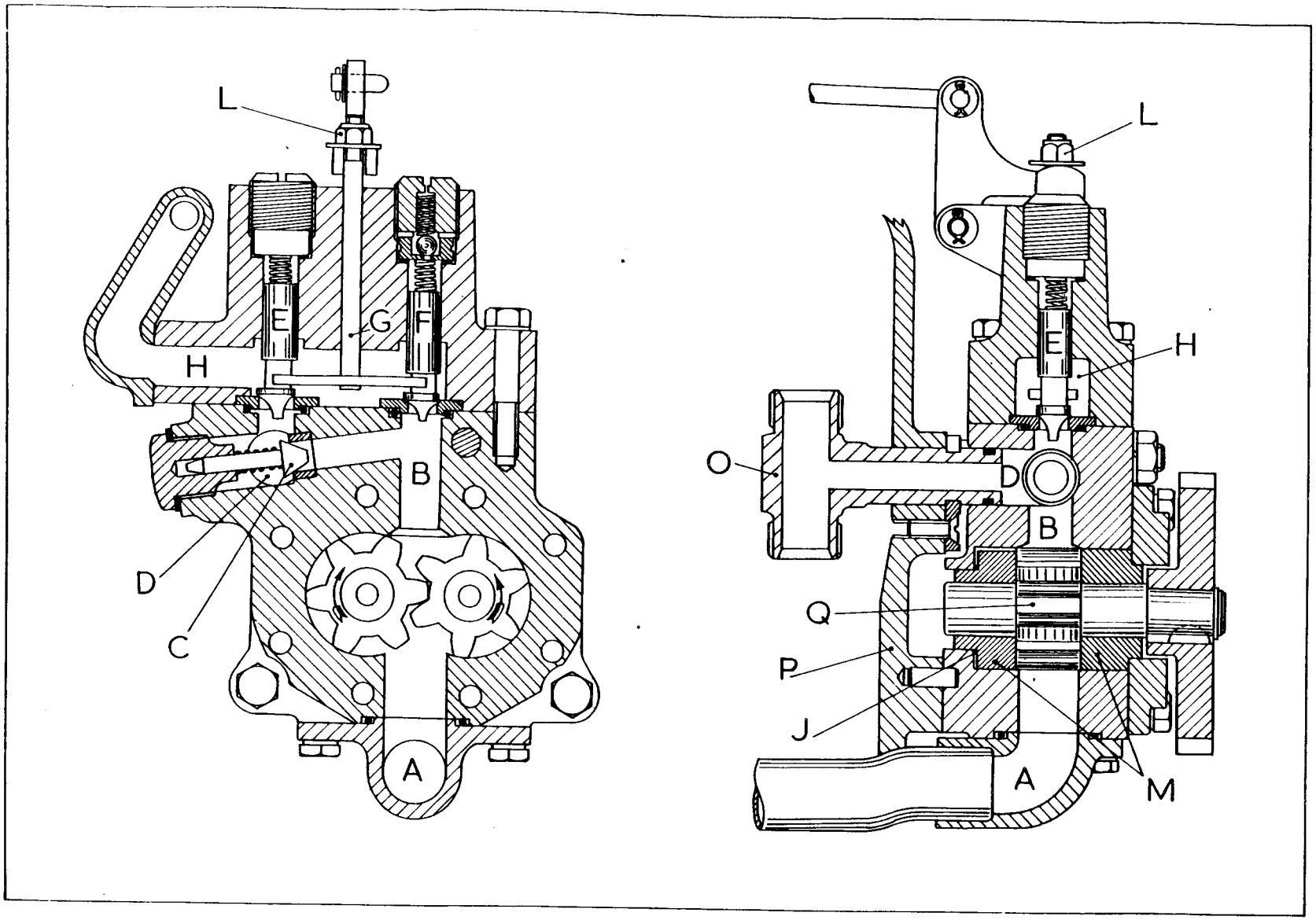

Fig. 19. SECTIONAL ARRANGEMENT OF HYDRAULIC PUMP

A. Inlet Elbow
B. Oil Passage
C. Non-return Valve
D. Outlet Port
E. Hold Valve
F. Main Relief Valve
G. Valve Stirrup
H. Waste Port
J. Sealing Ring
L. Adjusting Nut
M. Rotor Bushes
O. 'T' Connector
P. Backplate
Q. Rotor

Replacement of the pump unit is the reverse of removal. Special care being taken to ensure that the rubber sealing ring on the pump outlet connector is not displaced when the pump is pushed into position. When re-fitting the power take-off unit, ensure that the lubricating pipe from the pump enters the gear casing, otherwise the unit will be starved of oil. Turning the PTO shaft, with the unit in gear, will enable the drive shaft splines to line up with the coupling splines. The PTO shaft should also be turned to ensure meshing of the pump drive gears, on Livedrive tractors it will be necessary to hold the PTO clutch disengaged to enable the shaft to be turned.

Dismantling the Pump Unit

Remove the five bolts attaching the valve chest to the rotor housing and withdraw the valve chest. The valve seats will be released when the chest is removed and these should be identified so that they can be replaced in the same positions.

To remove the valve plungers, remove the nut from the top of the valve operating rod and withdraw the stirrup and valve plungers. Remove the plugs from the top of the valve bores, noting the number of shims fitted below the pressure relief valve plug. These shims adjust the pressure at which the valve operates and should be replaced as removed.

Remove the circlip securing the pump drive gear on to the rotor shaft then remove the gear using a suitable extractor. Do not remove the drive gear by hammering the end of the rotor shaft as this will damage the rotor bushes.

Remove the eight bolts attaching the cover to the rotor housing. Remove the end cover and withdraw the rotors and bushes. The bushes should slide out of the housing. If there is a little stiffness the rotor pack may be shaken out by tapping the edge of the housing on a wooden block.

The non-return valve assembly may be removed by unscrewing the hexagon headed plug. The valve seat is a steel insert and should not be removed.

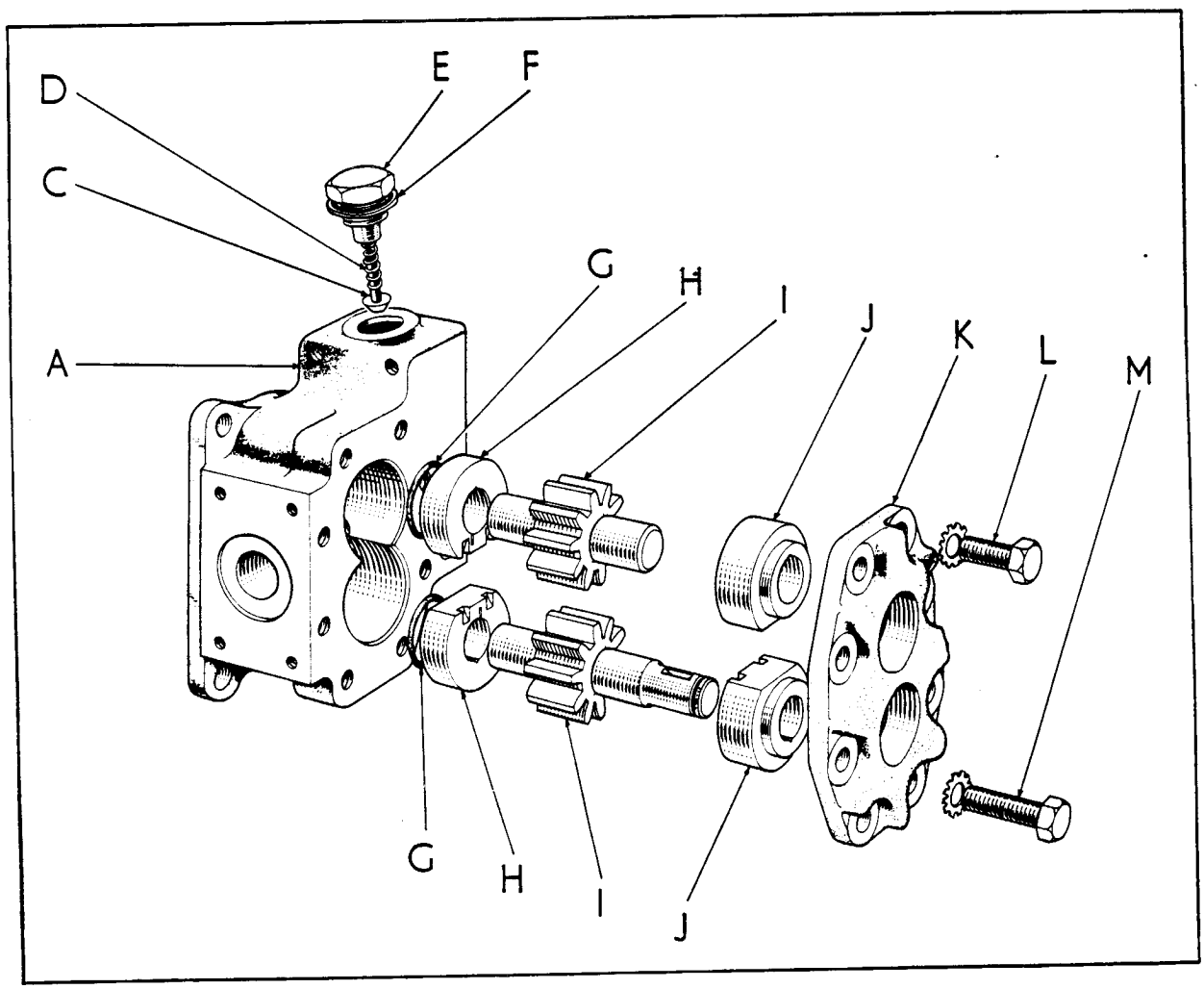

Fig. 20. ROTORS AND HOUSING

A. Pump Body
C. Non-return Valve
D. Valve Spring
E. Plug
F. Sealing Washer
G. 'O' Ring
H. Rotor Bushes
I. Rotors
J. Rotor Bushes
K. End Plate
L. Short Bolt
M. Long Bolt

Except for the withdrawal of the drive gear, no special tools are required for stripping or re-assembly. Hammers or similar tools must not be used on the pump.

Valve Plungers and Housings

For satisfactory operation of the pump valves it is essential for the valve plungers to be a close fit in the housing bores, and to obtain the accurate fit required plungers are graded, according to sizes shown in the chart, and then selectively assembled in bores of the same grade. Plungers must, therefore only be refitted in their original bores and not mixed with other valves. Replacement housings are only supplied with a pair of matched valves but valve plungers are available individually and the colour of the grade required should be specified when ordering.

Valve housings and plungers should normally be replaced together but valve plungers can be replaced separately if sufficient care is taken to obtain a satisfactory fit. Select a plunger that is a firm push fit in the bore, bearing in mind that plungers of the same grade may vary within the grade limits. Insert a piece of $\frac{3}{8}$ in. (9·5 mm) dowel into the plunger and grip the dowel in a vice. Clean the plunger and housing bore and after lightly smearing the plunger with marking blue, push the housing on to the plunger. Withdraw the housing and polish the contact areas on the plunger with fine abrasive tape dipped in paraffin. Repeat the marking and polishing, turning the plunger quarter of a turn each time so that the plunger will fit in any position, until the plunger slides freely into the bore. To check the fit of the plunger, thoroughly clean the bore and plunger and assemble the plunger and spring into the housing. If the plunger is then pushed against its spring and released it should return to its original position without being ejected out of the bore. Ensure that the valve housing and plungers are thoroughly cleaned before being re-assembled.

Pump Relief Valves

The ball type of relief valve has been superseded by a conical plunger type of valve and pumps originally fitted with ball valves can be converted to the later type by fitting a new plug, spring, conical plunger, seat and restrictor washer.

On 990 tractors an additional relief valve is fitted over the leak-off plunger. This relief valve limits the back pressure in the system when supporting a heavy implement or attachment, in the hold position. The back pressure build up under these conditions can be quite high, particularly when travelling over uneven ground, and pumps originally fitted with a single valve can be converted to twin valves by discarding the solid blanking plug and replacing this with a complete valve assembly.

It is most important that the relief valves are set to the correct pressure, otherwise damage may be caused to the system. The most convenient method of setting the valves is by means of a test rig, where the valves are accessible and shims can easily be removed, or added, until the required opening pressure is obtained. If a test rig is not available valves may be set with the pump on the tractor but it is necessary to remove the P.T.O. unit in order to adjust the amount of shims.

When two relief valves are fitted it is necessary to temporarily remove shims from the main control valve in order to obtain sufficient pressure to set the leak-off valve. When the leak-off valve has been set the shims should then be replaced in the main control valve and the pressure setting adjusted.

Note.—The difference in pressure setting obtained by adding, or removing, one shim is approximately 150 lb/sq in (110 kg/sq cm).

Assembling the Pump Unit (Fig. 20)

The pump components should be washed in clean paraffin and placed on a clean bench. If more than one pump is to be stripped at the same time, care should be taken to ensure that all components are segregated along with their housings and covers. The width of the rotors are paired to 0·0002 in. (0·005 mm) and the length of the major diameters of the bushes are also paired to the same limit. It is thus essential not to interchange pump components indiscriminately.

Smear the 'O' rings G with a good quality grease and fit them on to the tails of the bushes H. The tail diameters of the bushes H are smaller than the bushes J and the bushes are not, therefore, interchangeable.

With the 'O' rings fitted, slide the two bushes H down to the bottom of the pump bores. A little clean oil on the pump bores will assist this operation.

Apply a quantity of clean oil into the pump and slide the two rotors into their respective bores. Slide the two bushes J into the body with their slotted faces against the gears. Fit the cover K and replace the eight bolts, with shakeproof washers. Noting that two bolts are shorter than the others for use where the cover section is thinner. Tighten the bolts by diagonal selection, to 40 lb ft (5·5 kgm)

Replace the non-return valve assembly after ensuring that the valve and seat are in good condition.

Refit the pump drive gear on to the rotor shaft. First fitting the driving key into the shaft and then pressing the gear on to the shaft until the retaining circlip can be fitted. When fitting the driving gear, special care should be taken to ensure that no end loading is taken by the rotors, as the rotor teeth will easily damage the comparatively soft bushes. When pressing the gear on to the shaft, support the opposite end of the shaft on a peg or stop, the pump housing is open at the end to allow this.

Replace the valve seat inserts on to the pump body, positioning the sealing rings underneath the inserts, and fit the valve housing. Lightly tighten the housing bolts, then gently tap the housing on each side, to align the seats, before fully tightening the bolts.

Grade Colour		Housing Bore	Leak-off Valve 909288	Control Valve 89236
Red	in.	0·4684/0·4686	0·4680/0·4682	0·4668/0·4672
	mm.	11·897/11·902	11·888/11·892	11·860/11·867
Yellow	in.	0·4687/0·4689	0·4683/0·4685	0·4672/0·4676
	mm.	11·902/11·913	11·892/11·899	11·876/11·877
Blue	in.	0·4690/0·4692	0·4686/0·4688	0·4676/0·4679
	mm.	11·913/11·918	11·899/11·907	11·877/11·885

CHART OF VALVE PLUNGER DIAMETERS AND BORE GRADES.

TOP LINK UNIT AND CONTROL CABLE

Figure 21 shows a section through the top link unit. The screwed shaft is a sliding fit in the spring housing and is secured by means of a peg passing through the end of the shaft. The outer ends of the peg are located in slots in the spring housing so that when the linkage is raised and the link is in tension the link becomes solid due to the peg being at the end of the slot, but when the implement is in work and the link is in compression, the peg slides freely in the slot and allows the thrust to be taken by the compression spring.

Variations in the length of the compression spring, due to variations in the amount of thrust, are then transmitted to the flexible cable which is attached to the moving shaft (inner cable) and stationary housing (outer casing).

To remove the compression spring unscrew the locknut B then remove the cable bracket M. Remove the nut C and hold the housing vertical to allow the abutment washer and spring to fall out of the housing.

Whenever the unit is dismantled the spring dowel pin F should be removed, the shaft A withdrawn from the housing and lubricated with anti-scuffing paste before being assembled.

Replace the spring in the reverse order of removal, tightening the inner nut until there is no end play in the shaft but the spring is not compressed, then replace the cable bracket and outer nut. Overtightening the inner nut will pre-load the spring and affect the operation of the unit.

On later tractors shims are fitted between the inner nut and cable abutment bracket. The purpose of these shims is to set the distance between the inner and outer cable abutments (R, Fig. 11) to 4·300–4·310 in. (109·2–109·5 mm) so that the top link can be interchanged with any other top link that has been set to the same dimension. If top links that are not set to the same dimensions are interchanged it is necessary to readjust the flexible cable.

For satisfactory operation of the depth control valve it is essential that the flexible cable operates quite freely. The cable should be lubricated through the grease nipple at regular intervals and care should be taken to ensure that the outer casing is not damaged in any way.

To check the cable for freedom of operation. Lower the linkage and disconnect the cable from the top link, place the control lever into the "raise" position then pull the inner cable against the spring whilst holding the outer casing. If the spring tension does not return the inner cable back to its original position, the cable should be removed and freed or replaced.

To remove the flexible cable. Remove the traction control handwheel, this is secured to the shaft by means of a Mills Pin, then remove the control valve housing cover. A quantity of oil will be released when the cover is removed, this will, however, be replaced automatically when the system is in operation. Disconnect the cable from the top link and unscrew the abutment block off the cable adjuster. Remove the clevis pin attaching the cable to the depth control valve operating lever and remove the two screws attaching the cable casing H to the inside of the control valve housing. After removing the grease nipple from the centre of the cable casing, withdraw the complete cable assembly out of the control valve housing.

Refit the cable in the reverse order of removal, ensuring that the valve housing cover gasket is undamaged and finally adjusting the cable in accordance with the instructions on page 13.

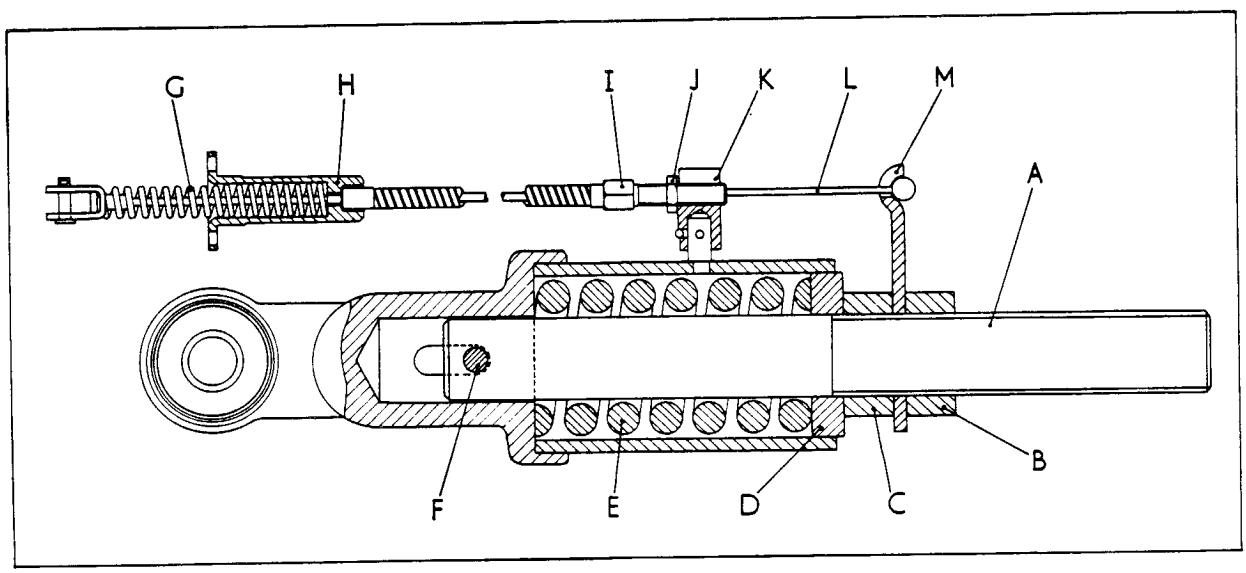

Fig. 21. TOP LINK COMPRESSION UNIT

A. Shaft
B. Outer Nut
C. Inner Nut
D. Abutment Washer
E. Compression Spring
F. Shaft Peg
G. Cable Spring
H. Cable Housing
I. Cable Adjuster
J. Locknut
K. Cable Abutment Block
L. Inner Cable
M. Cable Bracket

RAM CYLINDER AND RAMSHAFT

To remove the Ramshaft

Remove the cover from the right-hand ramshaft bracket and remove the Nyloc Nut and distance piece from the end of the hold mechanism linkage rod. Remove the four bolts attaching the right-hand housing to the axle case, then remove the six ram cylinder cover bolts; the two centre cover bolts pass through the axle case and are fitted with nuts adjacent to the ram cylinder union cover plate.

Whilst supporting the weight of the ramshaft, remove the ram cylinder cover then remove the ramshaft complete with right-hand bracket.

To remove the right-hand bracket from the ramshaft remove the two countersunk screws, securing the override control in the housing, then withdraw the control assembly out of the housing (Fig. 25). Remove the circlip from the ramshaft extension and slide the housing off the shaft.

After removing the ramshaft, remove the cover plate from the front of the axle casing then disconnect the oil pipe banjo union and push the ram cylinder out of the axle case. If the tractor is fitted with a three-way valve, it will be necessary to remove the union assembly from the front end of the ram cylinder (see page 27) before removing the ram cylinder.

To re-assemble, replace the components in the reverse order of removal, ensuring that the ramshaft bearing seals are positioned on the ramshaft before the ramshaft is placed in position.

To facilitate guiding the hold mechanism on to the linkage rod, the inner distance piece and rod are drilled to enable the compression spring on the rod to be held in the compressed position, by temporarily fitting a split pin through the distance piece and rod.

The ram cylinder cover has a faced joint and requires no gasket, the faces must, however, be clean and smeared with jointing compound. After attaching the housings to the axle case, remove the split pin from the hold mechanism rod and fit the outer distance piece and Nyloc Nut. Adjust the nut in accordance with the instructions on page 12, then replace the cover.

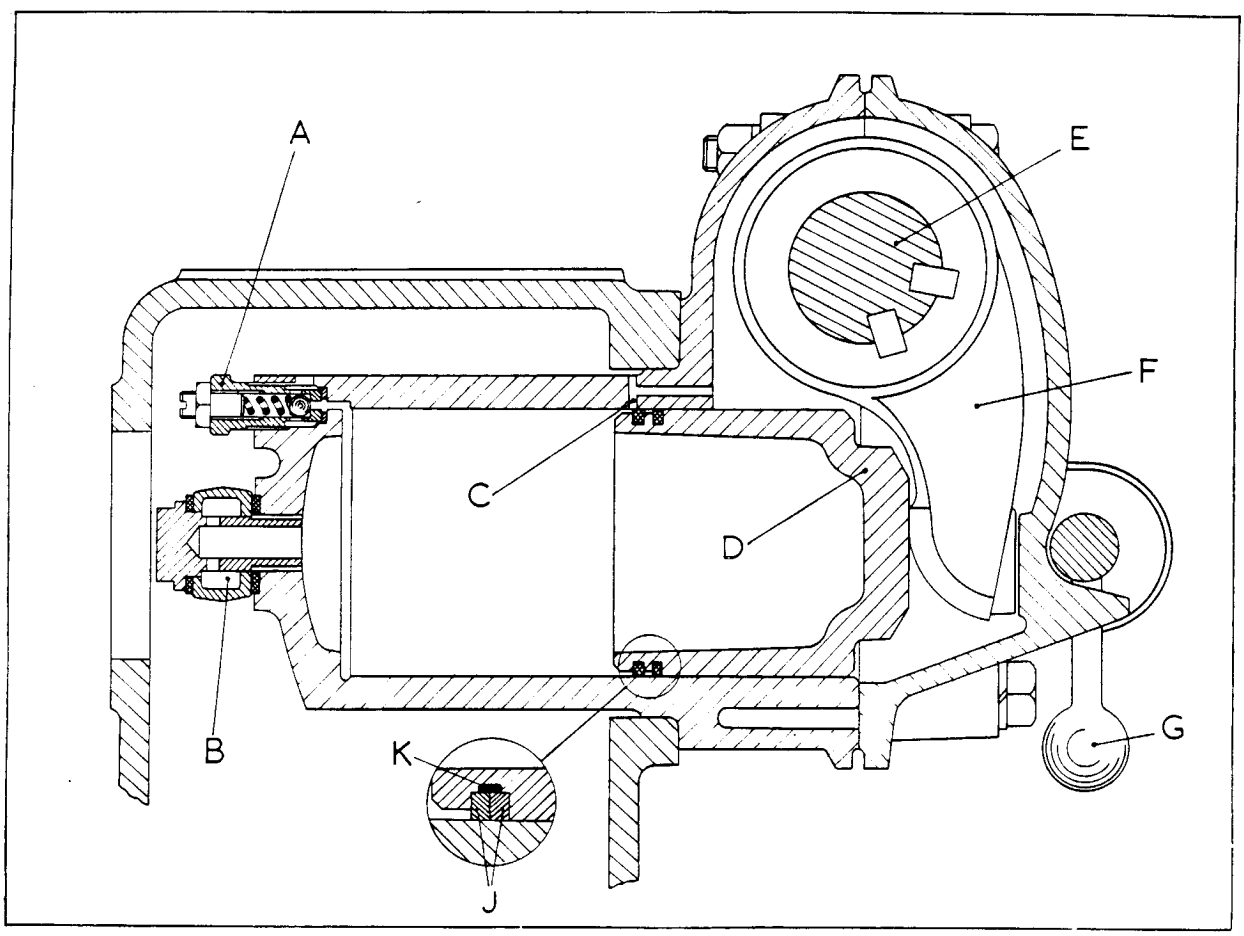

Fig. 22. SECTION THROUGH RAM CYLINDER (Early series tractors)

A. Pressure Relief Valve
B. Inlet Union
C. Spill Port
D. Ram Piston
E. Ramshaft
F. Ramshaft Arm
G. Lift Locking Bolt
J. Piston Rings
K. Rubber Seal

Ramshaft and Arms

The linkage arms are keyed and shrunk on to the shaft and should therefore be regarded as an integral assembly. The ramshaft assembly on later series 850 tractors is dimensionally identical to the ramshaft on 880-950 and 990 model tractors but as the shafts are of different material assembly number 908036 must only be fitted to 850 model tractors; to assist identification these shafts are stamped '850' adjacent to the top link attachment.

The ram cylinder arm is fitted with two keys and is shrunk on to the shaft. If the arm requires replacement, due to wear on the contact face, it may be pressed off the shaft provided that it is first split with a chisel adjacent to one of the keyways. The arm must not be pressed off the shaft without being split as this would damage the shaft surface. When fitting a replacement arm place the keys in position on the shaft and heat the arm boss with a welding torch until it expands sufficiently to be pressed on to the shaft. As the arm contact face is hardened and must not be heated to over 200°C (390°F), the heating must be confined to the arm boss only. Press the arm on to the shaft until the distance between the ram arm and left-hand linkage arm is 1·793 to 1·728 in. (4·55 to 3·39 cm). Take care not to damage the bearing surface at the end of the ramshaft and if necessary 'clean up' with fine abrasive tape after pressing the arm into position.

Ram Cylinder—Early series tractors

Figure 22 shows a section through the ram cylinder. Oil from the hydraulic pump enters the cylinder through the banjo union B and exerts pressure against the piston D, which turns the ramshaft E by means of the arm F.

The valve A is a pressure relief valve and is set to open at 1 500 lb/in² in order to protect the linkage from damage due to overloading.

The bolt G engages the ramshaft arm and may be used to lock the linkage in the raised position.

When the piston reaches the end of its stroke the port C is uncovered and allows oil to spill from the cylinder; a cross drilling into the spill port feeding oil into the cylinder cover to lubricate the piston face.

On earlier production tractors the two cast-iron piston rings were fitted in separate grooves but on later series tractors this arrangement was changed by fitting both rings in a single double-width groove and fitting a thin rubber seal underneath the ring joint.

When refitting the piston into the cylinder ensure that the ring gaps are diametrically opposite and the piston and bore are clean. Smear the piston thrust face with anti-scuffing paste and replace the relief

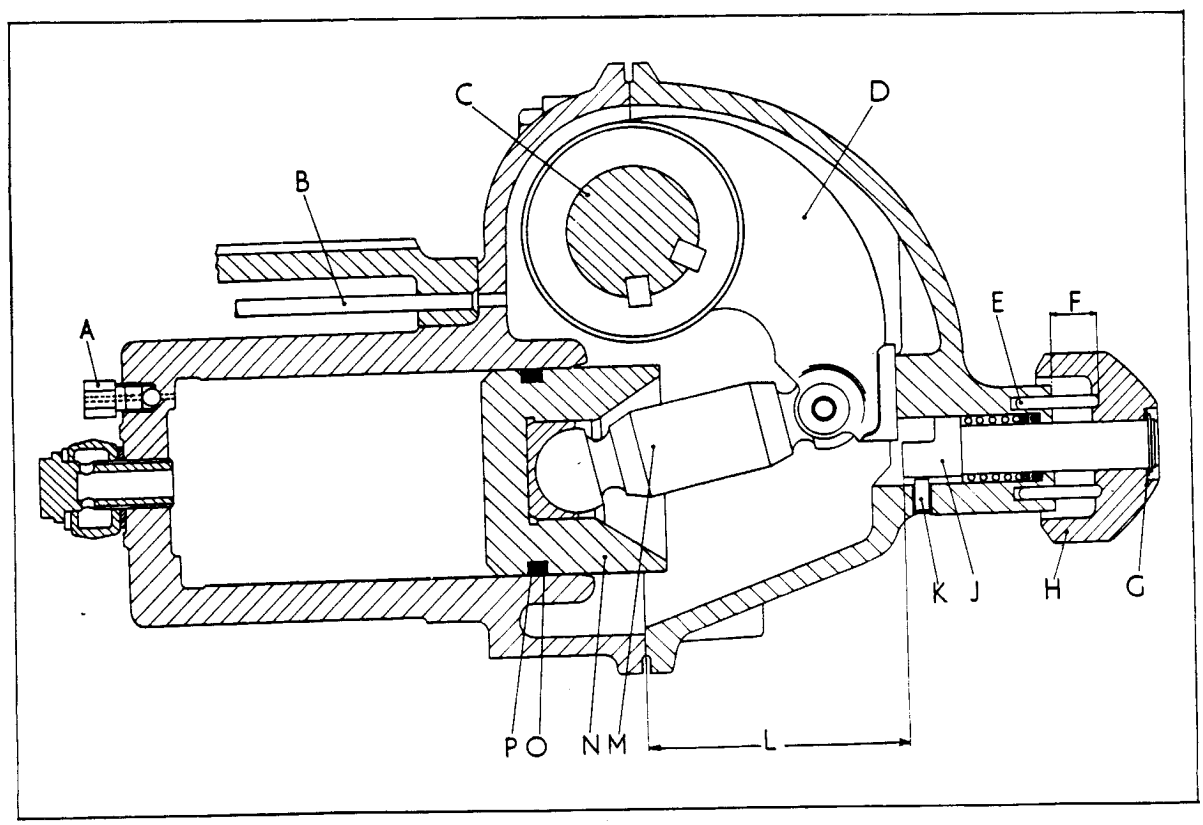

Fig. 23. SECTION THROUGH RAM CYLINDER (Later model tractors)

A. Bleeder Valve
B. Lubricating Oil Pipe
C. Ramshaft
D. Ramshaft Arm
E. Needle Roller
F. Setting Distance 0·718-0·728 in. (18·24-18 mm)
G. Shims
H. Catch Knob
J. Catch Plunger
K. Locating Screw
M. Connecting Rod
N. Piston
O. Anti-Extrusion Ring
P. 'O' Ring

valve: do not overtighten the relief valve, a tightening torque of 20 lb ft (2·76 km g) is sufficient.

Ram Cylinder—Later model tractors

Figure 23 shows a section through the ram cylinder. Oil from the hydraulic pump enters the cylinder through the banjo union and exerts pressure against the piston N, which turns the ramshaft C by means of the connecting rod M and Lever D.

The valve A is a bleeder valve for venting the system, to remove air left in the cylinder after assembly. The pipe B is connected to the gearbox lubrication pipe and feeds oil into the cylinder cover; a drain hole in the cylinder allowing surplus oil to return into the axle casing.

The plunger J is spring-loaded and may be used to lock the linkage in the raised position by turning the knob H, which releases the plunger and allows it to engage the ramshaft arm D when the lift reaches maximum height.

When assembling the cylinder, soak the leather anti-extrusion ring in light oil for 30 minutes before fitting the ring on to the piston. The ring should be fitted with the rough side towards the 'O' ring and special care should be taken not to stretch the ring when passing it over the piston crown. When the leather ring is correctly positioned in the groove fit the rubber 'O' ring, ensuring that this fits snugly alongside the leather ring and does not prevent the leather ring from standing proud of the piston.

Thoroughly clean the cylinder bore and piston then smear with oil before fitting the piston in to the cylinder. The end of the cylinder bore is chamfered to facilitate entering the sealing rings but care must be taken not to damage the rings as any damage, however slight, may allow leakage when under high pressure. If the ram cylinder is installed in the tractor, place the lift control lever into the "lower" position, to prevent air being trapped in the cylinder when inserting the piston. After fitting the piston smear the ends of the connecting rod with ant-scuffing paste and refit the ramshaft.

Before replacing the cover assembly check the setting of the locking plunger J, by turning the knob H into the 'disengage' position, placing a straight edge across the joint face and measuring the distance to the plunger end. This distance should be 4·00–4·06 in. (10·16–10·31 cm) and if not within this distance the knob H should be removed and shims G added, or removed, as required.

As the setting of the needle rollers E determines the position of the plunger J, when replacement needles are fitted these should be pressed into the cover until the protrusion F is 0·728–0·718 in. (18·49–18·24 mm) and then the catch assembled and the distance L checked. If the distance L is not within 4·00–4·06 in. (10·16–10·31 cm) the knob H should be removed and shims G added as required.

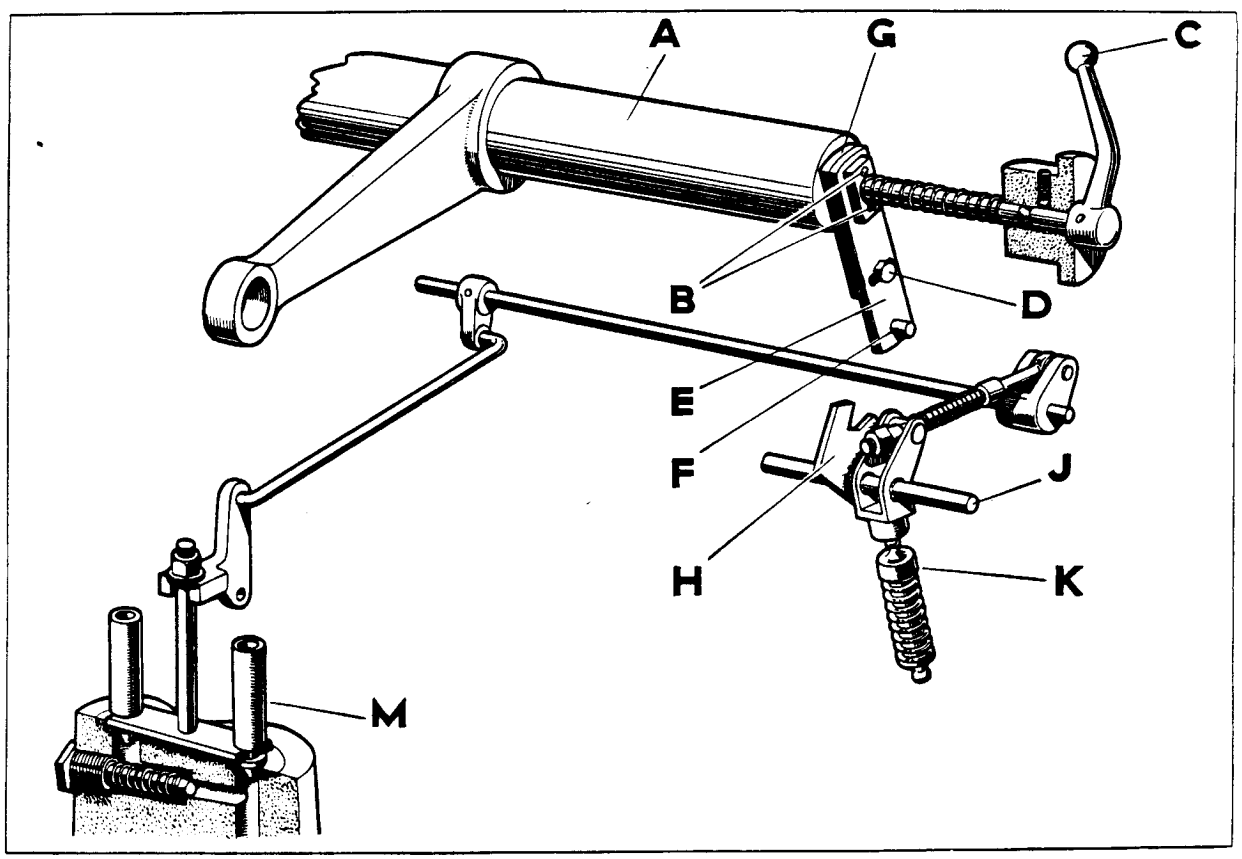

Fig. 24. AUTOMATIC HOLD MECHANISM

A. Ramshaft
B. Connecting Pegs
C. Override Control
D. Adjusting Bolt
E. Striker Arm
F. Striker Peg
G. Connecting Plate
H. Trip Lever
J. Pivot Shaft
K. Spring Toggle

AUTOMATIC HOLD MECHANISM

The automatic hold mechanism is housed inside the right-hand ramshaft bracket and consists of a spring-loaded toggle mechanism operated by a striker arm connected to the ramshaft.

With reference to figure 24, as the ramshaft A turns into the raised position, the striker arm E is also turned by means of the two connecting pegs B. When the striker arm stud F contacts the jaw of the trip lever H this commences to pivot on its shaft J and compresses the spring toggle K. Immediately the spring toggle reaches an "over centre" position the trip lever H springs over and pulls the valve linkage rod a sufficient distance to open the pump valve M, pump output then flows to waste and no further lift takes place.

To enable the maximum lift of the linkage to be adjusted to coincide with the position of the linkage locking bolt, the striker arm E is attached to the plate G by means of a bolt D fitted through an elongated hole. This permits the position of the striker arm to be moved if required.

When the override control lever C is moved sideways, away from the ramshaft, the two connecting pegs B are withdrawn from the holes in the ramshaft, thus permitting the ramshaft to turn without operating the striker arm

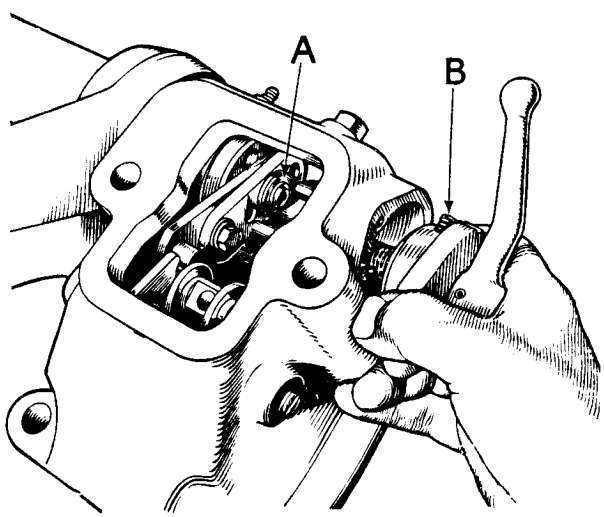

Fig. 25. REMOVING THE OVERRIDE CONTROL ASSEMBLY
A. Circlip B. Detent Spring

To remove the Automatic Hold Mechanism

Disconnect the flexible cable and remove the top link. Disconnect the lower links and remove the six ram cylinder cover bolts: the two centre bolts pass through the axle case and are fitted with nuts. Remove the right-hand ramshaft bracket cover and remove the Nyloc Nut and distance piece from the valve linkage rod. Remove the four bolts attaching the right-hand ramshaft bracket to the axle case, then break the joint on the ram cylinder cover and remove the ramshaft complete with right-hand housing.

Clamp the ramshaft in a vice, then remove the two countersunk screws from the housing end plate. Withdraw the end plate and override control, taking care of the detent spring and ball, which will be displaced when the assembly is withdrawn from the housing. To remove the striker arm from the ramshaft, remove the circlip (Fig. 25) from the ramshaft extension, then slide the housing off the ramshaft. The trip lever pivot shaft may be pushed out of the housing, after removing the two end plugs and the grub screw through the trip lever boss.

Re-assemble the mechanism in the reverse sequence to dismantling, ensuring that the ramshaft bearing seal is fitted in the recess in the housing and the ends of the spring toggle are correctly seated in their respective sockets. Before re-fitting the ramshaft on to the axle case, compress the spring on the pump valve operating rod and temporarily retain in this position by fitting a split pin through the distance piece and rod. This will facilitate guiding the rod into the trip lever when placing the ramshaft in position. After re-fitting the ramshaft, remove the split pin and fit the outer distance piece and nut, then adjust the pivot shaft end plugs so that the shaft has a slight end play with the trip lever positioned clear of the striker arm and in line with the valve operating rod.

After adjusting the mechanism in accordance with the instructions on page 12, lift the linkage several times by hand and check that the mechanism operates quite freely.

THREE-WAY VALVE UNIT U279

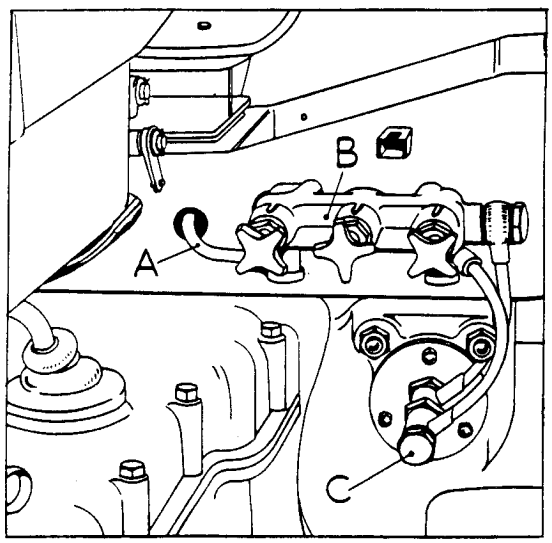

Fig. 26. THREE-WAY VALVE UNIT
A. External Connection B. Valve
C. Ram Cylinder Union

The three-way valve unit is mounted on the left-hand side of the seat support and contains three screw-in valves which may be operated to control the flow of oil to the tractor ram cylinder or the two external services as required. A permanent connection, from one of the external services, is made to an Exactor quick-release coupling which is mounted on the rear face of the tool compartment to provide a convenient connection for attachments positioned at the rear of the tractor.

On tractors incorporating height control the banjo bolt in the end of the ram cylinder union includes a flow control valve and care should be taken to ensure that this bolt is only refitted in its original position. If the bolt is fitted in the valve body the oil flow from the take-off connections will be restricted.

Oil supply to the valve is by means of a four-way union fitted on the front end of the ram cylinder. Figure 22 shows a section through the union assembly. Oil from the main feed pipe banjo flows along the outer passage and then through the inner banjo union and pipe to the three-way valve. Oil flow from the valve then returns through the outer banjo and along the inside of the centre tube into the ram cylinder.

To remove the union assembly from the tractor, remove the two pipes connecting the union to the valve then remove the three screws attaching the circular cover plate to the axle case. Unscrew the union body from the ram cylinder taking care of the two banjo sealing washers.

When re-fitting the union, ensure that the sealing washer is positioned between the end of the ram cylinder and the pipe banjo then fit the other sealing washer, 'O' ring and cover plate on to the union body. Before screwing the extension on the union body, check that the sealing ring is positioned in the internal groove. Leakage past this seal will allow oil to pass into the ram cylinder when the three-way valve is closed.

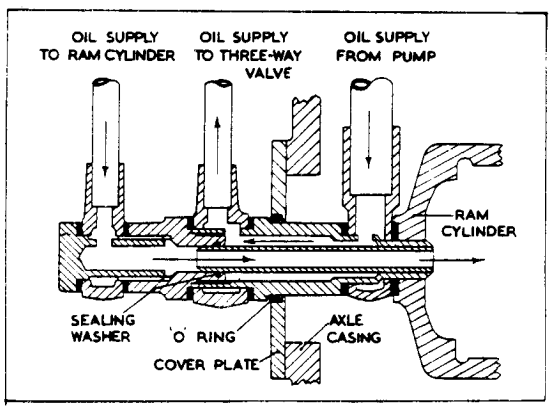

Fig. 27. SECTION THROUGH RAM CYLINDER UNION

DIMENSIONAL DATA

Pump Control Valve Pressure Setting		2 300 lb/in² (161·7 kg/cm²)
Pump Leak-Off Valve Pressure Setting		2 500 lb/in² (175·7 kg/cm²)
Maximum Lift at end of Links (total)		1 800 lb (187 kg)
Ram Cylinder Relief Valve Pressure Setting	Early model tractors	1 500 lb/in² (105·6 kg/cm²)
Pump Output (at maximum pressure and rated engine speed)	Early model tractors	6¼ gall/min (28 litres/min)
Maximum T.C.U. Pressure	Early model tractors	550–600 lb/in² (38·5–42 kg/cm²)
Maximum Lift at end of Links with T.C.U.	Early model tractors	840 lb (381 kg)
Ram Cylinder Diameter	Early model tractors	3·50–3·499 in (88·9–88·875 mm)
Ram Piston Diameter	Early model tractors	3·4985–3·498 in (88·86–88·85 mm)
Ram Piston Stroke	Early model tractors	3·562 in (9·05 cm)
Ram Piston Ring Gap	Early model tractors	0·003–0·007 in (0·08–0·18 mm)
Pump output (at maximum pressure and rated engine speed)	Later model tractors	5 gall/min (22·7 litres/min)
Maximum T.C.U. Pressure	Later model tractors	670–720 lb/in² (48·9–52·6 kg/cm²)
Maximum lift at end of links with T.C.U.	Later model tractors	896–980 lb (406–444 kg.)
Ram Cylinder Bore	Later model tractors	3·125–3·127 in (79·37–79·42 mm)
Ram Piston Diameter	Later model tractors	3·123–3·124 in (79·32–79·35 mm)
Ram Piston Stroke	Later model tractors	4·675 in (118·7 mm)
Locking Catch Needle Roller Protrusion	Later model tractors	0·718–0·728 in (18·24–18·49 mm)
Locking Plunger Setting Dimension	Later model tractors	4·000–4·060 in (101·6–103·12 mm)
Top Link Compression Spring Length (free)		4·25 in (10·79 cm)
Top Link Compression Spring Rate		2 730 lb/in (485·58 kg/cm)
Top Link Setting Distance		4·300–4·310 in (109·2–109·5 mm)

TIGHTENING TORQUES

Location	Torque
Depth control valve banjo bolt	100 lb ft (13·83 kg metres)
Magnetic filter cover bolts	15 lb ft (2·07 kg metres)
Pump body cover bolts	40 lb ft (5·5 kg metres)
Ram cylinder bleeder bolt	8 lb ft (1·11 kg metres)
Ram cylinder relief valve	20 lb ft (2·76 kg metres)
Ram cylinder banjo bolt	60 lb ft (8·29 kg metres)

SUMMARY OF DESIGN CHANGES

Details of Change	When Introduced
Restrictor valve 903475 changed to 904835. The new restrictor reduces the possibility of oil leakage through the ramshaft seal, by directing the oil jet away from the ramshaft bearing	950/65811 (January 1960)
Position of cam plate on lever 903357 altered to ensure more positive operation of the automatic hold mechanism. Part number of lever (903357) unchanged	950/65969 (February 1960)
Lubrication of ram piston crown increased by raising the ram cylinder drain hole 1 in. (25 mm), to just below the centre of the piston. Part number of ram cylinder (901919) unchanged and earlier tractors may be modified by fitting a short piece of pipe, suitably shaped, into the existing drain hole	950/66823 (March 1960)
Material of ramshaft oil seals changed from hard felt to graphited hemp. Part number of seals changed from 30062 to 905120	950/66842 (March 1960)
Components of magnetic filter changed to facilitate manufacture. Part number of complete filter assembly (62794) unchanged. Component parts of old and new assemblies are not interchangeable	850/300582 950/67549 (June 1960)
Ram piston rings fitted side-by-side in a single groove, instead of two separate grooves as previously, and a rubber sealing ring (626900) fitted inside the two cast iron rings. Part number of piston (30059) changed to 906709. Part number of piston rings (68122) unchanged	850/302414 950/72387 (December 1960)
Oil seals on ramshaft changed from graphited hemp type to synthetic rubber 'O' rings. Part number of seals changed from 905120 to 623538	850/304051 950/75237 (March 1961)
Ram cylinder relief valve (901936) replaced by relief valve 906864. The new valve, which has a greater flow capacity than the previous valve and prevents damage to the ramshaft under maximum flow conditions, is not interchangeable with the previous valve and can only be fitted if the ram cylinder is suitably modified. Part number of cylinder changed from 901919 to 906865	850/304656 950/76970 (May 1961)
Face of ramshaft arm surface hardened, to reduce the possibility of damage by the piston crown. Part number of arm (64770) unchanged	850/305093 950/78082 (June 1961)
Unground centre portion of ramshaft increased in length, so that the shoulders form a positive location for the lift arms. No part number changes.	850/305146 950/78081 (June 1961)
Position of flexible cable abutment on top link moved from vertical position to 45 degrees to the right. Part number of spring housing changed from 904211 to 906979 and screwed shaft changed from 903911 to 907043	850/305901 950/79974 (September 1961)
Diameter of ram cylinder reduced from $3\frac{1}{2}$ to $3\frac{1}{8}$ in. (88·9 to 79·37 mm). Piston fitted with rubber sealing ring and spring-loaded locking latch mounted in ram cylinder cover. .Introduction of UNC threads	850/310001 880/350001 950/400001 990/440001 (November 1961)
Heat treatment of locking latch needle rollers modified give greater resistance to breakage. Part number of rollers (620027) unchanged	850/311116 880/351176 950/400770 990/443974 (March 1962)
Spring on control lever plunger (903437) changed from 12043 to 908934. The new spring, which is interchangeable with the previous spring, has a shorter closed length and reduces any tendency for the 'E' clip to be forced out of the plunger groove ..	(June 1962)
Nyloc nut on control lever shaft (906003) replaced by two plain nuts (607052). The two nuts, which are locked together to give a positive lock, overcome any tendency for the lever to become loose during service.	850/312008 880/352084 950/400905 990/445828 (July 1962)

Summary of Design Changes (continued)

Details of Change	When Introduced
Screw locating latch pin (906877) changed from 906878 to 606052. The new screw may be fitted to earlier tractors if the $\frac{5}{16}$ UNC thread in the cylinder cover is extended to the full depth of the hole	850/312229 880/352744 950/401091 990/447369 (September 1962)
Control lever shaft (906003) zinc plated to give a corrosion resistant finish and prevent any possibility of the shaft becoming tight in the housing. No part number change	850/313556 880/345927 950/401490 990/452076 (March 1963)
Changes to top link, flexible cable, depth control valve and ramshaft to enable system to provide height control. Hold valve plunger (903298) modified to give more progressive rate of lowering. Part number of plunger changed to 909288	850/313773 880/355341 990/453124 (April 1963)
Control lever plunger (903437) modified to accommodate a circlip (24568) in place of the 'E' clip (621583) used previously. The new plunger, which has changed to part number 911999, is interchangeable with the previous plunger if a new circlip (24568) is also fitted	850/314791 880/356870 990/456743 (August 1963)
Material of hydraulic pump 'O' rings (960648) changed to prevent the rings from becoming permanently deformed during service. The part number of the ring has not been changed but to assist identification the marking on the ring has been changed from two light brown spots to one light brown and one orange spot	850/314791 880/356895 990/457014 (September 1963)
Pressure relief valve in hydraulic pump changed from ball type to conical plunger type. Individual parts of the two valves are not interchangeable but the later type valve can be fitted complete	850/314791 880/356895 990/457320 (September 1963)
Hydraulic pressure pipes, 903391 and 901889, changed from $\frac{3}{4}$ in. (20 mm) diameter to $\frac{5}{8}$ in. (15·9 mm) diameter. Part number of the new pipes are 910808 and 910810 respectively and these are only interchangeable in pairs	850/314894 880/357140 990/458958 (January 1964)
Material of ramshaft bearings changed from white metal to bronze. The new bearings, which are interchangeable with the previous bearings, have changed part numbers from 30060 and 621341 to 912013 and 912012 respectively.	850/315403 880/358402 990/458177 (January 1964)
Relief valve fitted over pump hold valve plunger. This valve, which is set to limit the hold pressure to 2,500 lb/in² (175 kg/cm²), is in addition to the valve over the main relief valve plunger and prevents excessive back pressure when operating heavy implements or attachments	990/461135 (February 1964)