HYDRAULIC SYSTEM

HOW IT WORKS and OIL FLOW

Service Manual 9-50881

J I Case
A Tenneco Company

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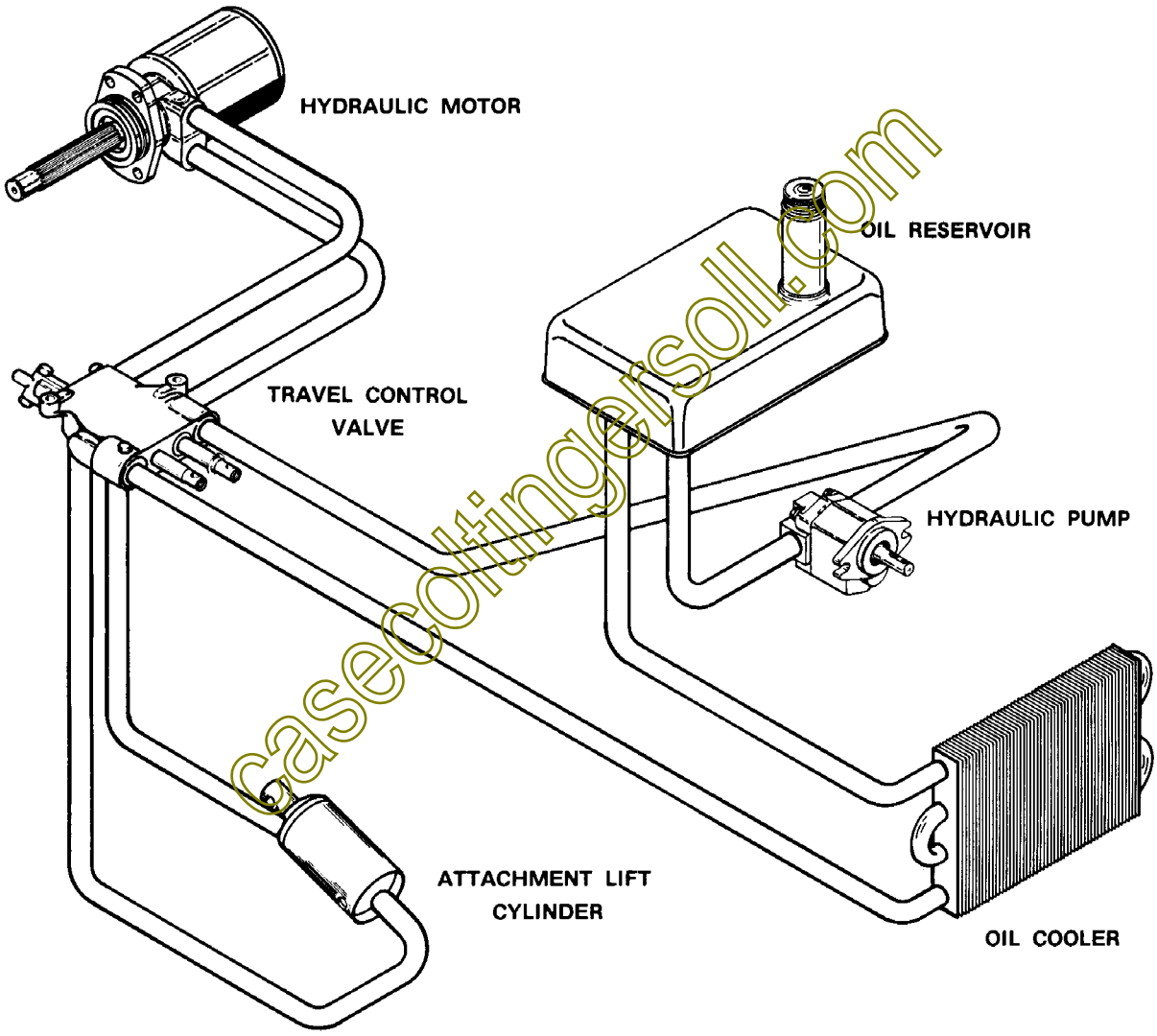
The Case compact tractor hydraulic drive system is of open center design. The system is composed of an atmospheric reservoir, positive displacement gear pump, open center control valve and geroller hydraulic torqmotor.

Detailed explanations of each component follow in this service manual section.



DEFINITIONS OF MAJOR COMPONENTS

RESERVOIR

1. **Atmospheric hydraulic reservoir.** This is the hydraulic oil storage tank. The area above the oil level is vented to the atmosphere through a small, baffled hole in the fill cap. The reservoir also helps to dissipate heat created when the hydraulic system is working and is internally baffled to prevent airation of oil.

SUCTION LINE

2. **Pump inlet line (commonly called suction line).** This hose or tube carries oil from the reservoir outlet to the pump inlet. It normally operates under negative pressure (created by gear rotation at the pump inlet) must be non-collapsable and connections must be tight to prevent air entry.

PUMP

3. **The hydraulic pump** is gear type, positive displacement and directly coupled to the engine crankshaft. As shown in Fig. 1 the gears rotate in the direction of the heavy black arrows drawing oil into gear tooth pockets (on the inlet side) and trapping oil between the gears and pump housing as the gears rotate. Oil is discharged on the outlet side as the gear teeth come back into mesh with each other. The pump is equipped with a pressure - balanced loading or wear plate to provide an effective seal for the gear ends over a full range of operating pressures. Return oil passages are provided in the pump housing and idler gear shaft to prevent pressure buildup behind the shaft seal.

   The purpose of the hydraulic pump is to create oil flow (measured in gallons per minute (GPM) or liters per minute (l/min).

   Resistance to flow resulting from work done by the hydraulic motor or cylinder causes pressure in the System. This is measured in pounds per square inch (PSI) or kilopascals (kPa).

CONTROL VALVE

4. The travel control valve is of open center design and contains the pressure relief valves for both the travel and attachment lift circuits. The valve controls the direction of oil flow and the volume of oil flowing in each direction.

   The travel control spool is manually centered on tractors and spring centered on 600 series loaders.

   The attachment lift spool (optional on smaller model tractors) is spring centered and also has float position with detent mechanism.

   Travel control valves on 600 series loaders are equipped with a power-beyond sleeve which connects the open center passage to an additional external port and on to the loader bucket valve.

   To achieve full speed and power, the valve spool must be moved to the end of its stroke. To achieve the variable speed or feathered action of hydraulic motor or cylinder spool, the valve is moved less than full stroke. This divides the oil flow from the pump between the work device (motor or cylinder) and return to reservoir.

   For clarity, most oil flow diagrams are shown with the valve spool in neutral or fully stroked.

MOTOR

5. The hydraulic motor produces rotary motion from the hydraulic flow created by the pump to turn the two speed transaxle. The motor will perform with equal efficiency in either direction yielding a full and equal range of speed and power in both forward and reverse.

LIFT CYLINDER

6. The attachment lift cylinder lifts when extending and lowers when retracting. The cylinder piston seal is a simple o-ring and there is an o-ring and wiper seal on the piston rod.

Additions to the Basic Tractor Hydraulic Drive System.

Versatility is one of the key features of the Case Hydraulic Drive System. The fact that auxiliary hydraulic circuits may be easily added to this system permits this versatility. Additions to the basic system include a hydraulic PTO valve for operating the hydraulic rotary tiller or other compatible hydraulic tools, a Davis D-100 Backhoe and a Flow Control Valve used primarily in severe tilling applications. The attachment lift, 3-PT hitch and loader bucket hydraulic circuits are also additions to the Basic Tractor Hydraulic Drive System.

EXPLANATION OF COLOR CODING KEY

The following flow diagrams have been color coded for ease of understanding. The following color coding is used.

Dark blue is used to designate supply oil to the hydraulic pump. This includes oil in the reservoir and the suction line. This oil is either at atmospheric pressure or below.

Dark red is used to designate pump supply oil (oil leaving the pump outlet port). This oil flow will be considered pump flow until it enters a work device (cylinder or motor) or a return oil passage. The pressure of this oil is determined by the resistance to flow caused by the work device (motor or cylinder) and is limited by the relief valve.

Light green is used to designate return oil. Oil with a free flow path back to the oil cooler and reservoir will be considered return oil. Return oil is always low pressure.

Light red is used to designate two oil flows in different diagrams.

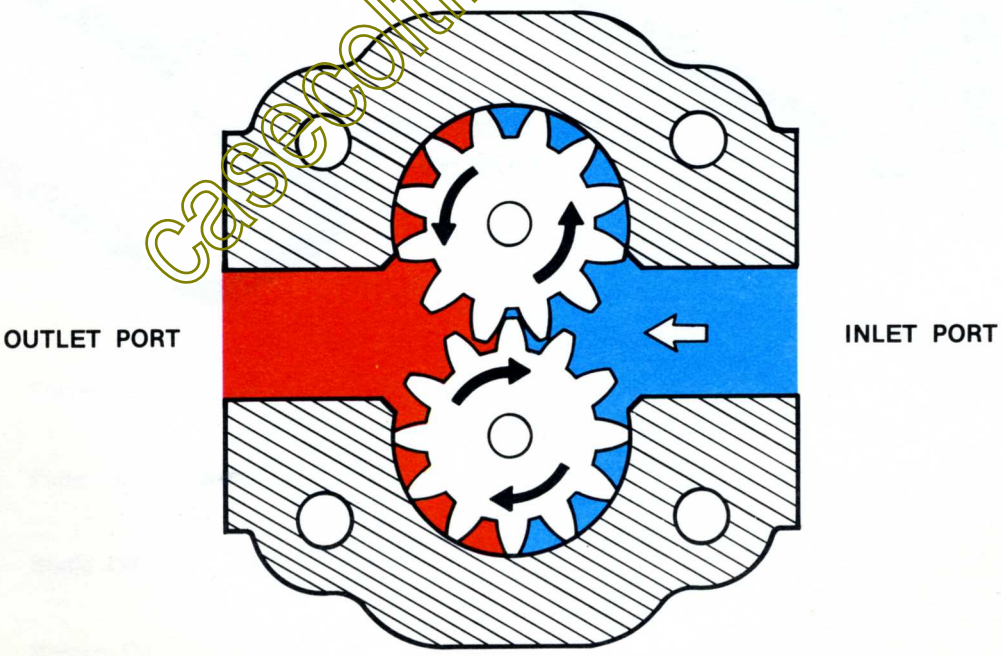
1. Retard Oil Flow - This is return oil from the hydraulic motor, restricted at the return port of the travel valve. The pressure of this oil flow will vary with the amount of retard being applied.

2. Series Connection Oil. The system design provides for hydraulic circuits to be connected in series. The light red oil will then designate oil on the return side of one work device that is energizing a second work device. That is, return oil from the first device becomes supply oil for the second.

Yellow is used to designate controlled flow oil. Metered oil from the optional flow control valve to the travel valve inlet is the controlled flow oil. This oil flow is adjustable from stop to full speed by turning the rotary orifice of the valve.

Dark green is used to designate static oil. This is oil trapped by valving in the system with no way of escape.

HYDRAULIC PUMP
FIGURE 1



OIL FLOW

Neutral Drive - Neutral Lift

PUMP:

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

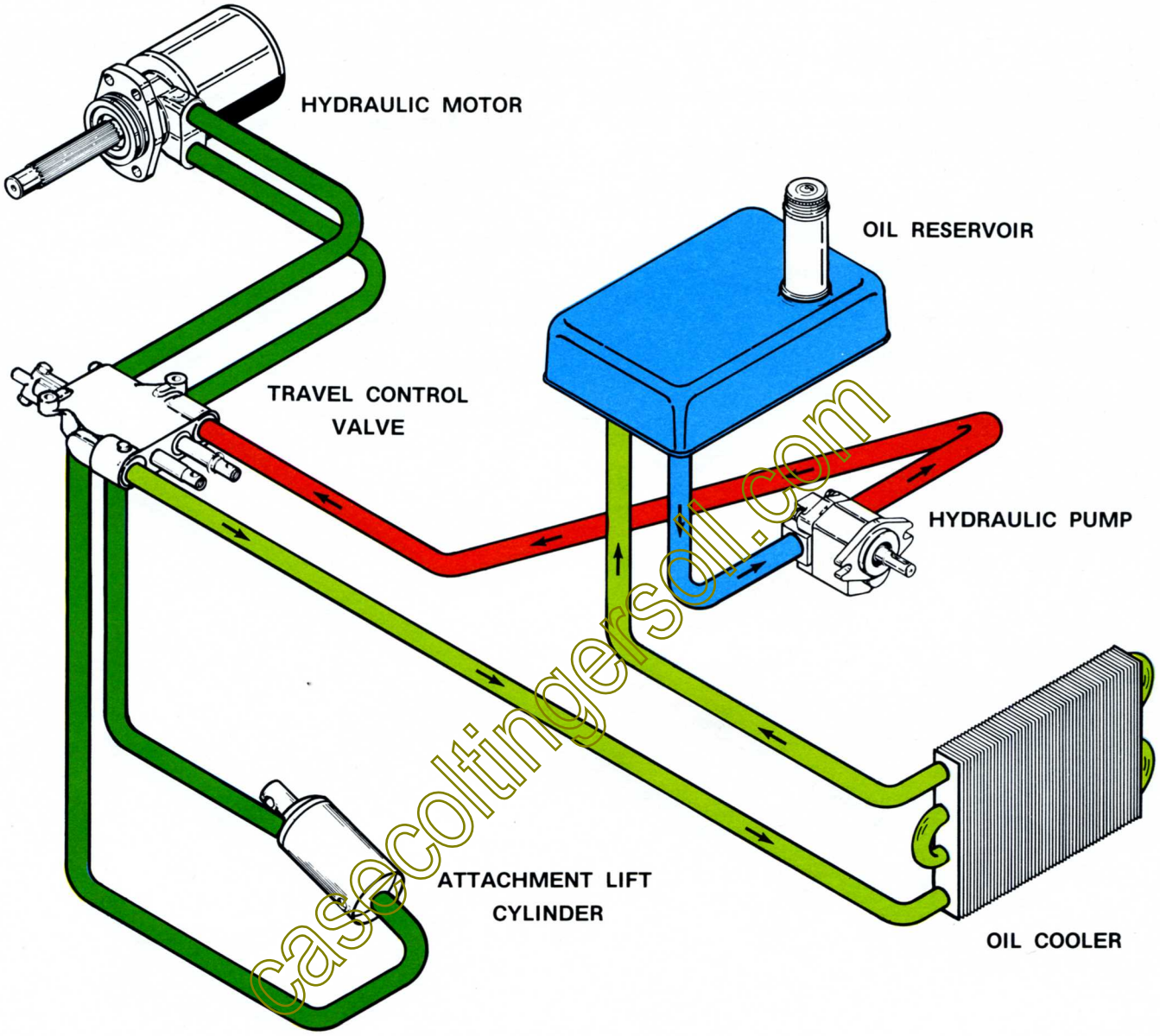
TRAVEL VALVE

Both the travel and lift spools are in neutral providing an open, resistance free pathway, for the oil to follow through the valve. From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

MOTOR AND CYLINDER

The hydraulic motor and lift cylinder are static.

OIL FLOW
Neutral Drive
Neutral Lift



Suction Line

Pump Supply Oil

Static Oil

Return Oil

OIL FLOW

Forward Drive - Neutral Lift

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel valve spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil

b. opens the passage for pump supply oil to leave the front work port of the valve to the hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

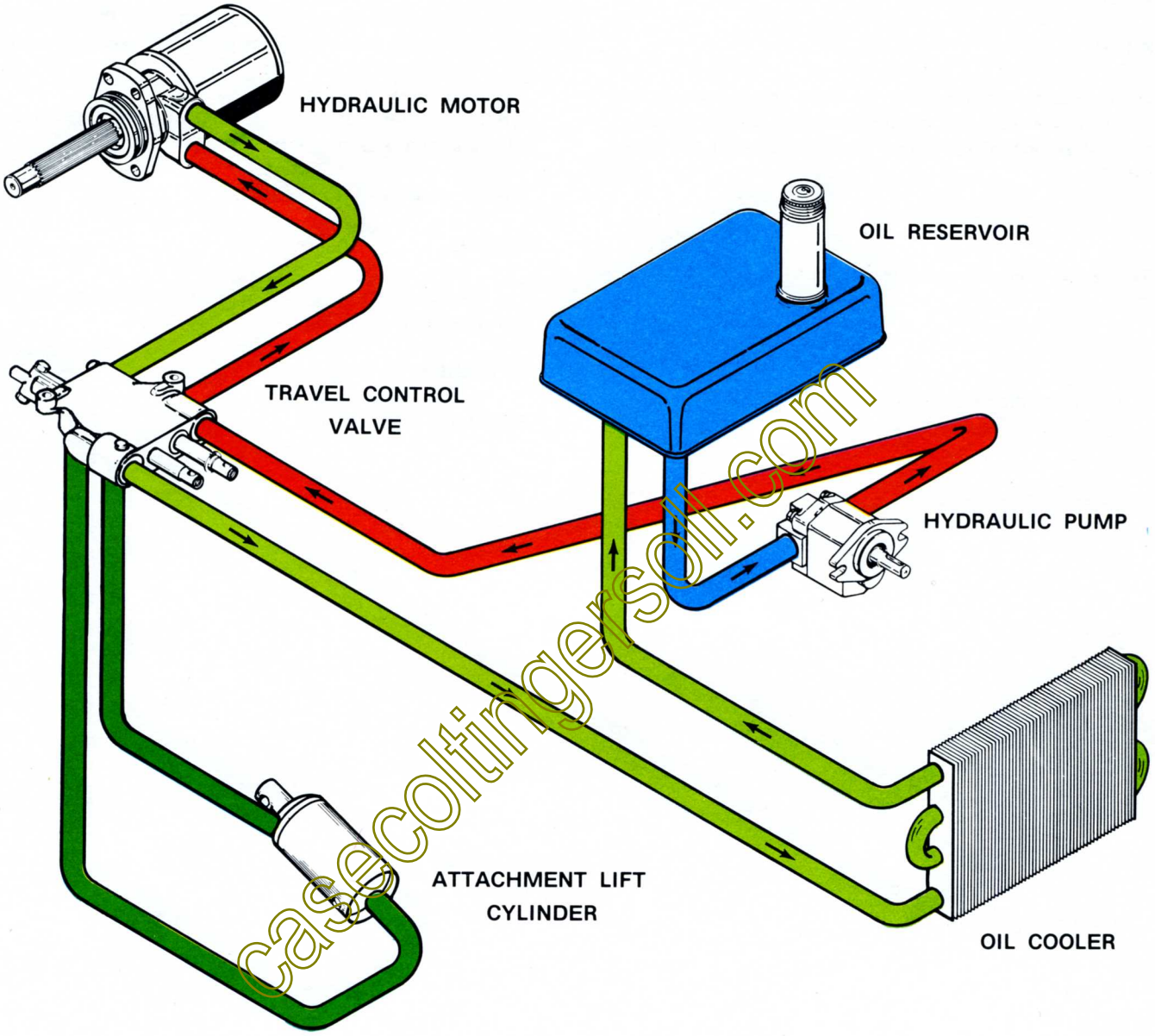
MOTOR

The motor is driven in the forward direction by the oil flow passing through it.

CYLINDER

The lift cylinder is static

OIL FLOW
Forward Drive
Neutral Lift



- Suction Line
- Pump Supply Oil
- Static Oil
- Return Oil

OIL FLOW

Reverse Drive - Neutral Lift

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel valve spool is stroked out of the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the rear work port of the valve to the hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the front work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

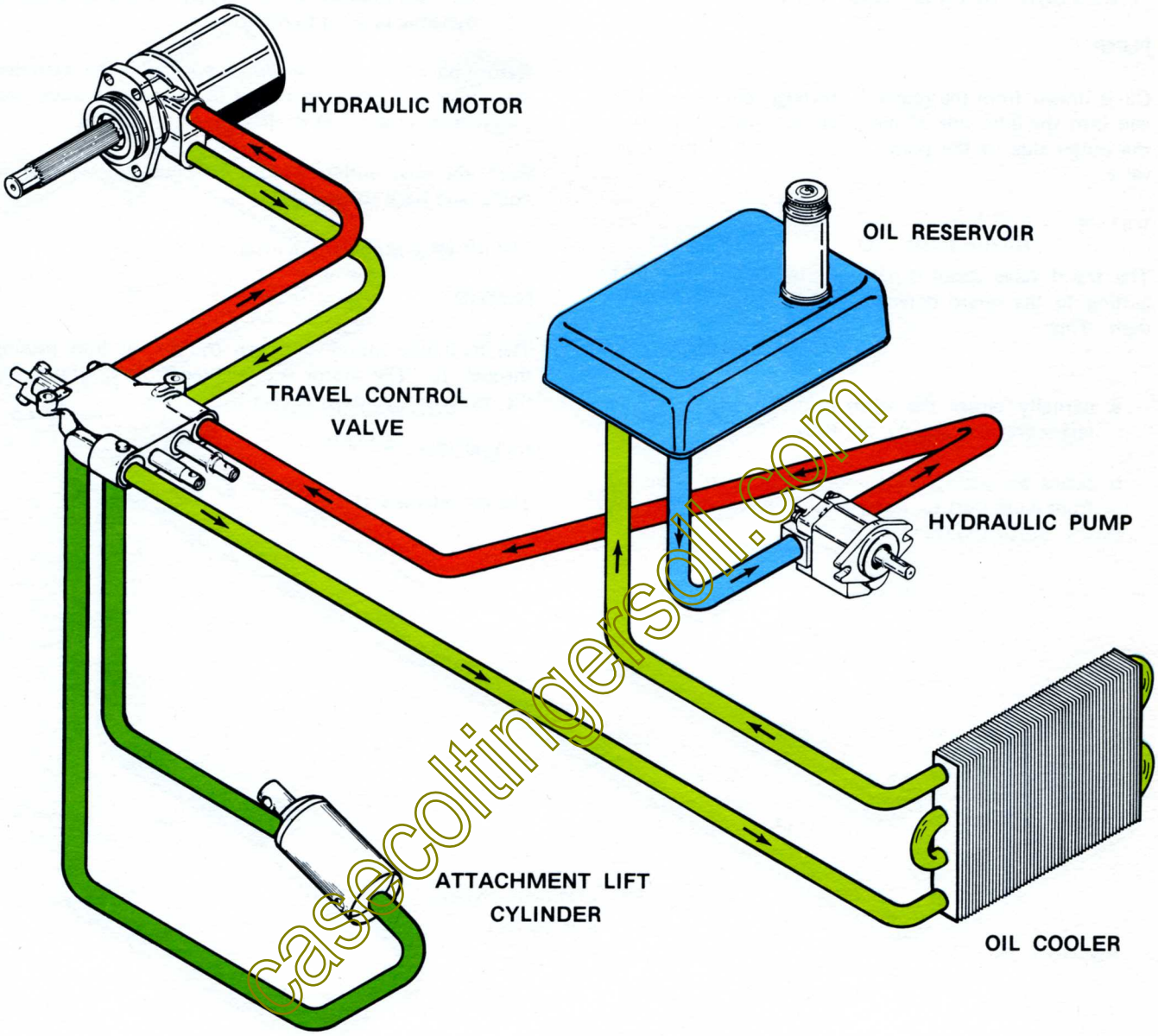
MOTOR

The motor is driven in the reverse direction by the oil flow passing through it.

CYLINDER

The lift cylinder is static.

OIL FLOW
Reverse Drive
Neutral Lift



- Suction Line
- Pump Supply Oil
- Static Oil
- Return Oil

OIL FLOW

Forward Drive - RETARD - Neutral Lift

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel valve spool is partially stroked into the valve casting to the retard detent as indicated on the tractor dash. This:

a. partially closes the open center passage partially restricting the supply oil flow.

b. opens the passage for pump supply oil to leave the front work port to the hydraulic motor.

c. the passage for return oil from the hydraulic motor remains restricted. This restriction places an effective back-pressure on the hydraulic motor allowing dynamic braking to occur.

Return oil, entering the rear work port, joins the restricted flow from the partially closed open center passage and flows to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

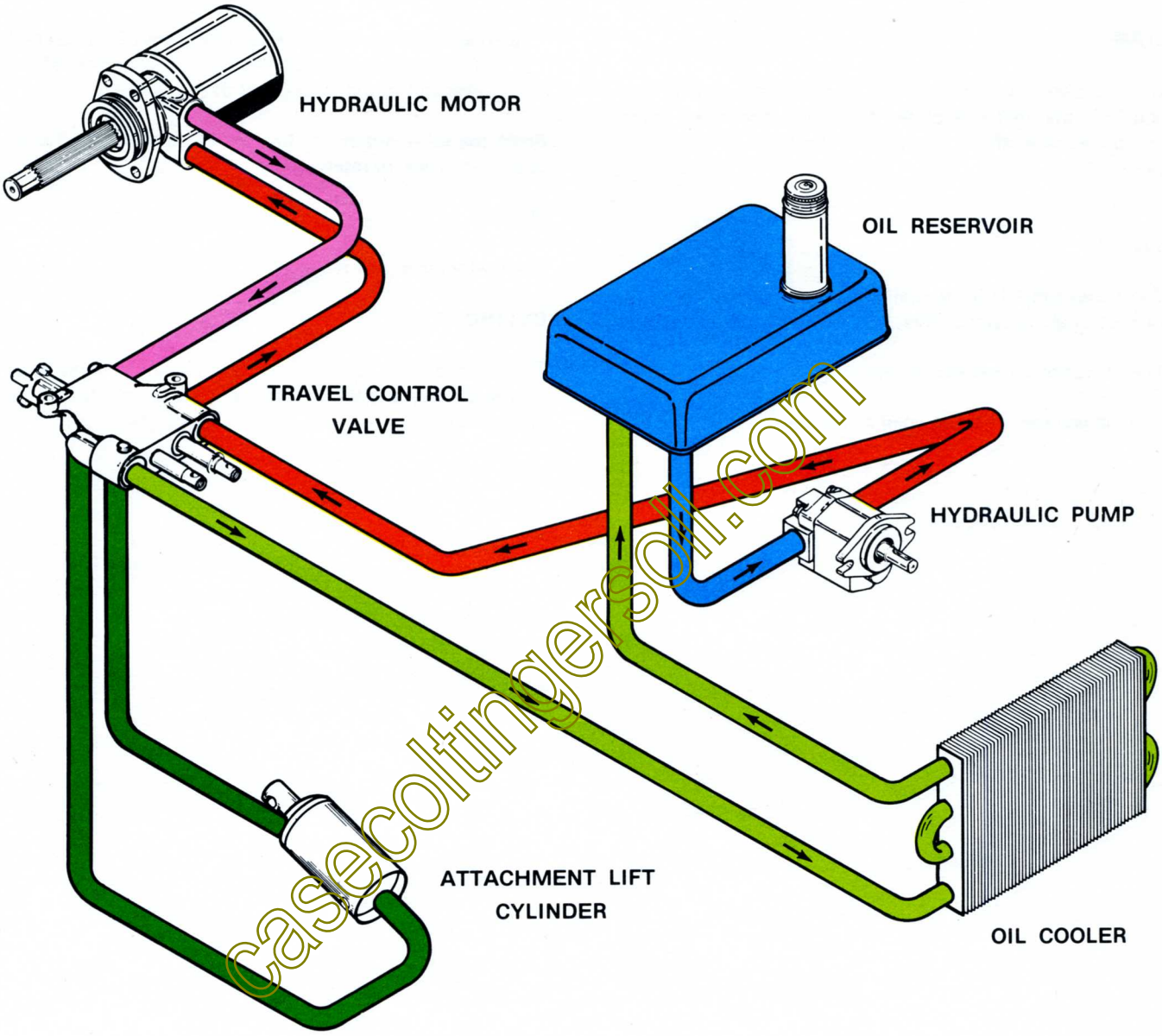
MOTOR

The hydraulic motor is driven by the oil flow passing through it. The motor is prevented from cavitating by the restriction on its outlet port.

CYLINDER

The cylinder is static.

OIL FLOW
Forward Drive - Retard
Neutral Lift



- Suction Line
- Pump Supply Oil
- Static Oil
- Return Oil
- Retard Oil

OIL FLOW

Neutral Drive, Hydraulic Lift-Lowering

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel spool is in neutral allowing pump supply oil to flow through, resistance free, to the lift spool.

The lift spool is stroked into the valve casting. This:

a. closes the lift spool open center passage.

b. opens the passage for pump supply oil to leave the front work port of the valve to the rod end of the lift cylinder.

c. opens the passage for return oil from the piston end of the cylinder to flow in the rear work port of the valve and to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

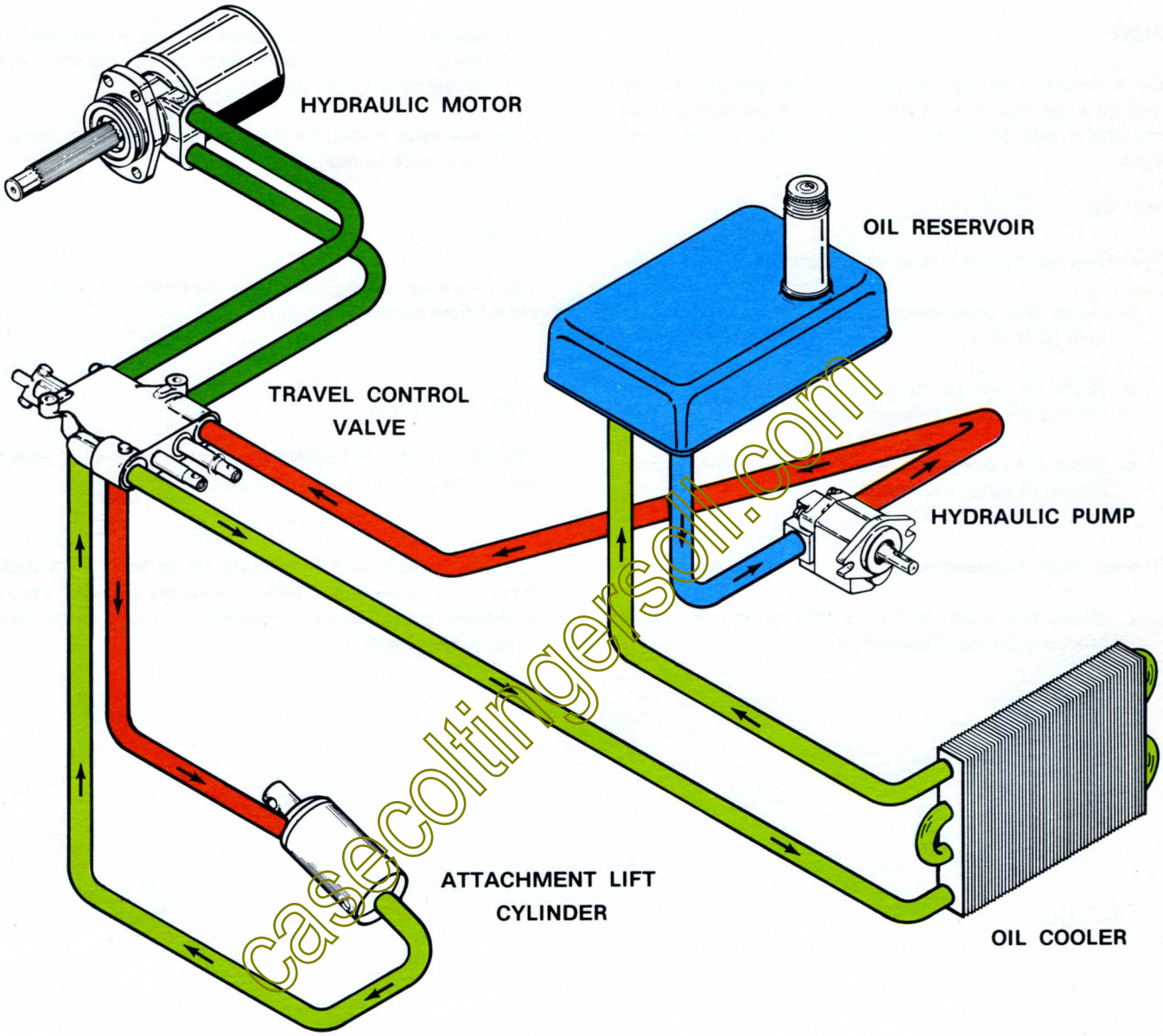
MOTOR

The hydraulic motor is static.

CYLINDER

The cylinder rod retracts (cylinder closes) as a result of supply oil entering the rod end and return oil leaving the piston end.

OIL FLOW
Neutral Drive
Lower Lift



- Suction Line
- Pump Supply Oil
- Static Oil
- Return Oil

OIL FLOW

Forward Drive, Hydraulic Lift-Raising

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel valve spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the front work port of the valve to the hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the open center of the lift spool.

The lift spool is stroked out of the valve body. This:

a. closes the open center passage of the lift spool blocking the free flow path of oil.

b. opens the path for return oil from the hydraulic motor to leave the rear work port of the valve to the piston end of the lift cylinder.

c. opens the passage for return oil from the rod end of the cylinder to the front work port of the valve and to the valve outlet port.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

MOTOR

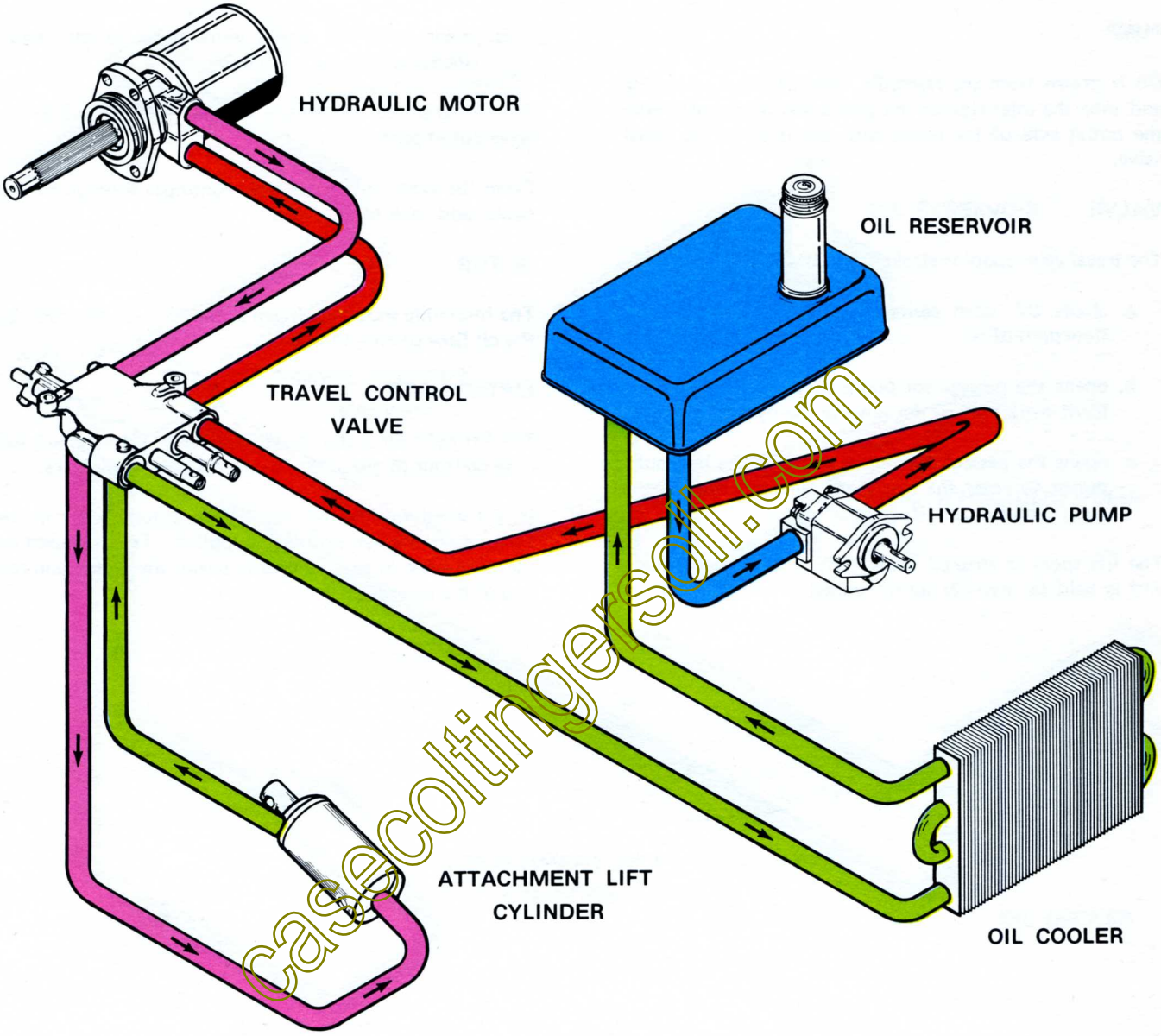
The hydraulic motor is driven in the forward direction by the oil flow passing through it.

LIFT CYLINDER

The lift cylinder rod extends (opens) as supply oil enters the piston end and return oil leaves the rod end.

The drive circuit and lift circuit are in series with each other. Therefore, when both circuits are actuated simultaneously, the pressures generated by resistance to flow in each circuit add.

OIL FLOW
Forward Drive
Raise Lift



Suction Line

Pump Supply Oil

Series Connection Supply Oil

Return Oil

OIL FLOW

Forward Drive, Hydraulic Lift - Float

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel valve spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the front work port of the valve to the hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the open center of the lift spool.

The lift spool is stroked completely into the valve body and is held by two (2) spring loaded detent balls. This:

a. opens the open center passage allowing return oil from the hydraulic motor to flow to the valve outlet port.

b. opens both lift circuit work ports to the return passage within the valve body.

Oil displaced by movement of the piston flows to the valve outlet port.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

MOTOR

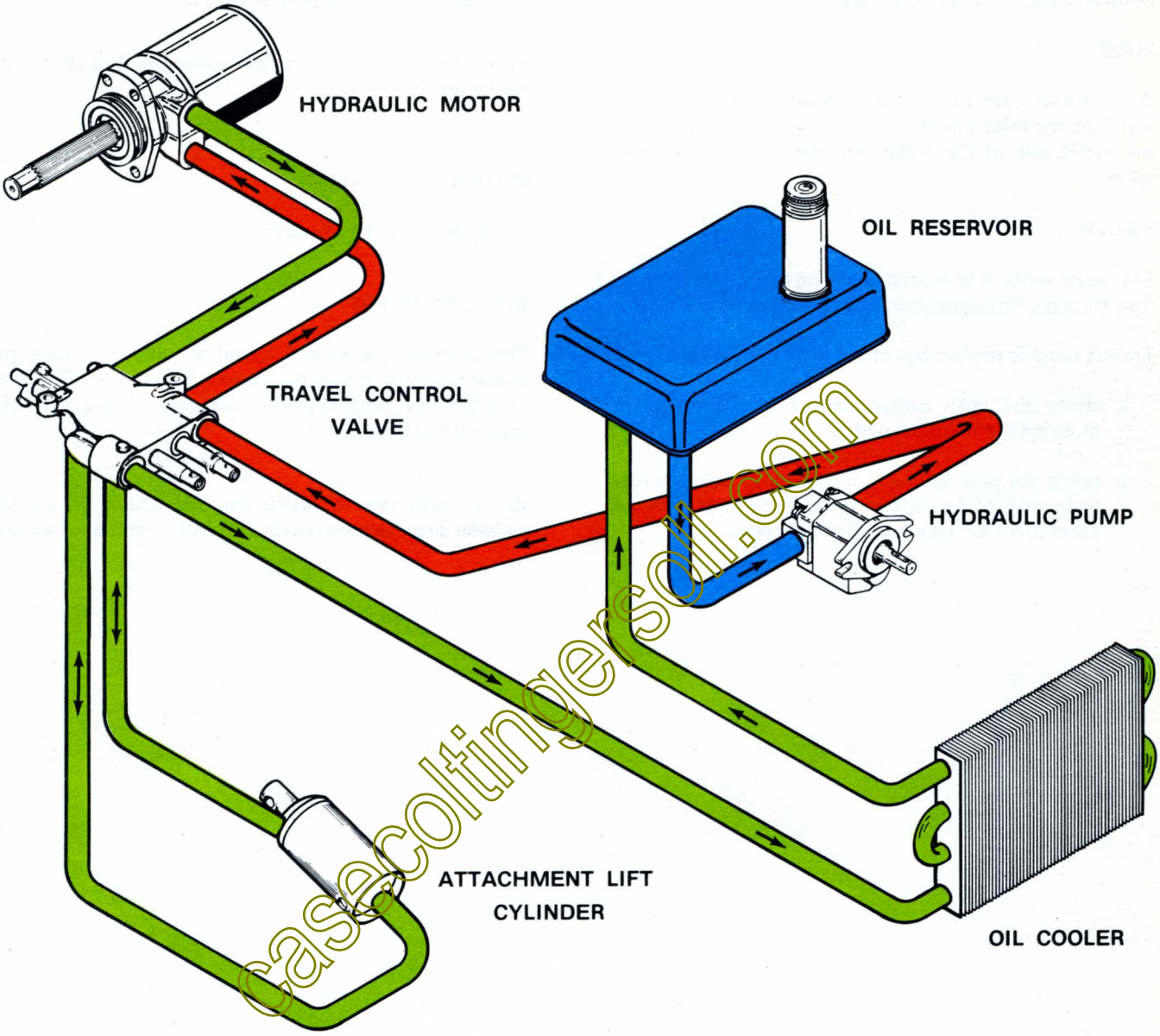
The hydraulic motor is driven in the forward direction by the oil flow passing through it.

LIFT CYLINDER

The lift cylinder piston moves in and out (attachment follows contour of ground) without hydraulic resistance.

It is normal for the lift cylinder to extend when in the float position when no load is applied. This is caused by the difference in surface area between the piston and rod end of the cylinder.

OIL FLOW
Forward Drive
Float Lift



Suction Line

Pump Supply Oil

Return Oil

OIL FLOW

Neutral Drive, Hydraulic Lift - Raise

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

VALVE

The travel spool is in neutral, allowing pump supply oil to flow through, resistance free, to the lift spool.

The lift spool is stroked out of the valve body. This:

a. closes the open center passage of the lift spool blocking the free flow path of oil.

b. opens the path for pump supply oil to leave the rear work port of the valve to the piston end of both the attachment lift and 3-pt hitch cylinders.

c. opens the passage for return oil from the rod ends of both cylinders into the front work port of the valve and to the valve outlet port.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

MOTOR

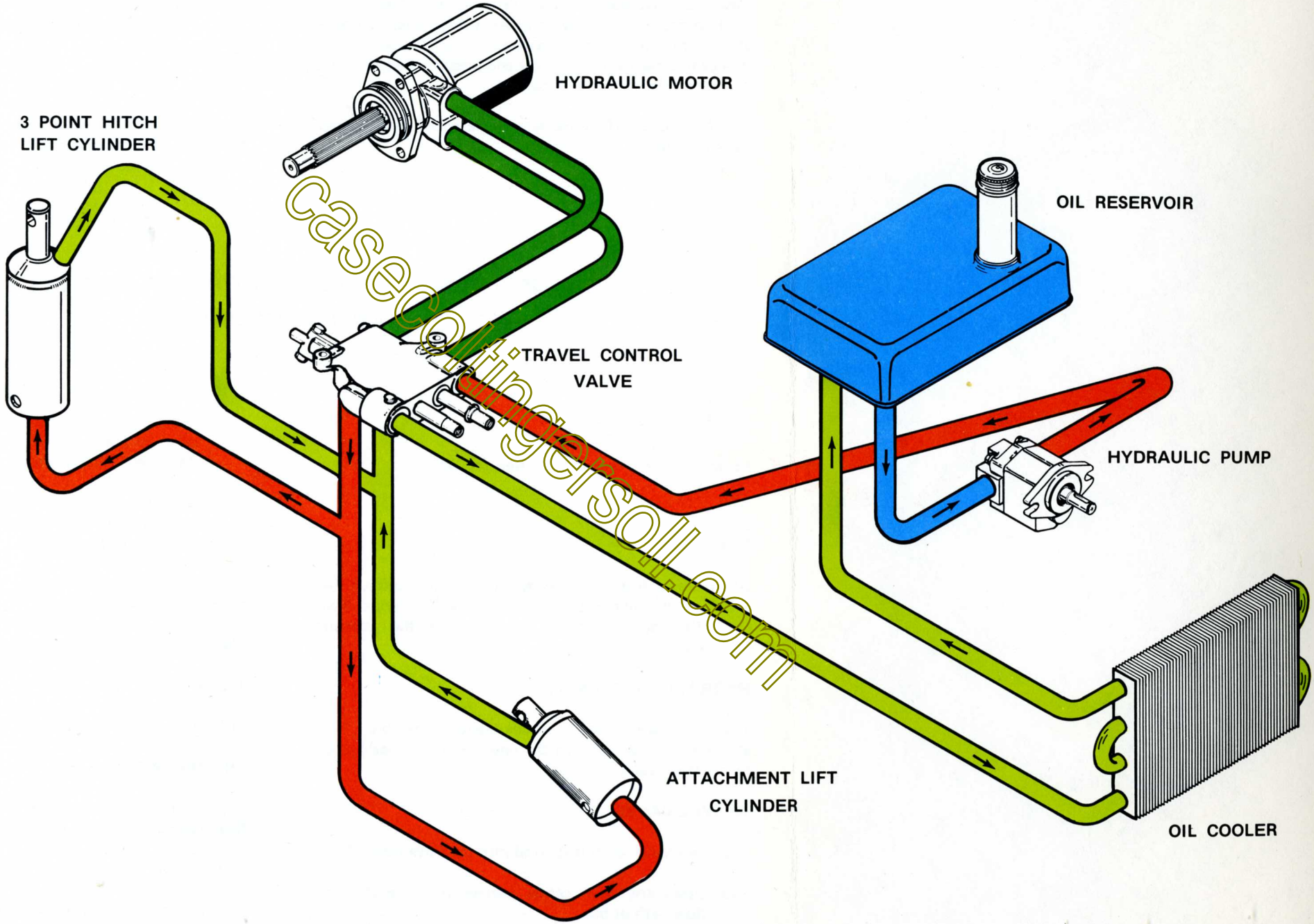
The hydraulic motor is static.

LIFT CYLINDERS

The cylinder rods extend (open) as supply oil enters the piston ends and return oil leaves the rod ends. Since the cylinders are teed together, the one offering the least resistance will move first.

An optional selector valve may be added to the lift cylinder circuit allowing each cylinder to stroke separately.

Neutral Drive
Raise Lift



Suction Line

THE HYDRAULIC PTO VALVE

The hydraulic PTO valve is primarily used to control the Case built hydraulic rotary tiller. It may, however, be used to provide oil flow to other, compatible, hydraulic equipment. Refer to the Hydraulic Test Procedures section of this manual for the flow and pressure specifications of each model tractor and loader.

The hydraulic PTO valve is a single spool, open center valve with relief.

NOTE: Some earlier production valves were provided without relief valves. Care should be used with these to prevent excessive pressure buildup.

The hydraulic PTO valve is connected in series between the pump and tractor travel valve.

200 - 400 SERIES TRACTORS WITH HYDRAULIC LIFT AND HYDRAULIC PTO

OIL FLOW

Forward Drive - Neutral Lift - Neutral PTO

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve spool is in the neutral position. This allows oil to pass through the open center passage and on to the travel valve.

TRAVEL VALVE

The travel valve spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for supply oil (from the PTO valve) to leave the front work port of the valve to the travel hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

TILLER MOTOR

The rotary tiller motor is static.

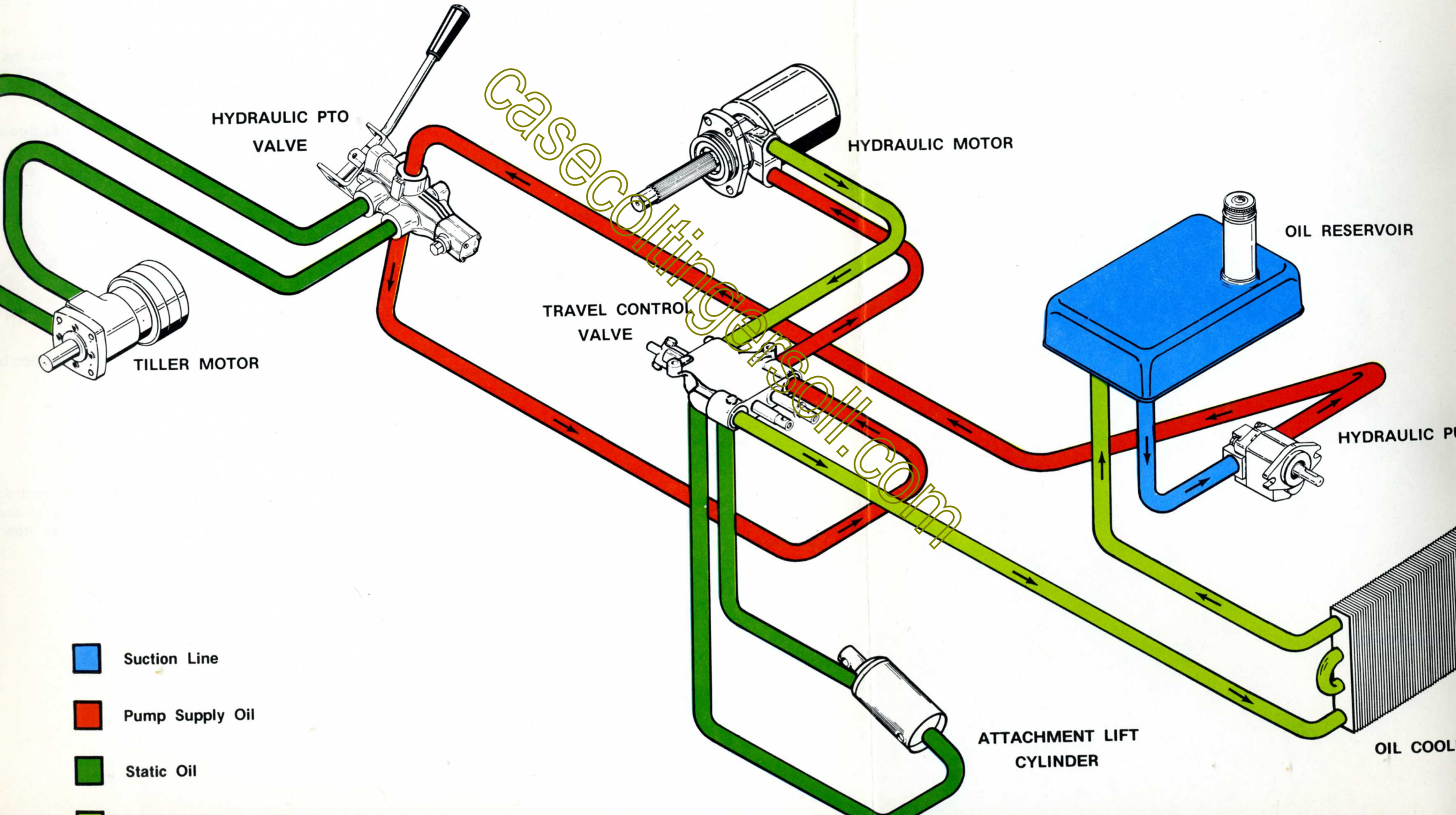
TRAVEL MOTOR

The travel motor is driven in forward direction by the oil flow passing through it.

CYLINDER

The attachment lift cylinder is static.

OIL FLOW
Forward Drive
Neutral Lift
Neutral P T O



200 - 400 SERIES TRACTORS WITH HYDRAULIC LIFT AND HYDRAULIC PTO

OIL FLOW

Forward Drive - Neutral Lift - Tiller Engaged

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve is stroked into the valve body to cause the tiller to rotate in the forward direction. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the rear work port of the PTO valve to the tiller hydraulic motor.

c. opens the passage for return oil from the tiller hydraulic motor to enter the front work port of the PTO valve and flow to the outlet port of the valve.

From the outlet port, oil flow continues to the inlet port of the travel valve.

TRAVEL VALVE

The travel valve is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for supply oil (from the PTO valve) to leave the front work port of the valve to the travel hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

TILLER MOTOR

The rotary tiller motor is driven in the forward direction by the oil flow passing through it.

TRAVEL MOTOR

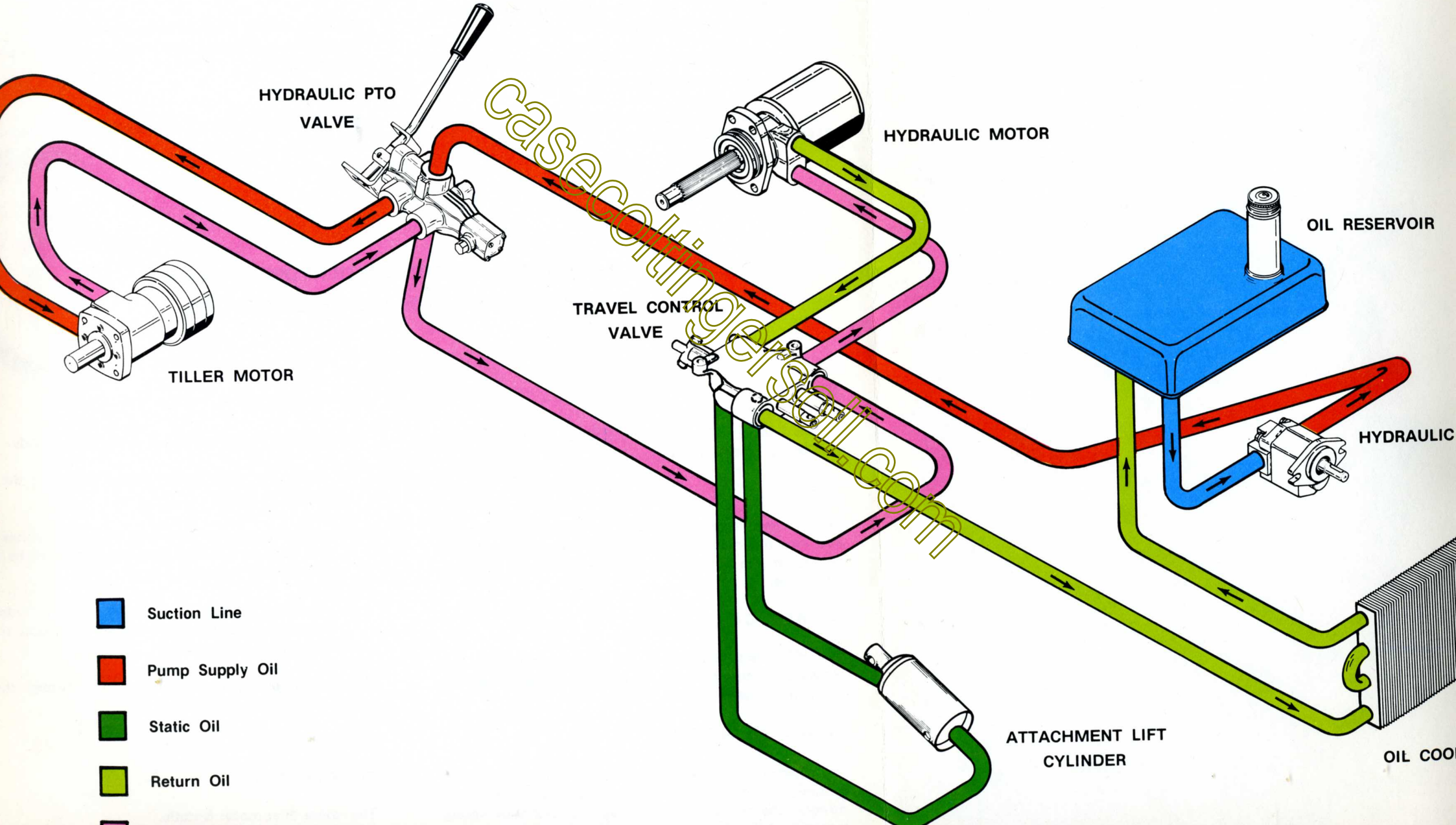
The travel motor is driven in forward direction by the oil flow passing through it.

CYLINDER

The attachment lift cylinder is static.

The tiller circuit and drive circuit are connected in series. Therefore, when both circuits are actuated simultaneously, the pressures generated by resistance to flow in each circuit add.

Forward Drive
Neutral Lift
Engaged P T O



THE HYDRAULIC FLOW CONTROL VALVE

The optional hydraulic flow control valve provides more precise ground speed control of the tractor when using the tiller commercially or in adverse soil conditions. This is achieved by metering oil to the tractor travel valve (with the travel valve placed in full forward or full reverse). The amount of metered oil depends on the position of the flow control valve handle and does not change with pressure requirements at the tractor drive motor.

The flow control valve is connected in series between the hydraulic PTO valve and the tractor travel valve.

The inlet port is connected to the outlet of the hydraulic PTO valve to receive supply oil.

The controlled flow port is connected to the travel valve inlet.

The excess flow port is connected to the return line just ahead of the oil cooler.

The flow control valve contains a rotary orifice to which the handle is attached and a spring tensioned pressure balanced spool.

See the internal valve oil flow section of ths manual for more detail.

200 - 400 SERIES TRACTORS WITH HYDRAULIC LIFT HYDRAULIC PTO, HYDRAULIC FLOW CONTROL

OIL FLOW

Forward Drive - Neutral Lift - Neutral Hydraulic PTO - Full Speed Flow Control

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve spool is in the neutral position. This allows oil to pass through the open center passage and on to the travel valve.

FLOW CONTROL VALVE

The rotary orifice (operated by handle) is positioned so it is fully opened. The pressure drop created by oil flow through the orifice is not enough to overcome spring tension and the spool remains seated to the right.

This closes the excess flow port and full pump flow is available to the controlled flow port.

From the controlled flow port of the flow control valve, oil enters the travel valve inlet port.

TRAVEL VALVE

The travel valve spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for supply oil from the flow control valve to leave the front work port of the valve to the travel hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift valve spool is in neutral.

TILLER MOTOR

The rotary tiller motor is static.

TRAVEL MOTOR

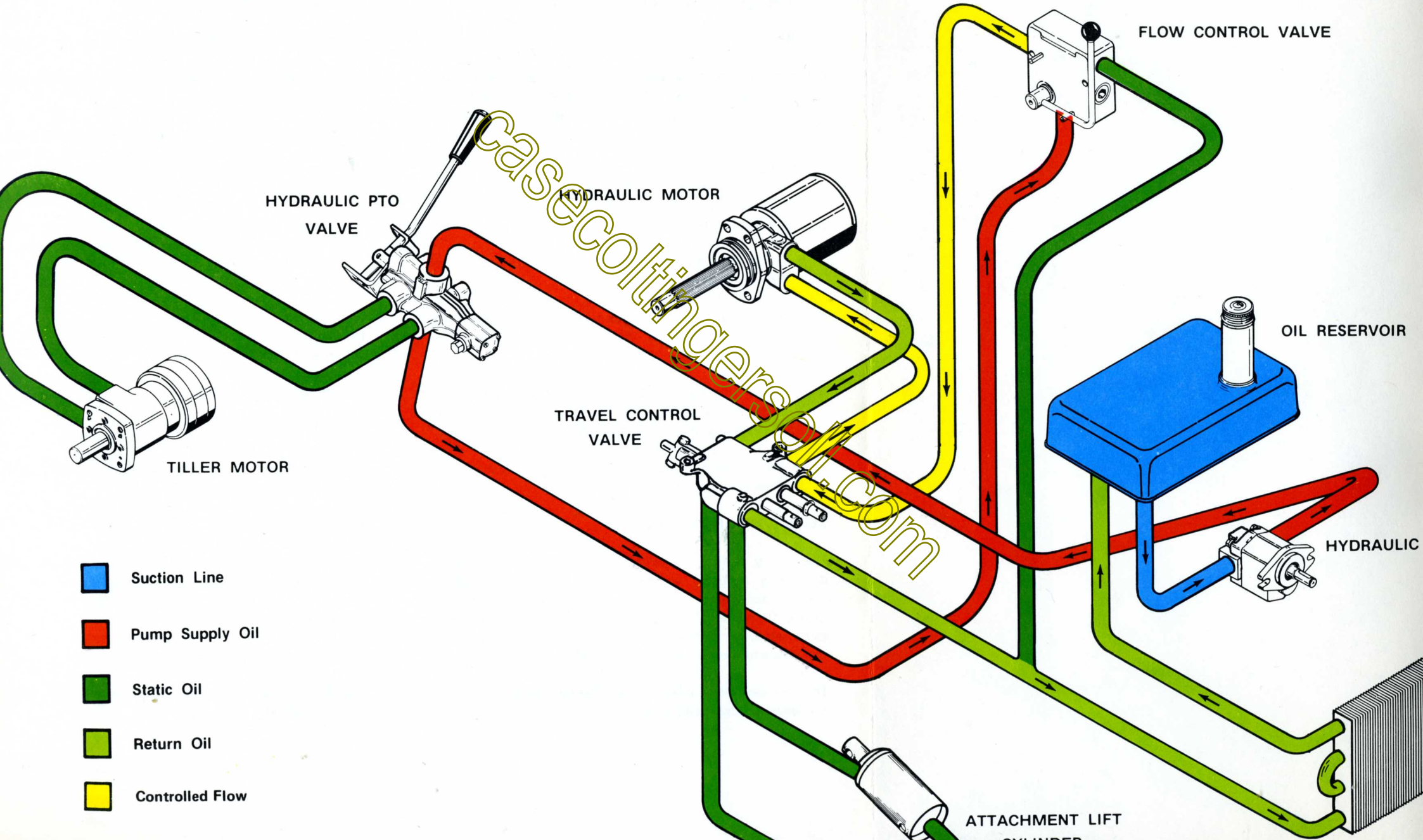
The travel motor is driven in the forward direction by the oil flow passing through it.

CYLINDER

The attachment lift cylinder is static.

OIL FLOW

Forward Drive
Neutral Lift
Neutral PTO
Full Speed - Flow Control



200 - 400 SERIES TRACTORS WITH HYDRAULIC LIFT
HYDRAULIC PTO, HYDRAULIC FLOW CONTROL

OIL FLOW

Forward Drive - Neutral Lift - Engaged Hydraulic PTO-Reduced Speed Flow Control

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve is stroked into the valve body to cause the tiller to rotate in the forward direction. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the rear work port of the PTO valve to the tiller hydraulic motor.

c. opens the passage for return oil from the tiller hydraulic motor to enter the front work port of the PTO valve and flow to the outlet port of that valve.

From the outlet port, oil flow continues to the inlet port of the flow control valve.

FLOW CONTROL VALVE

The rotary orifice (operated by handle) is positioned so it is only partially opened. Flow through the orifice (restriction) causes a relative pressure drop on the controlled flow side of the spring tensioned spool. The spool shifts partway to the left, partially compressing the spring and opening the excess flow port slightly.

The reduced flow volume from the controlled flow port continues to the travel valve inlet.

The excess flow tees into the return line ahead of the oil cooler, goes through the oil cooler and returns to reservoir.

TRAVEL VALVE

The travel valve is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for supply oil (from the controlled flow port of the flow control valve) to leave the front work port of the valve to the travel hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the rear work port and flow to the outlet port of the valve.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

The lift spool is in neutral.

TILLER MOTOR

The rotary tiller motor is driven in the forward direction by the oil flow passing through it.

TRAVEL MOTOR

The travel motor is driven in the forward direction, at reduced speed, by the oil flow passing through it.

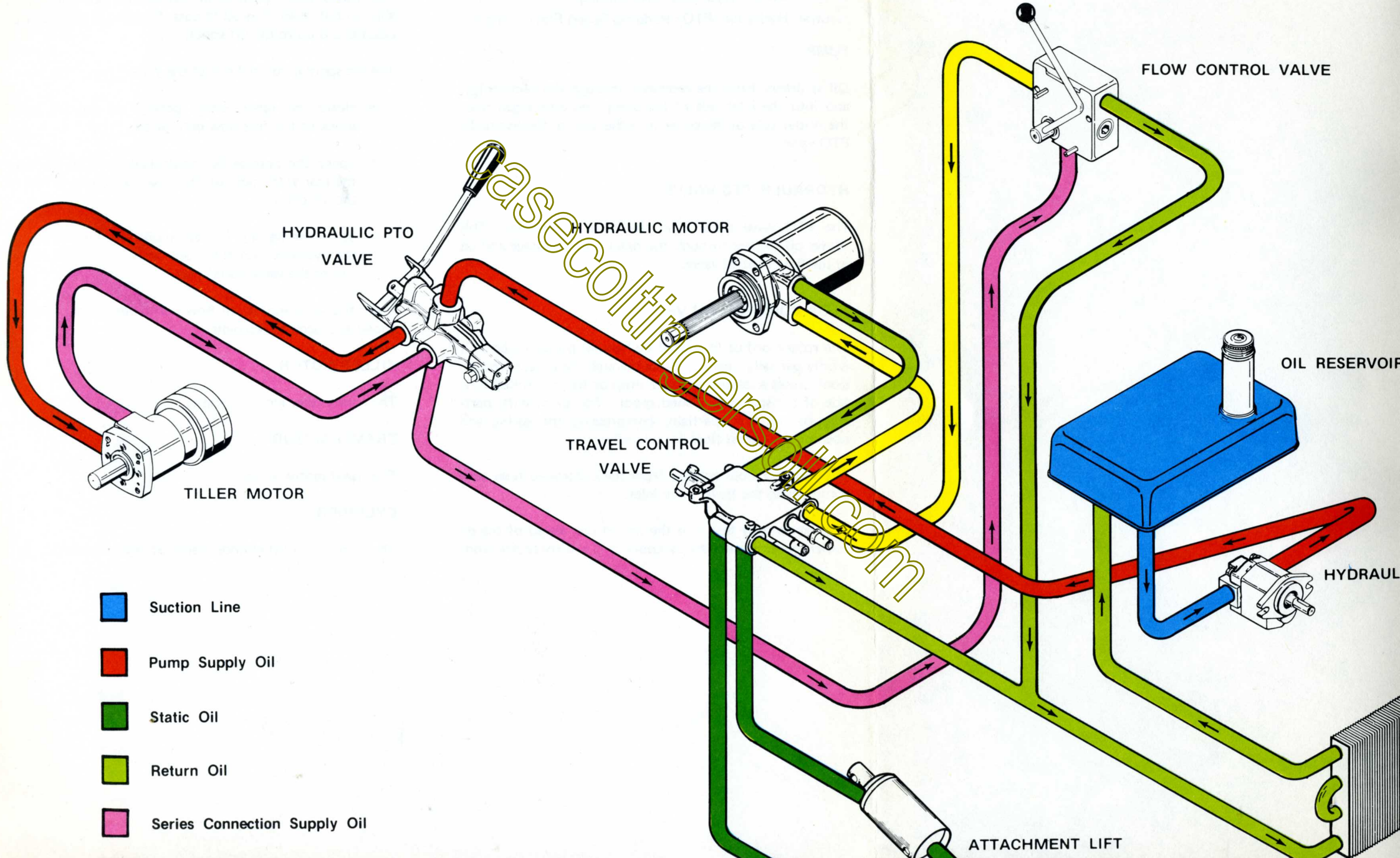
CYLINDER

The attachment lift cylinder is static.

The PTO valve and travel valve are in series and their pressures add.

OIL FLOW

Forward Drive
Neutral Lift
Engaged PTO
Reduced Speed - Flow Control



OIL FLOW

Neutral Drive - Hydraulic Lift Raising -
Neutral Hydraulic PTO - Reduced Speed Flow Control

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve spool is in the neutral position. This allows oil to pass through the open center passage and on to the flow control valve.

FLOW CONTROL VALVE

The rotary orifice (operated by handle) is positioned so it is only partially opened. Flow through the orifice (restriction) causes a relative pressure drop on the controlled flow side of the spring tensioned spool. The spool shifts partway to the left, partially compressing the spring and opening the excess flow port slightly.

The reduced flow volume from the controlled flow port continues to the travel valve inlet.

The excess flow tees into the return line ahead of the oil cooler, goes through the oil cooler and returns to reservoir.

TRAVEL VALVE

The travel valve spool is in the neutral position. This allows controlled flow oil to pass through the open center passage and on to the lift spool.

The lift spool is stroked out of the valve body. This:

a. closes the open center passage of the lift spool blocking the free flow path of oil.

b. opens the passage for controlled flow oil to leave the rear work port of the valve to the piston end of the lift cylinder.

c. opens the passage for return oil from the rod end of the cylinder into the front work port of the valve and to the valve outlet port.

From the valve outlet, oil flow continues through the oil cooler and back to reservoir.

TILLER MOTOR

The rotary tiller motor is static.

TRAVEL MOTOR

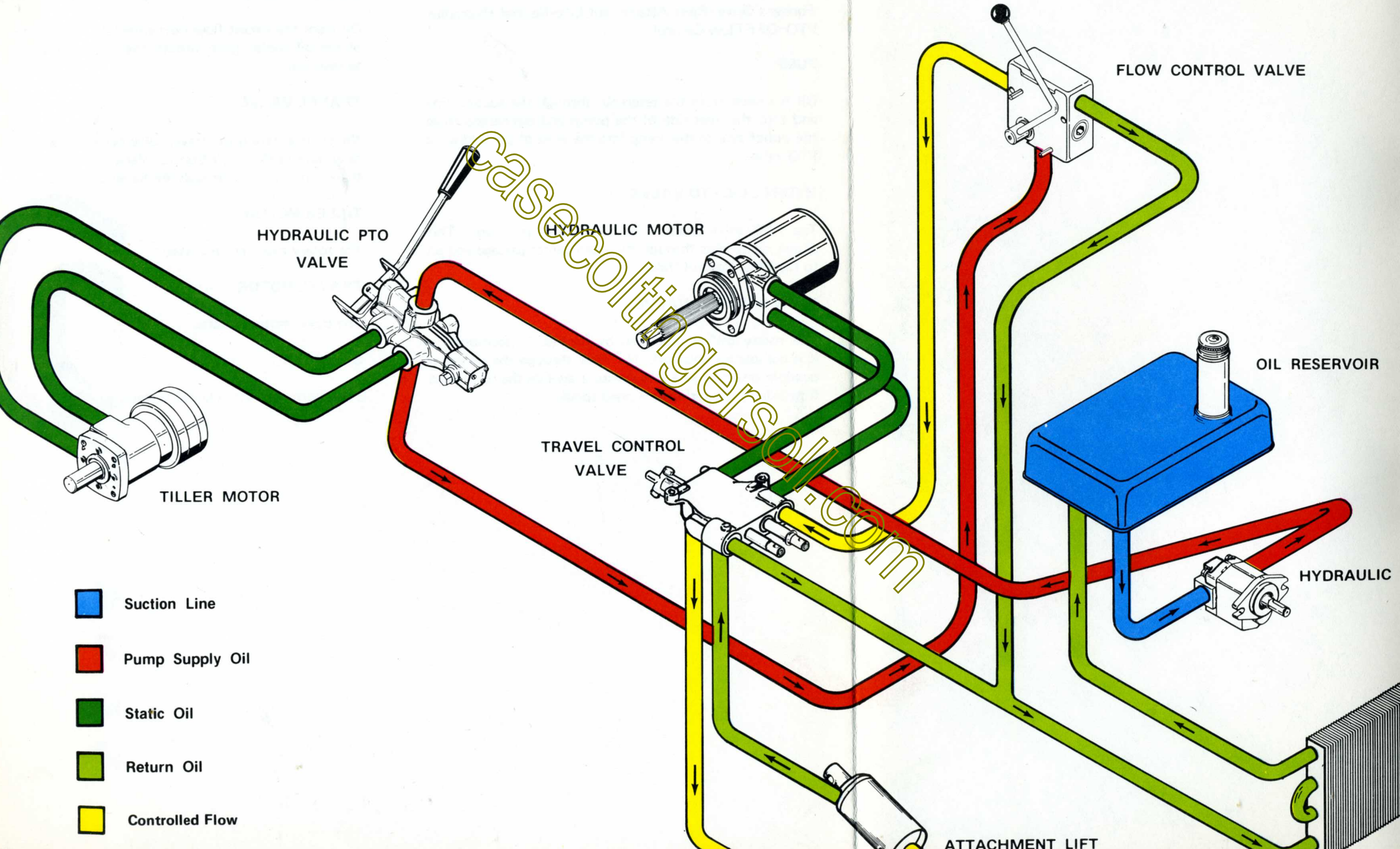
The travel motor is static.

CYLINDER

The attachment lift cylinder raises at reduced speed.

OIL FLOW

Neutral Drive
Raise Lift
Neutral PTO
Reduced Speed - Flow Control



OIL FLOW

Forward Drive-Raise Attachment Lift-Neutral Hydraulic PTO-OFF Flow Control

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the hydraulic PTO valve.

HYDRAULIC PTO VALVE

The PTO valve spool is in the neutral position. This allows oil to pass through the open center passage and on to the Flow Control Valve.

FLOW CONTROL VALVE

The rotary orifice (operated by handle) is positioned so it is completely shut off. No flow through the orifice is possible resulting in a low pressure area on the controlled flow side of the spring tensioned spool.

The spool then shifts fully to the left completely opening the excess flow port and closing the controlled flow port.

Oil from the excess flow port enters the return line ahead of the oil cooler, goes through the oil cooler and returns to reservoir.

TRAVEL VALVE

No oil is entering the travel valve because the controlled flow port in the Flow Control Valve is static. Therefore, there is no oil flow through the travel or lift circuit.

TILLER MOTOR

The rotary tiller motor is static.

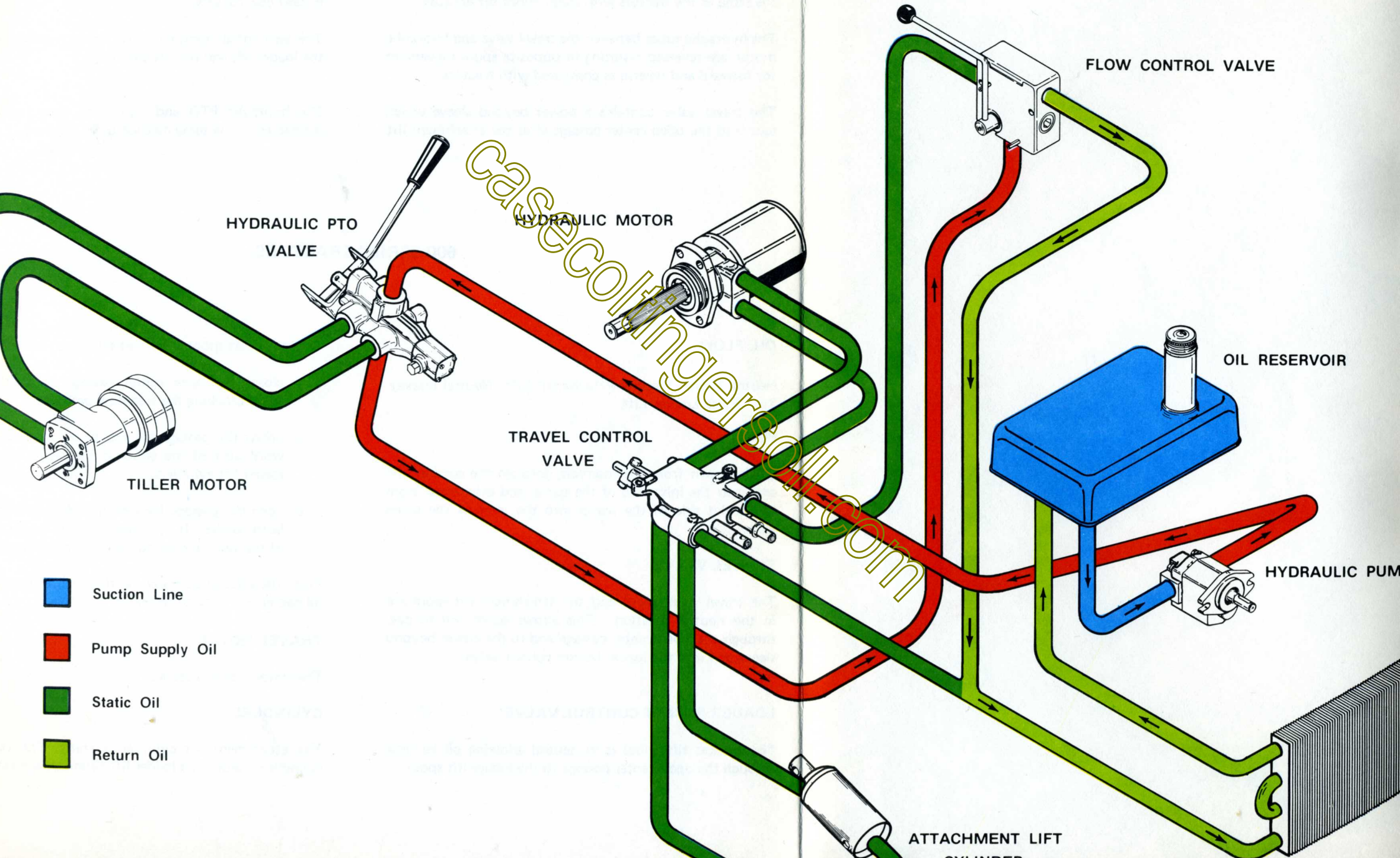
TRAVEL MOTOR

The travel motor is static.

CYLINDER

The attachment lift cylinder is static.

OIL FLOW
Forward Drive
Raise Lift
Neutral PTO
Stop - Flow Control



The hydraulic drive system for 600 series loaders functions the same as the tractors with some minor differences.

The hydraulic tubes between the travel valve and hydraulic motor are reversed resulting in opposite spool movement for forward and reverse as compared with tractors.

The travel valve contains a power beyond sleeve which taps into the open center passage after the attachment lift spool to carry supply oil flow into the two spool loader bucket control valve.

The two spool bucket control valve is added to control the loader lift and bucket circuits.

The hydraulic PTO and 3-pt hitch (both optional) are connected in the same method as on tractors.

600 SERIES TRACTORS

OIL FLOW

Neutral Drive - Neutral Attachment Lift - Neutral Bucket Tilt - Raise Loader Lift.

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

TRAVEL VALVE

The travel valve spool and the attachment lift spool are in the neutral position. This allows supply oil to pass through the open center passage and to the power beyond sleeve and into the loader bucket control valve.

LOADER BUCKET CONTROL VALVE

The bucket tilt spool is in neutral allowing oil to flow through the open center passage to the loader lift spool.

The loader lift spool is stroked out of the valve body. This:

a. closes the open center passage of the loader lift spool blocking the free flow path of oil.

b. opens the passage for supply oil to leave the lower work port of the valve to the piston ends of both loader lift cylinders.

c. open the passage for return oil from the rod ends of both loader lift cylinders into the upper work port of the valve and on to the valve outlet port.

From the valve outlet port, oil flow continues through the oil cooler and back to reservoir.

TRAVEL MOTOR

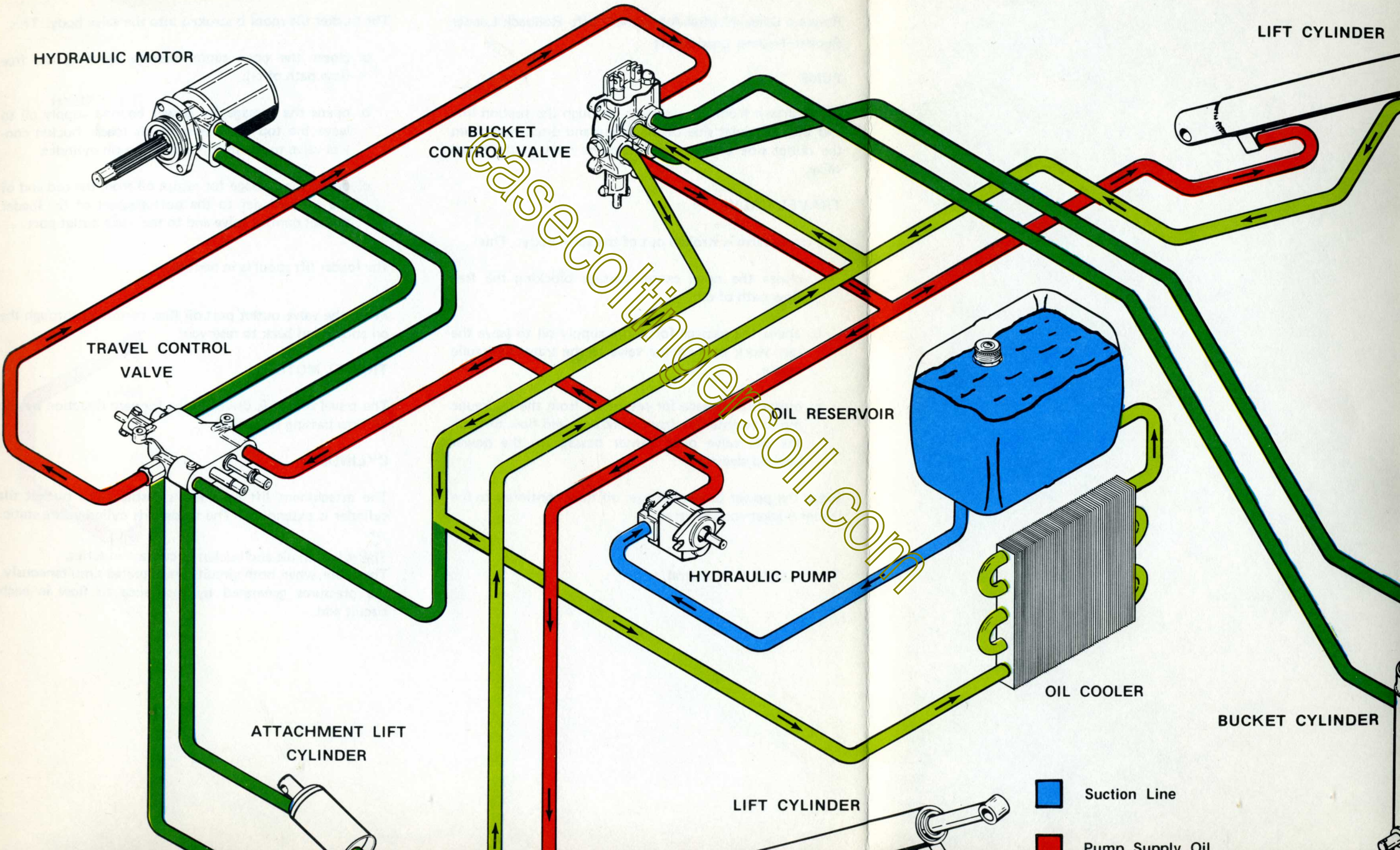
The travel motor is static.

CYLINDERS

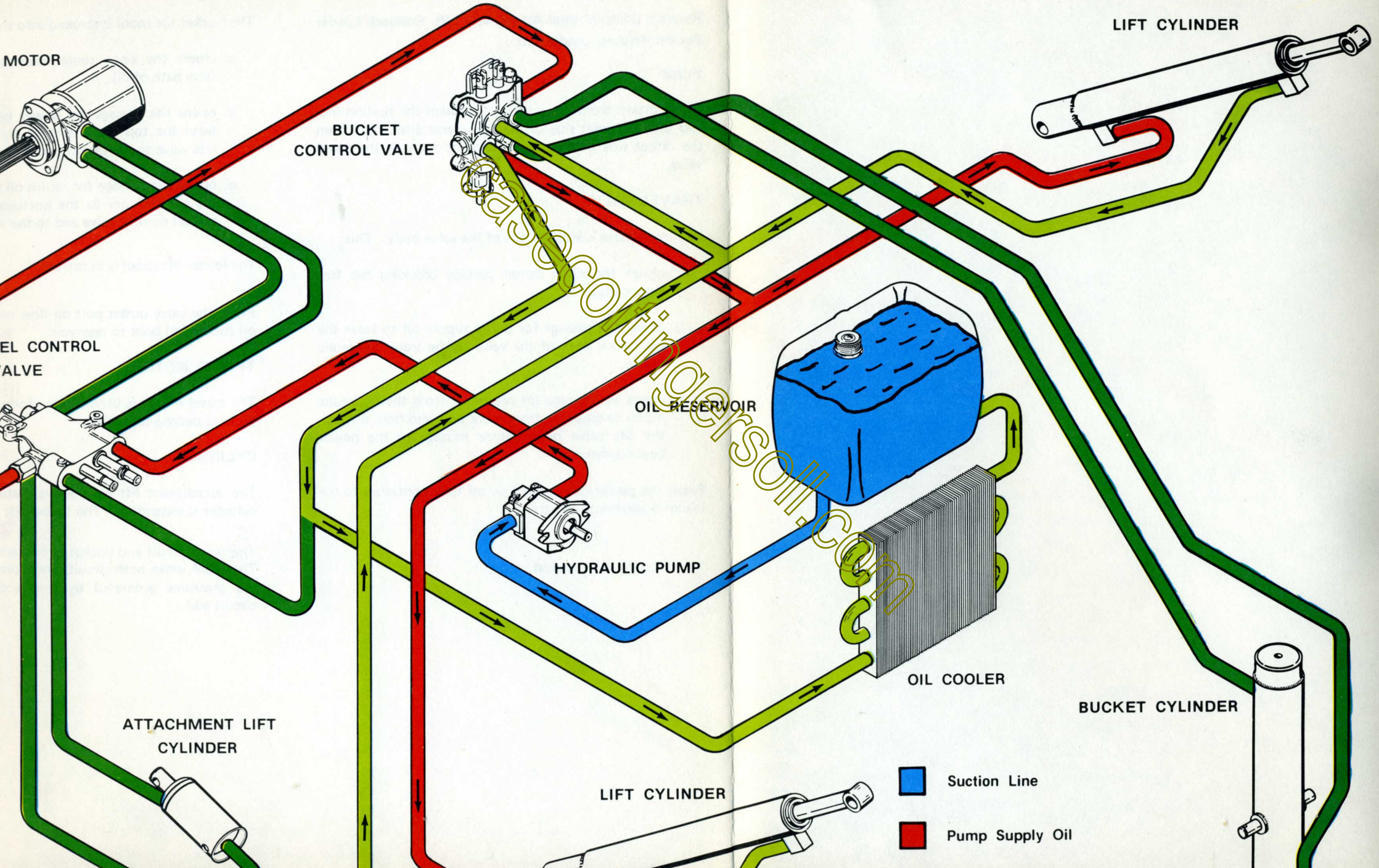
The attachment lift cylinder is static. The bucket tilt cylinder is static. The loader lift cylinders are extending.

OIL FLOW

Neutral Drive
Neutral Lift
Neutral Bucket Tilt
Raise Loader Lift



Neutral Drive
Neutral Lift
Neutral Bucket Tilt
Raise Loader Lift



OIL FLOW

Forward Drive-Neutral Attachment Lift-Rollback Loader Bucket-Neutral Loader Lift

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the travel valve.

TRAVEL VALVE

The travel valve is stroked out of the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for pump supply oil to leave the rear work port of the valve to the travel hydraulic motor.

c. opens the passage for return oil from the hydraulic motor to enter the front work port and flow through the lift valve open center passage to the power beyond sleeve.

From the power beyond sleeve, oil flow continues to the loader bucket control valve.

The lift spool is in neutral.

LOADER BUCKET CONTROL VALVE

The bucket tilt spool is stroked into the valve body. This:

a. closes the open center passage blocking the free flow path of oil.

b. opens the passage for power beyond supply oil to leave the top work port of the loader bucket control valve to the piston end of the tilt cylinder.

c. opens the passage for return oil from the rod end of the tilt cylinder to the bottom port of the loader bucket control valve and to the valve outlet port.

The loader lift spool is in neutral.

From the valve outlet port oil flow continues through the oil cooler and back to reservoir.

TRAVEL MOTOR

The travel motor is driven in the forward direction by the oil flow passing through it.

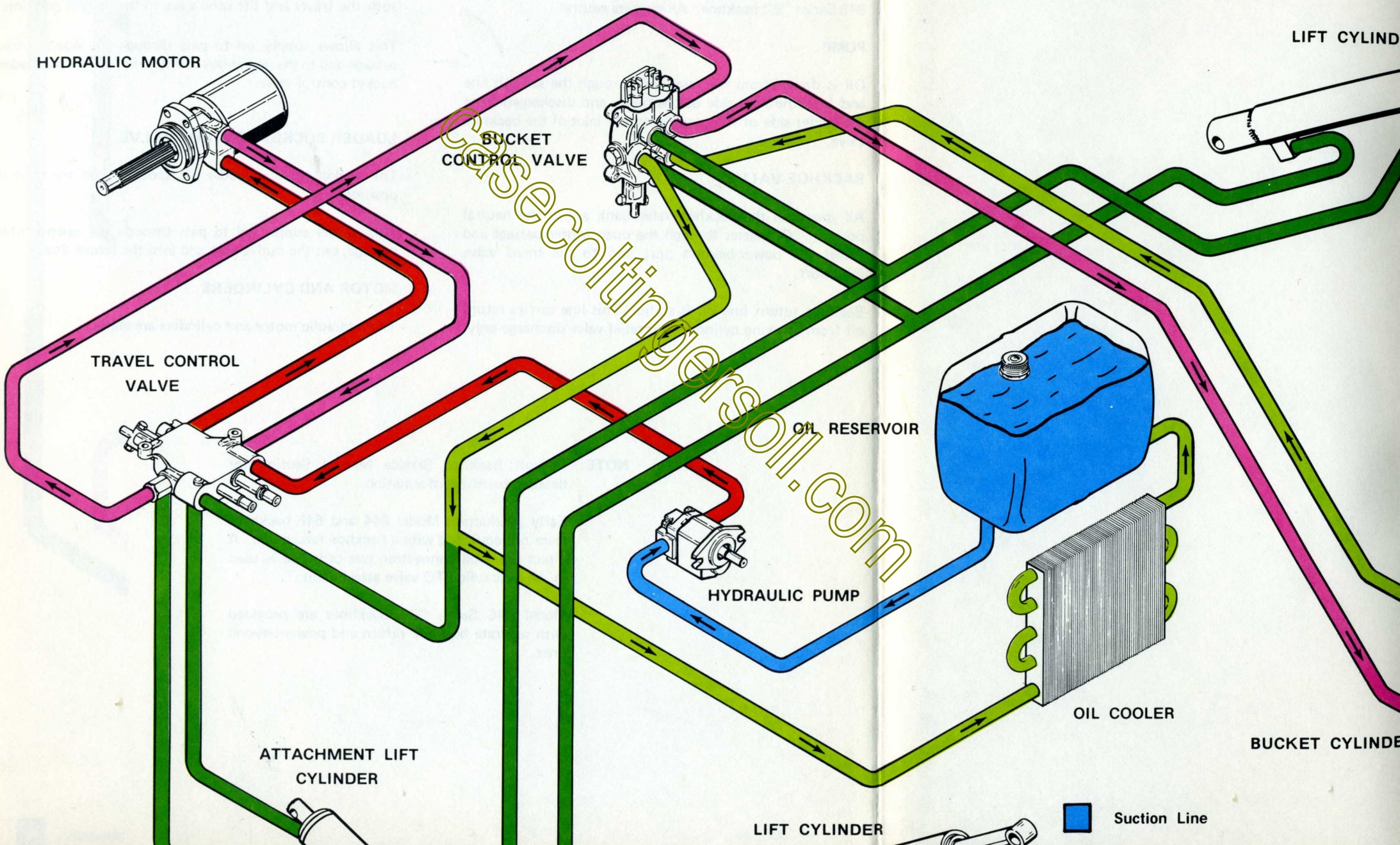
CYLINDER

The attachment lift cylinder is static. The bucket tilt cylinder is extending. The loader lift cylinders are static.

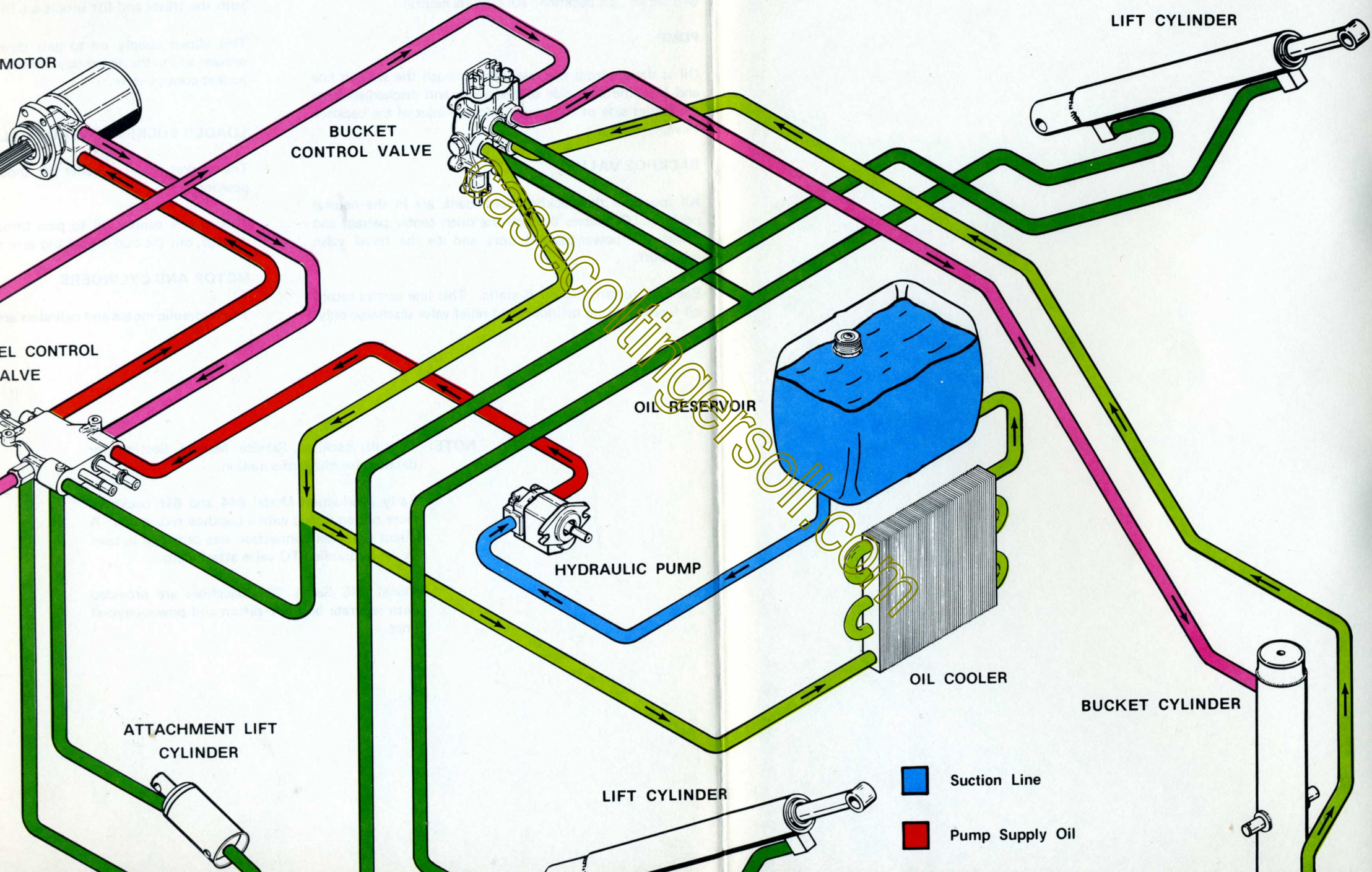
The drive circuit and bucket circuit are in series. Therefore, when both circuits are actuated simultaneously, the pressures generated by resistance to flow in each circuit add.

OIL FLOW

Forward Drive
Neutral Lift
Rollback Bucket Tilt
Neutral Loader Lift



Forward Drive
Neutral Lift
Rollback Bucket Tilt
Neutral Loader Lift



OIL FLOW

646 Series "B" backhoe. All circuits neutral.

PUMP

Oil is drawn from the reservoir, through the suction line and into the inlet side of the pump and discharged from the outlet side of the pump into the inlet of the backhoe valve.

BACKHOE VALVE

All spools in the backhoe valve bank are in the neutral position. Oil passes through the open center passage and leaves the power-beyond port and to the travel valve inlet port.

Backhoe return line oil is static. This line carries return oil from stroking cylinders and relief valve discharge only.

TRAVEL VALVE

Both the travel and lift spools are in the neutral position.

This allows supply oil to pass through the open center passage and to the power-beyond sleeve and into the loader bucket control valve.

LOADER BUCKET CONTROL VALVE

The bucket tilt and loader lift spools are in the neutral position.

This allows supply oil to pass through the open center passage, out the outlet port and into the return line.

MOTOR AND CYLINDERS

The hydraulic motor and cylinders are static.

NOTE: Consult Backhoe Service Manual Section for detailed backhoe information.

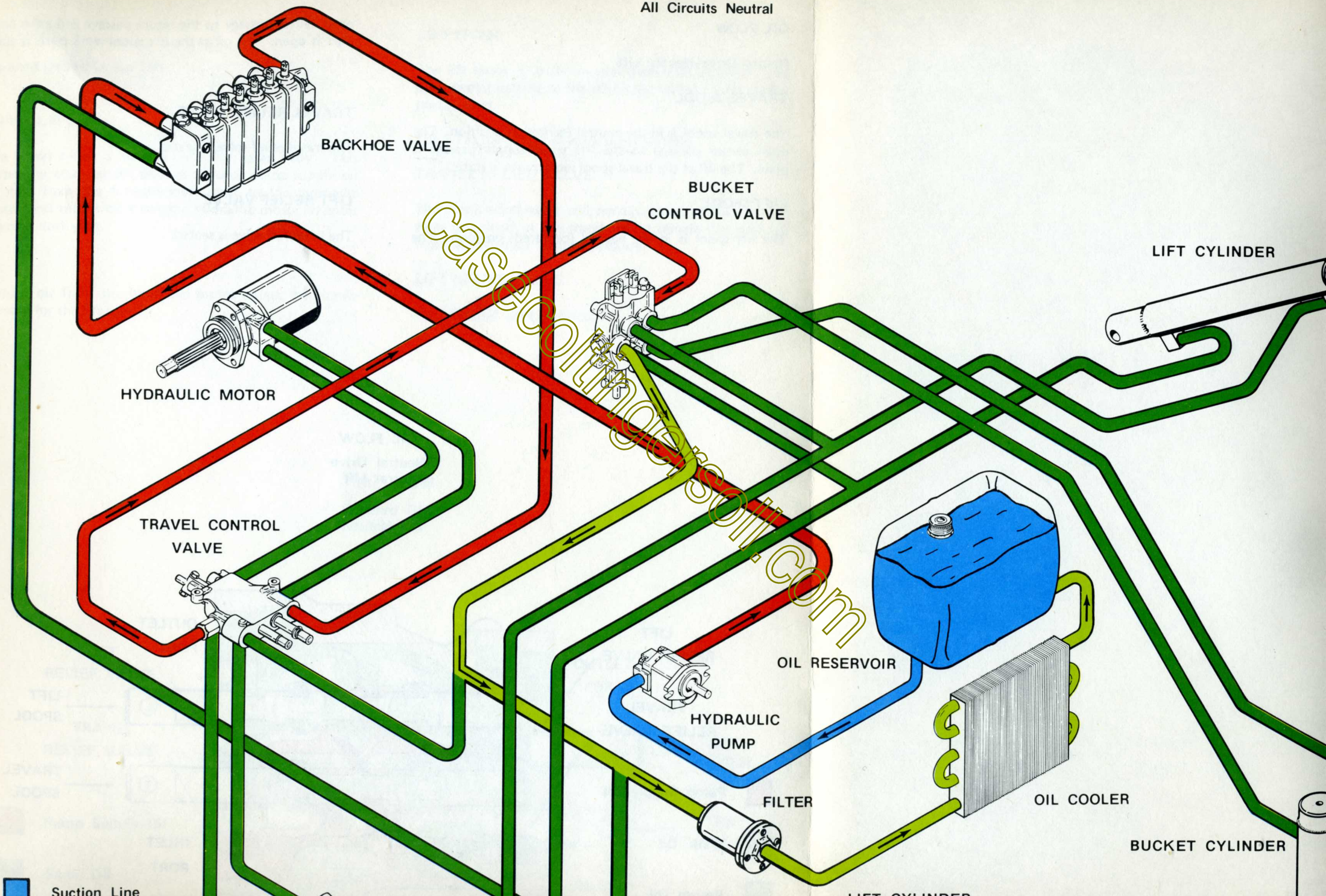
Early production Model 644 and 646 backhoes were not equipped with a backhoe return line. A direct series oil connection was provided as used in the hydraulic PTO valve attachment.

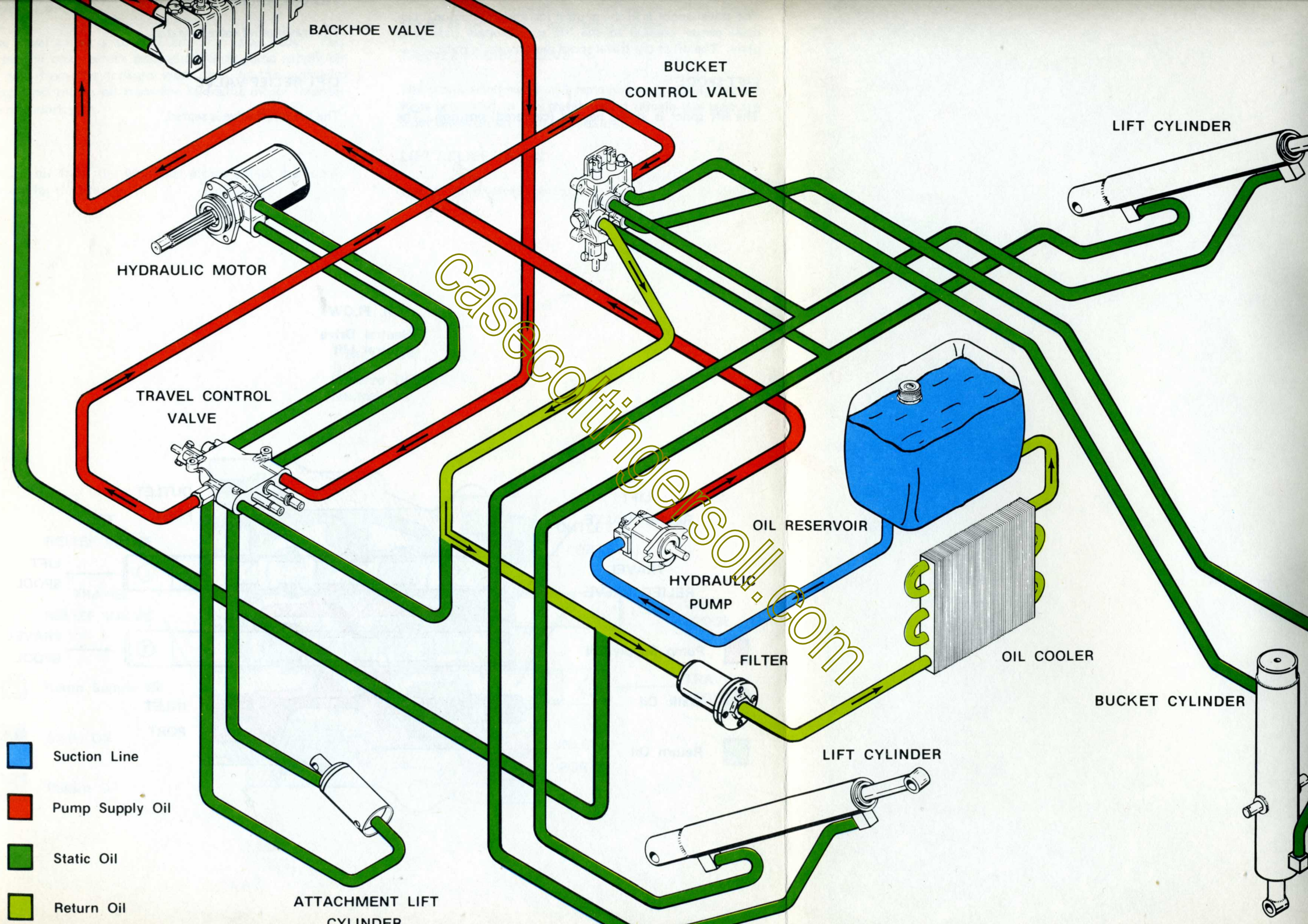
Model 646 Series "B" backhoes are provided with separate backhoe return and power-beyond lines.

646 SERIES "B" BACKHOE

OIL FLOW

All Circuits Neutral





TRACTOR TRAVEL VALVE

OIL FLOW

Neutral Drive-Neutral Lift

TRAVEL SPOOL

The travel spool is in the neutral (centered) position. The open center passage to the lift spool supply passage is open. The oil at the travel spool work ports is static.

LIFT SPOOL

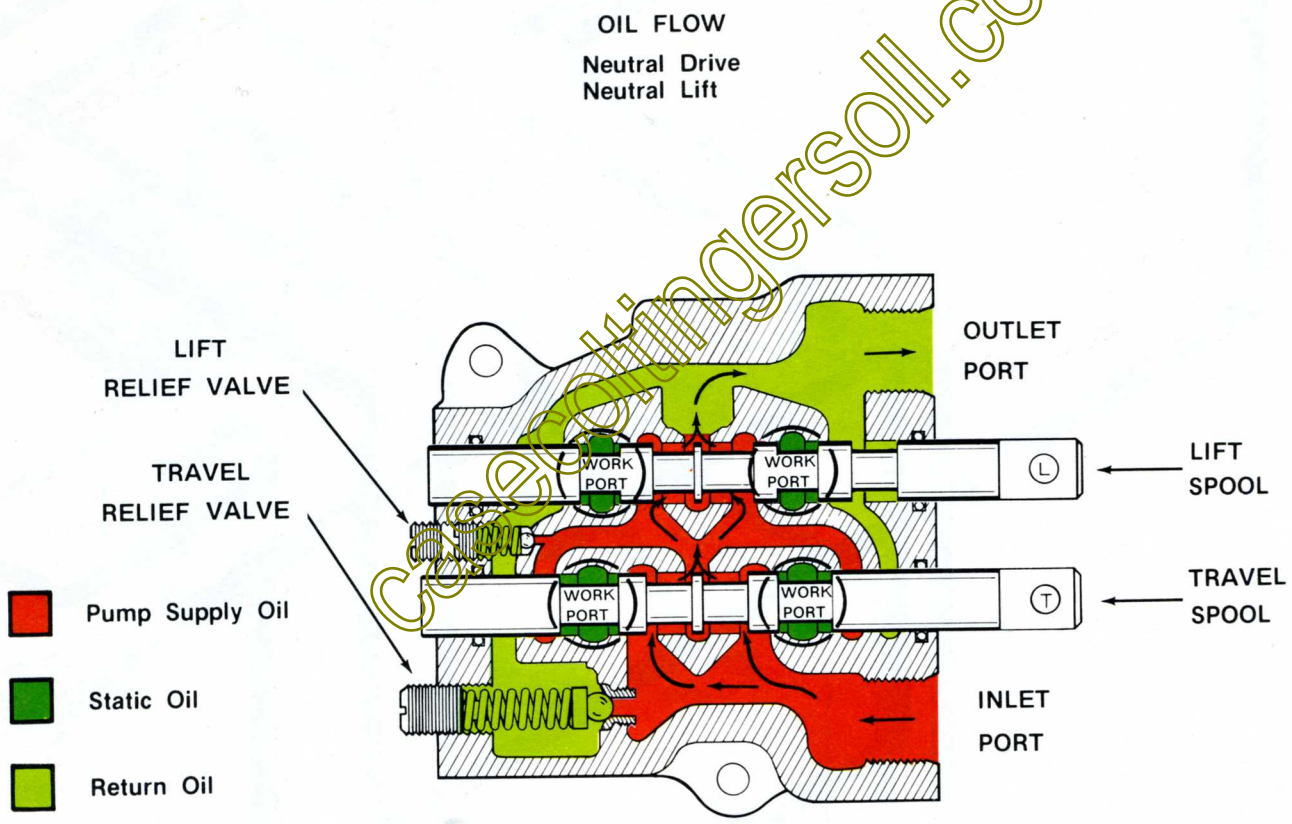
The lift spool is in the neutral (centered) position. The open center passage to the return passage and valve outlet port is open. The oil at the lift spool work ports is static.

TRAVEL RELIEF VALVE

The travel relief valve is seated.

LIFT RELIEF VALVE

The lift relief valve is seated.



TRACTOR TRAVEL VALVE

OIL FLOW

Forward Drive-Neutral Lift

TRAVEL SPOOL

The travel spool is stroked into the valve body. This closes the open center passage allowing pump supply oil to flow from the forward work port to the hydraulic motor and return oil from the hydraulic motor to enter the rear work port.

Return oil from the hydraulic motor enters the supply passage for the lift spool.

LIFT SPOOL

The lift spool is in the neutral (centered) position. The open center passage to the return passage and valve outlet port is open.

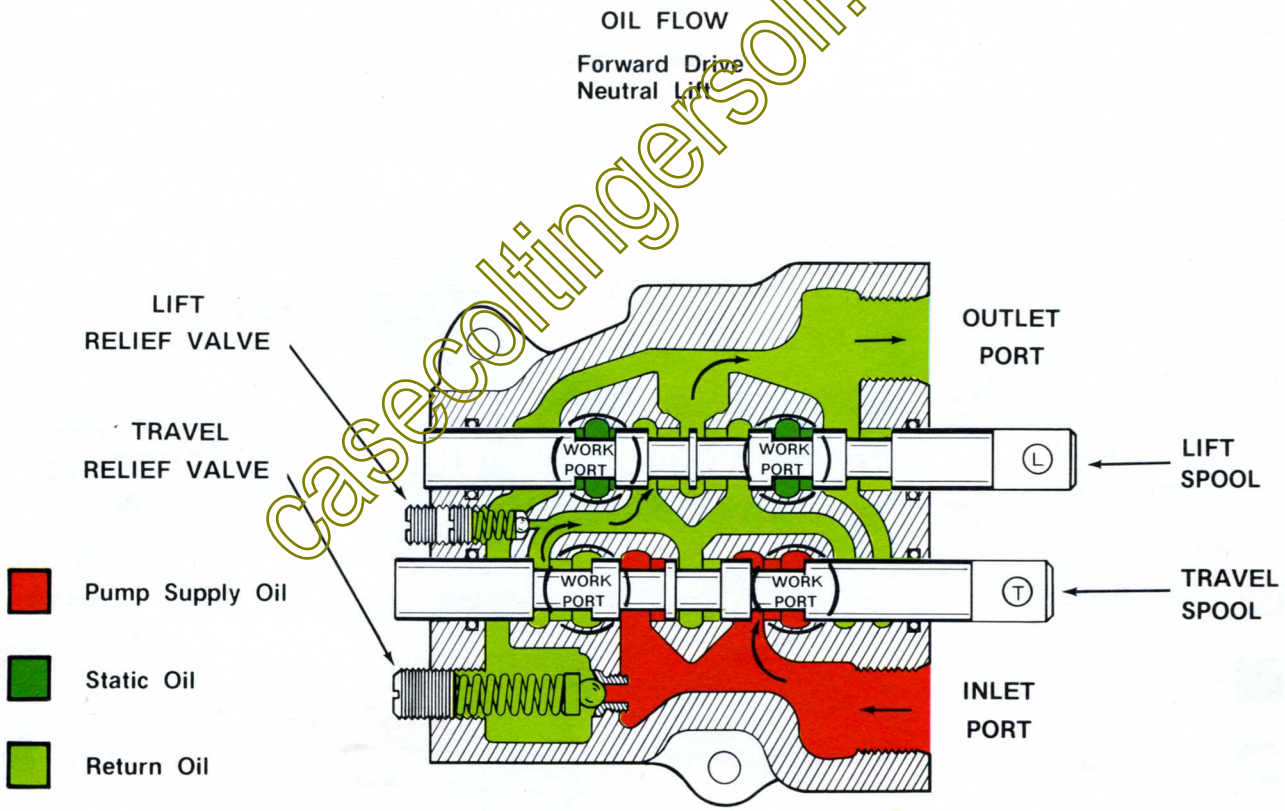
The oil at the lift spool work ports is static.

TRAVEL RELIEF VALVE

The travel relief valve will remain seated as long as pressures generated in the travel circuit remain less than the relief valves preset opening pressure.

LIFT RELIEF VALVE

The lift relief valve is seated.



TRACTOR TRAVEL VALVE

OIL FLOW

Reverse Drive–Neutral Lift

TRAVEL SPOOL

The travel spool is stroked out of the valve body. This closes the open center passage allowing pump supply oil to flow from the rear work port to the hydraulic motor and return oil from the hydraulic motor to enter the front work port.

Return oil from the hydraulic motor enters the supply passage for the lift spool.

LIFT SPOOL

The lift spool is in the neutral (centered) position. The open center passage to the return galley and valve outlet port is open.

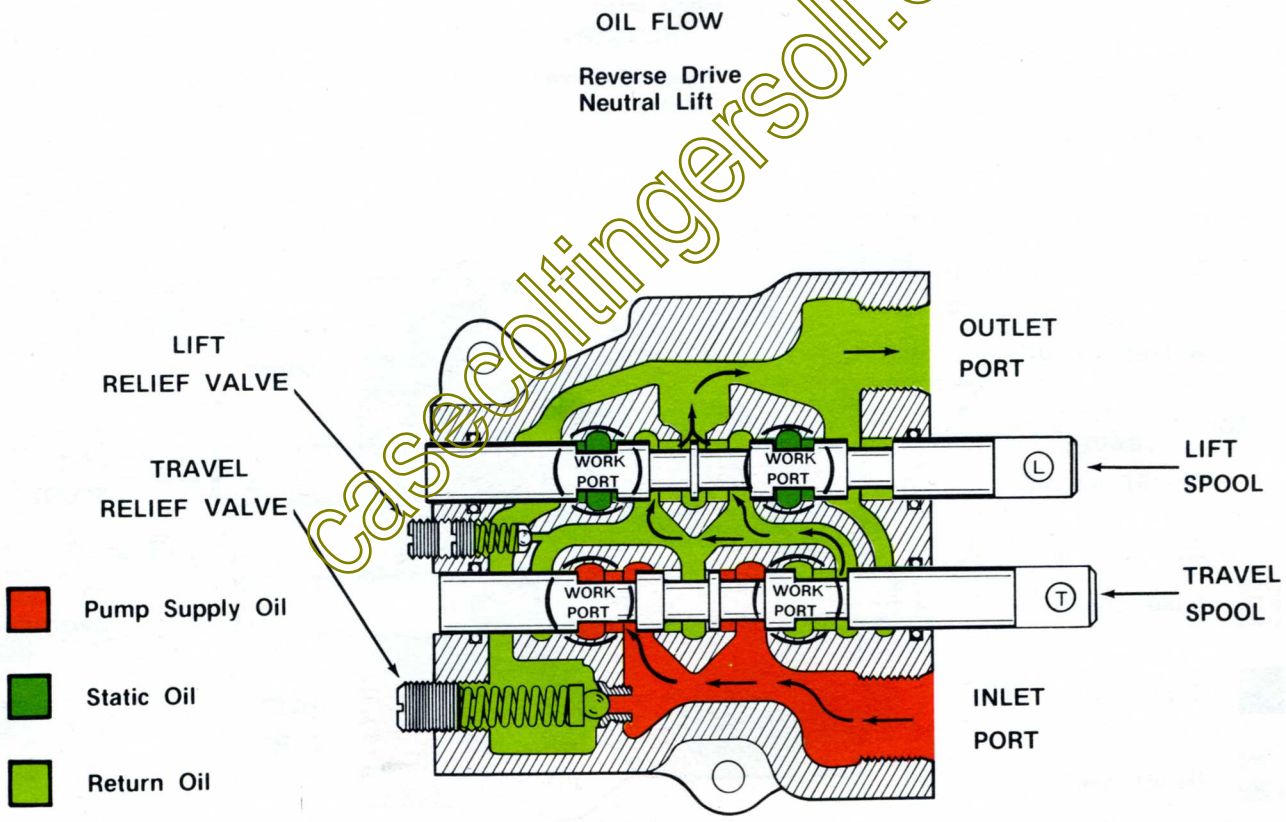
The oil at the lift spool work ports is static.

TRAVEL RELIEF VALVE

The travel relief valve will remain seated as long as pressures generated in the travel circuit remain less than the relief valve preset opening pressure.

LIFT RELIEF VALVE

The lift relief valve is seated.



TRACTOR TRAVEL VALVE

OIL FLOW

Forward Drive, Retard - Neutral Lift

TRAVEL SPOOL

The travel spool is stroked slightly into the valve body into the retarding position.

This partially closes the open center passage. Some pump supply oil still penetrates the open center passage.

This opens the path for pump supply to flow from the forward work port to the hydraulic motor.

A slight overlap exists between the travel spool and rear work port. This restricts return oil from the hydraulic motor. (Feathering grooves in the valve casting exist at this point of overlap).

This restriction prevents the hydraulic motor from cavitating.

LIFT SPOOL

The lift spool is in the neutral (centered) position. The open center passage to the return passage and valve outlet port is open.

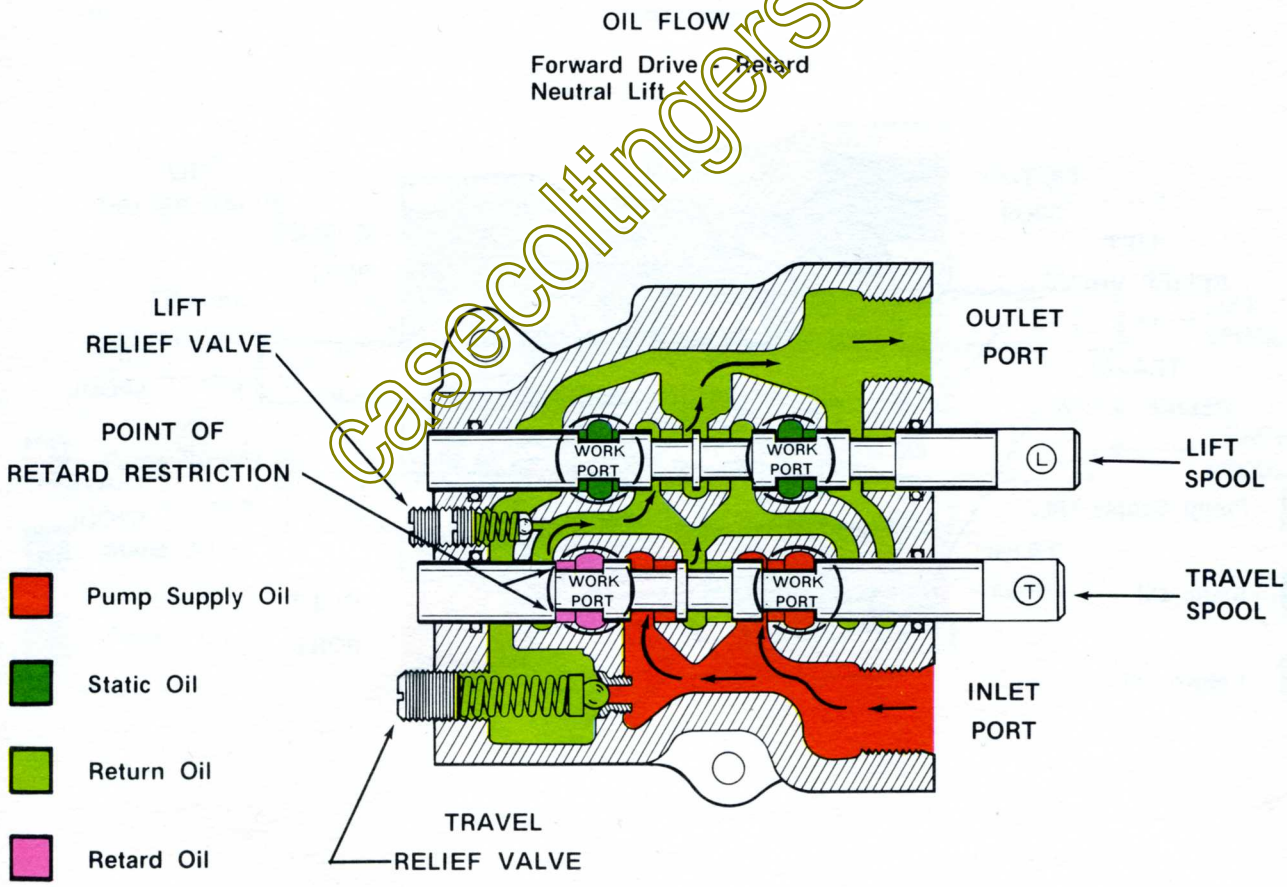
TRAVEL RELIEF VALVE

Since retard is a position of partial flow (open center still partially opened) the preset relief valve opening point will not be reached and the relief valve remains seated.

LIFT RELIEF VALVE

The lift relief valve is seated.

NOTE: Reverse retard is the opposite of the travel spool position described above.



TRACTOR TRAVEL VALVE

OIL FLOW

Forward Drive-Relief Valve Open-Neutral Lift

TRAVEL SPOOL

The travel spool is stroked into the valve body. This closes the open center passage allowing pump supply oil to flow from the forward work port to the hydraulic motor and return oil from the hydraulic motor to enter the rear work port.

Return oil from the hydraulic motor enters the supply passage for the lift spool.

The hydraulic motor is stalled, therefore oil flow through the motor stops.

LIFT SPOOL

The lift spool is in the neutral (centered) position. The open center passage to the return galley and valve outlet port is open.

The oil at the lift spool work ports is static.

TRAVEL RELIEF VALVE

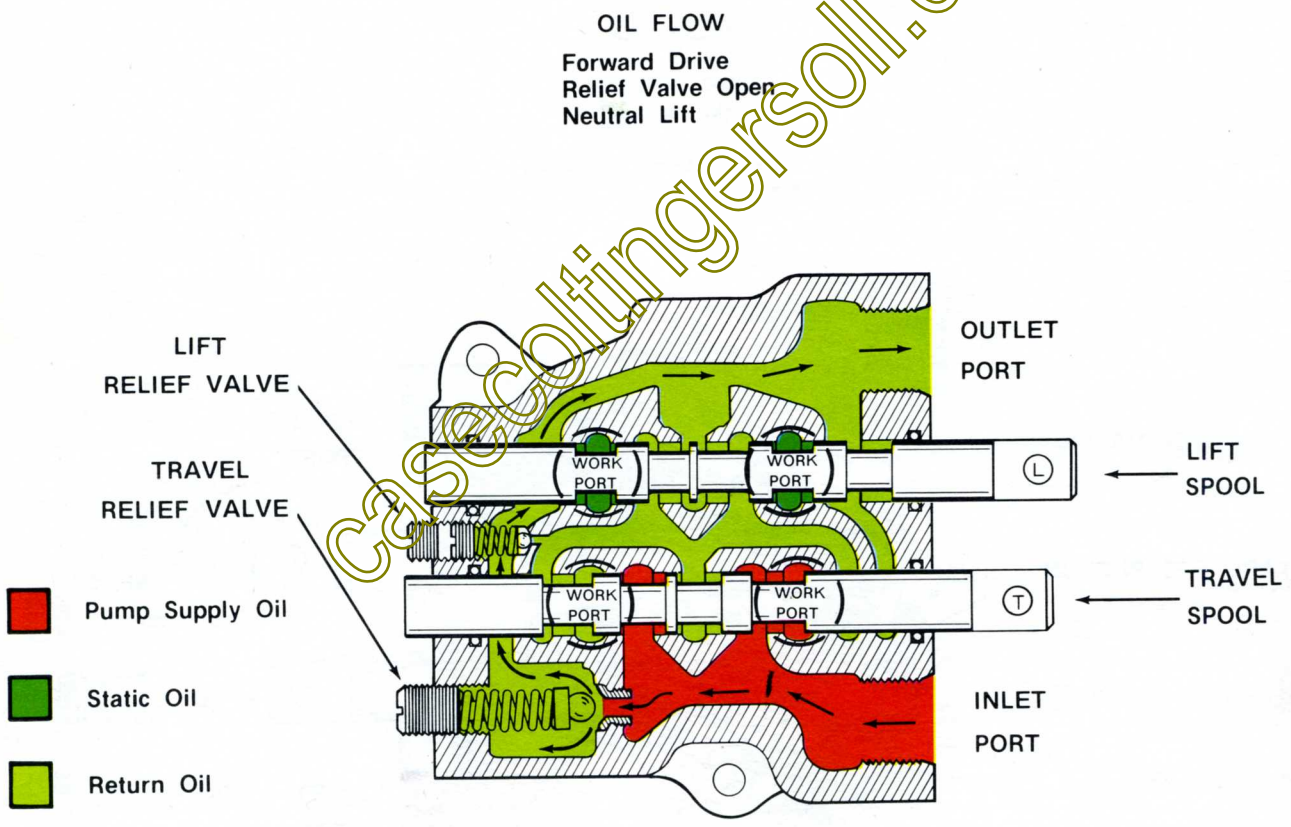
In this example we are implying pressure in the forward drive circuit has exceeded the relief valve preset opening point.

Pump supply oil is forced through the relief valve seat and the ball is held off its seat against spring pressure.

Reducing pressure in the circuit will allow the relief valve to reseat.

LIFT RELIEF VALVE

The lift relief valve is seated.



TRACTOR TRAVEL VALVE

OIL FLOW

Neutral Drive–Raise Lift

TRAVEL SPOOL

The travel spool is in the neutral (centered) position. The open center passage to the lift spool supply passage is open. The oil at the travel spool work ports is static.

LIFT SPOOL

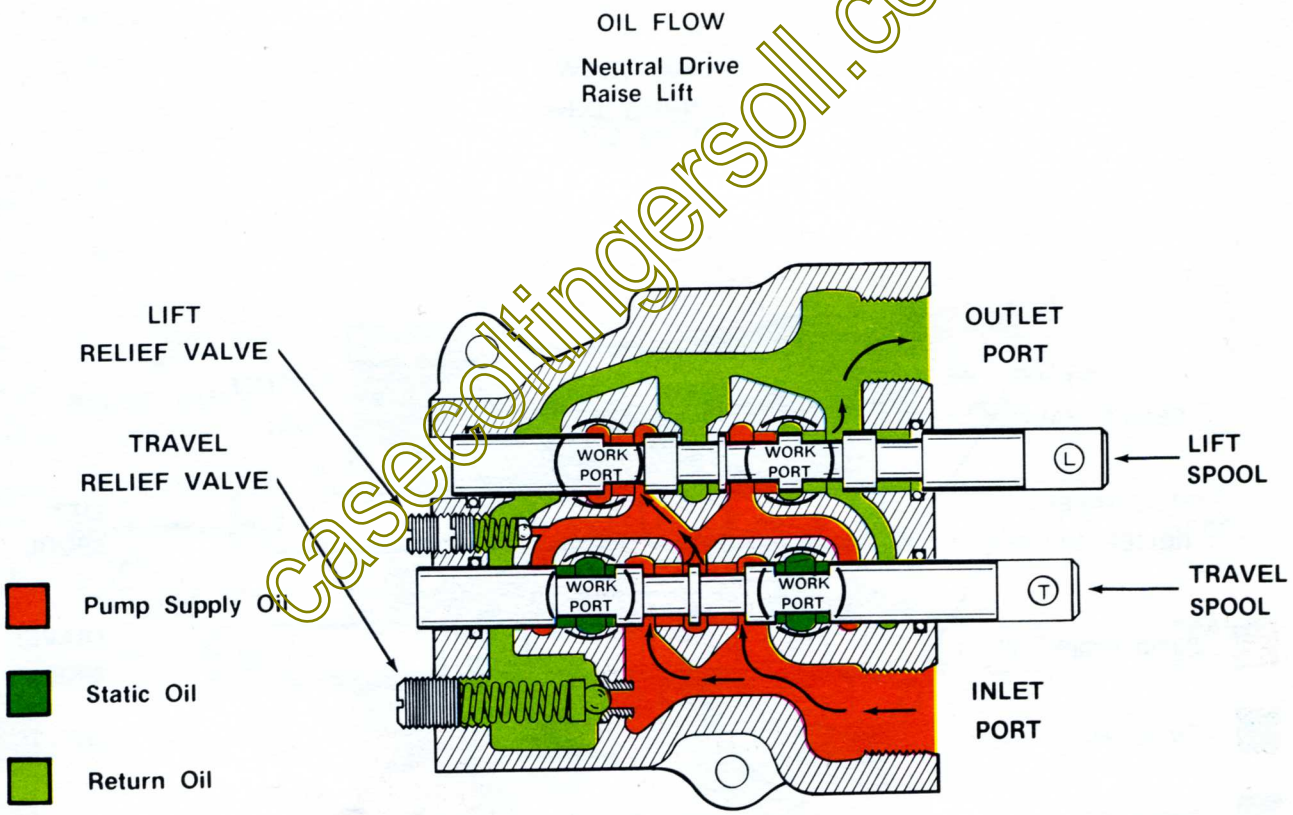
The lift spool is stroked out of the valve body. This closes the open center passage allowing pump supply oil to leave the rear work port to the lift cylinder. Return oil from the lift cylinder enters forward work port and flows into the return passage and out the valve outlet port.

TRAVEL RELIEF VALVE

The travel relief valve is seated. This valve will remain seated regardless of lift circuit pressures, because the lift circuit relief valve pressure setting is always less than the travel relief valve.

LIFT RELIEF VALVE

The lift relief valve will remain seated as long as pressures generated in the lift circuit remain less than the relief valve preset opening pressure.



TRACTOR TRAVEL VALVE

OIL FLOW

Neutral Drive-Lower Lift

TRAVEL SPOOL

The travel spool is in the neutral (centered) position. The open center passage to the lift spool supply passage is open.

The oil at the travel spool work ports is static.

LIFT SPOOL

The lift is stroked into the valve body. This closes the open center passage allowing pump supply oil to leave the front work port to the lift cylinder and return from the lift cylinder to the rear work port.

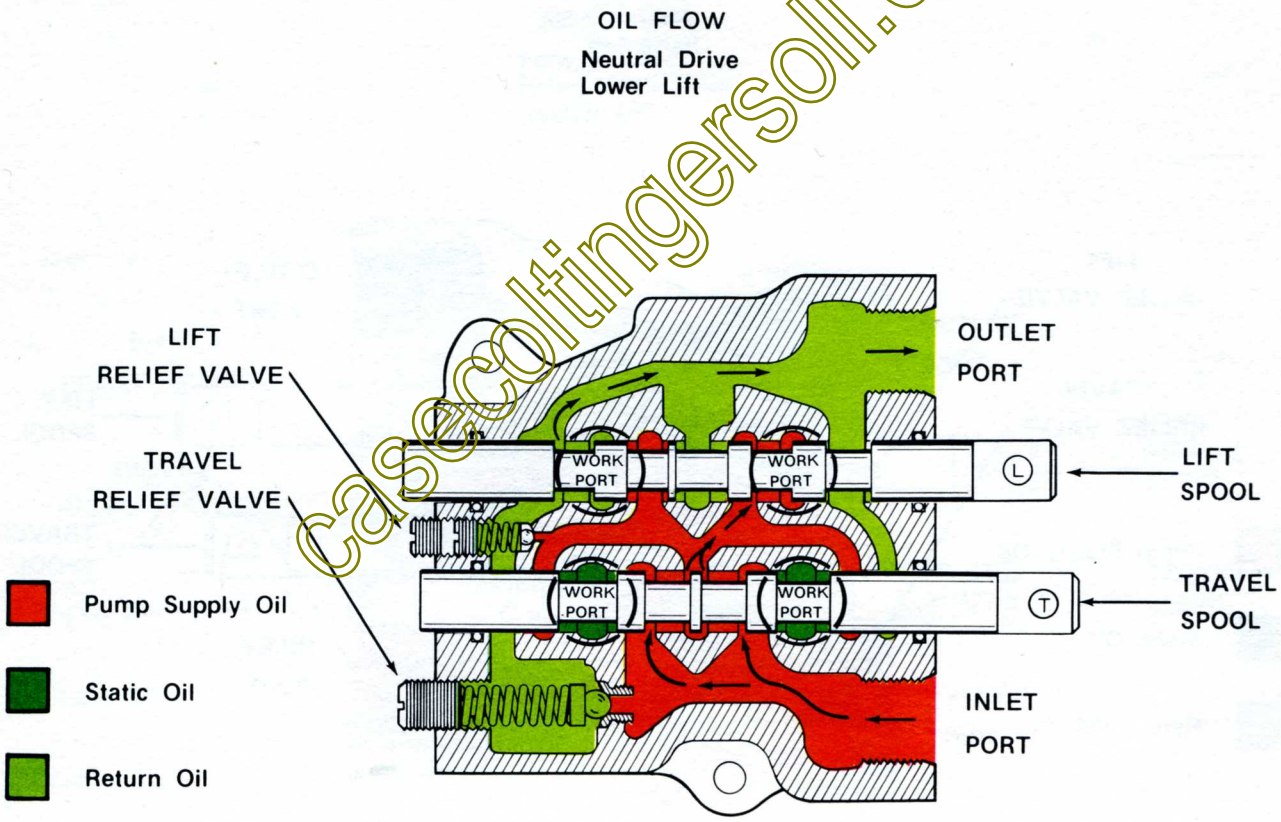
Return oil from the lift cylinder enters the return oil passage and flows to the valve outlet port.

TRAVEL RELIEF VALVE

The travel relief valve is seated. This valve will remain seated regardless of lift circuit pressures, because the lift circuit relief valve pressure setting is always less than the travel relief valve.

LIFT RELIEF VALVE

The lift relief valve will remain seated as long as pressures generated in the lift circuit remain less than the relief valve preset opening pressure.



TRACTOR TRAVEL VALVE

OIL FLOW

Forward Drive - Raise Lift

TRAVEL SPOOL

The travel spool is stroked into the valve body. This closes the open center passage allowing pump supply oil to flow from the forward work port to the hydraulic motor and return oil from the hydraulic motor to enter the rear work port.

Return oil from the hydraulic motor enters the supply passage for the lift spool.

LIFT SPOOL

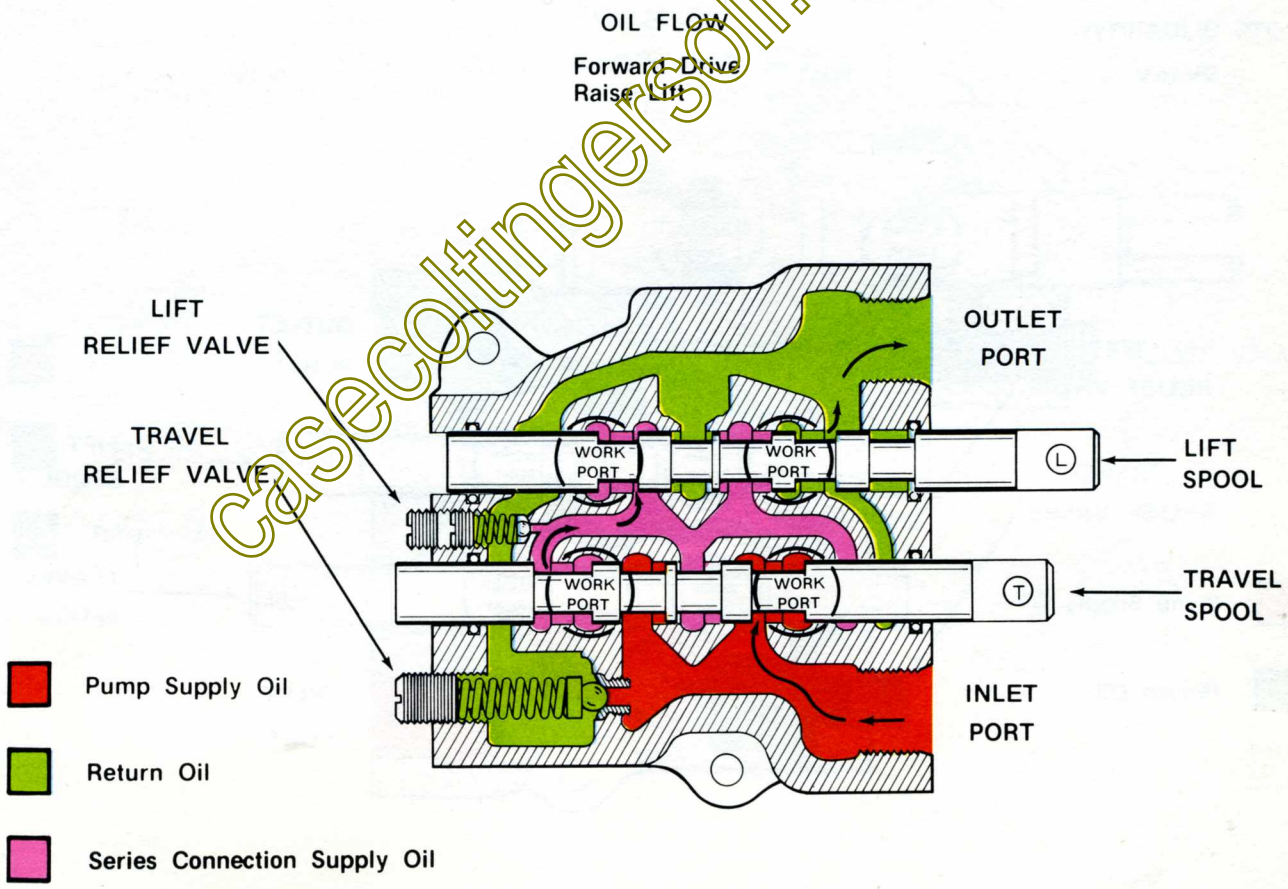
The lift spool is stroked out of the valve body. This closes the open center passage allowing series connection oil returned from the hydraulic motor to leave the rear work port to the lift cylinder. Return oil from the lift cylinder. Return oil from the lift cylinder enters the forward work port and flows into the return galley and out the valve outlet port.

TRAVEL RELIEF VALVE

The travel relief valve will remain seated as long as the sum of travel circuit pressure plus lift circuit pressure remains less than the relief valve preset opening point.

LIFT RELIEF VALVE

The lift relief valve will remain seated as long as pressures generated in the lift circuit remain less than the relief valve preset opening point.



TRACTOR TRAVEL VALVE

OIL FLOW

Forward Drive-Float Lift

TRAVEL SPOOL

The travel spool is stroked into the valve body. This closes the open center passage allowing pump supply oil to flow from the forward work port to the hydraulic motor and return oil from the hydraulic motor to enter the rear work port.

Return oil from the hydraulic motor enters the supply passage for the lift spool.

LIFT SPOOL

The lift spool is stroked fully into the valve body and is physically held in the detent mechanism.

The open center passage is open allowing supply oil to flow into the return oil galley.

Both lift spool work ports are open to the return oil galley.

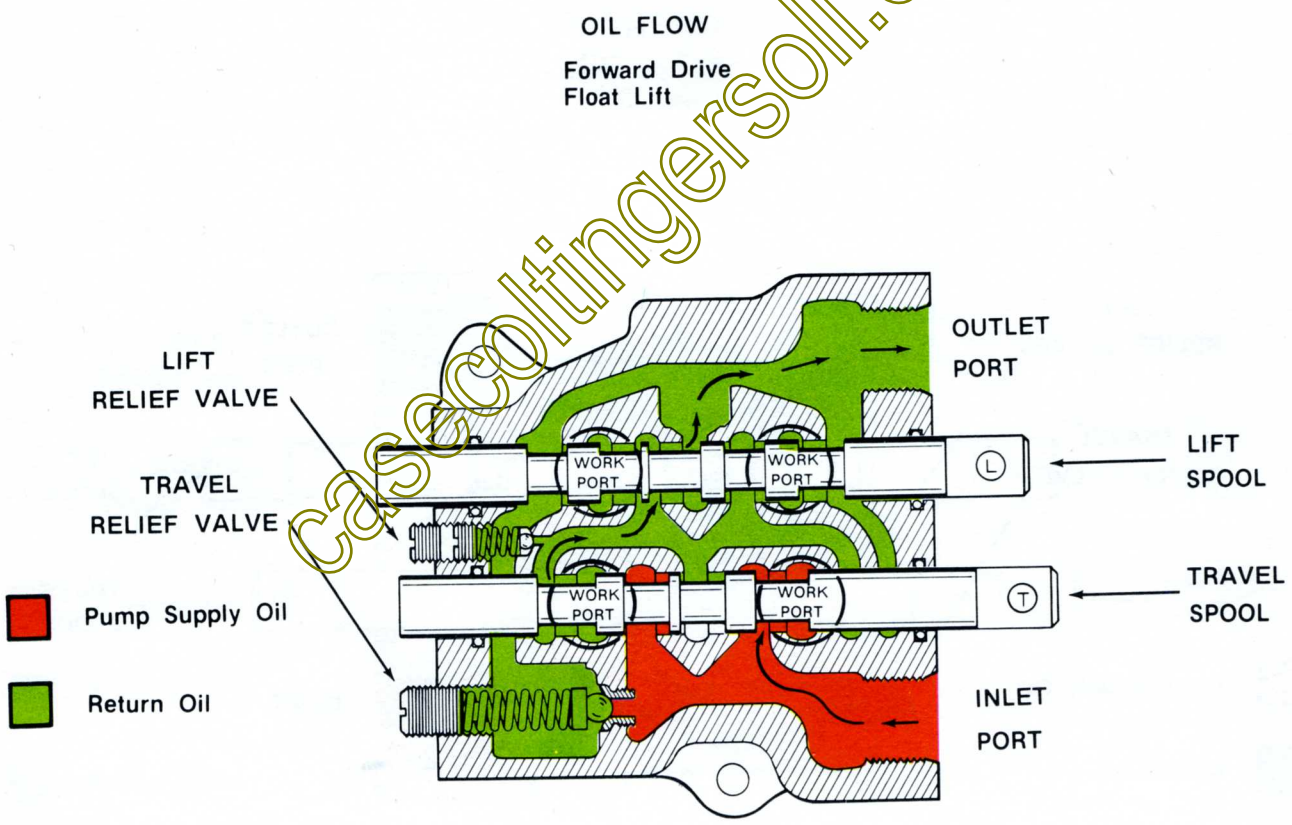
This allows the lift cylinder piston to move in and out (attachment follows contour of ground) without hydraulic resistance.

TRAVEL RELIEF VALVE

The travel relief valve will remain seated as long as the pressure generated in the travel circuit remains below the relief valve preset opening point.

LIFT RELIEF VALVE

The lift relief valve is seated.



OIL FLOW

Neutral (Tiller off)

VALVE SPOOL

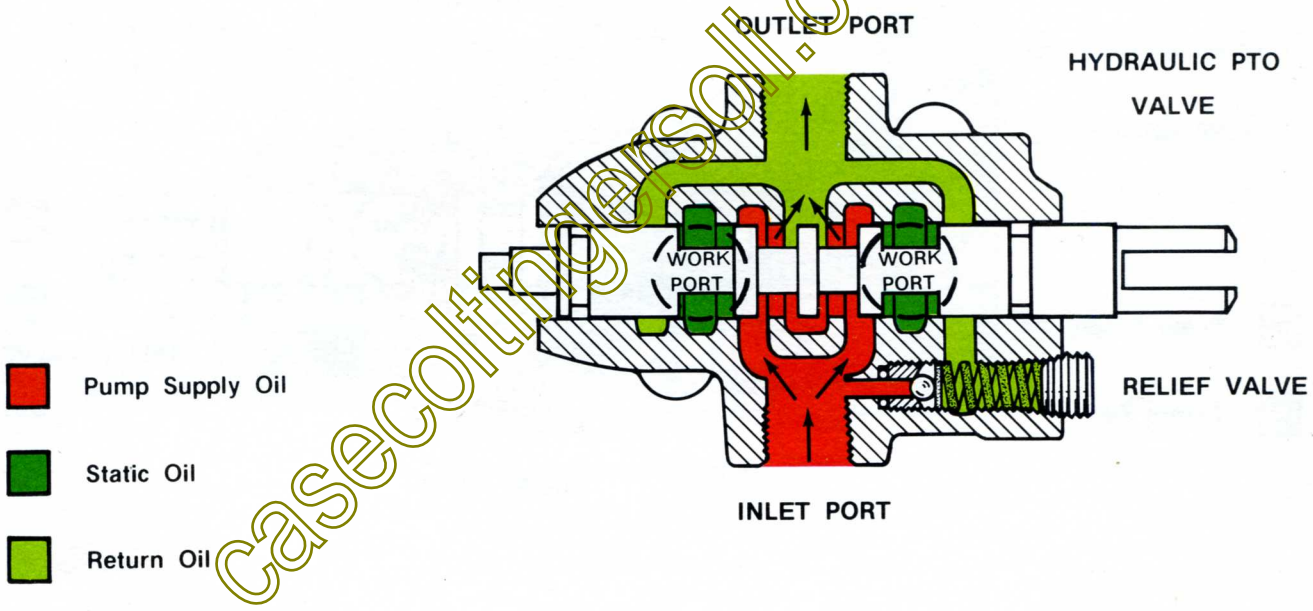
The valve spool is in the neutral (centered) position. The open center passage is open allowing pump supply oil to pass through the valve and continue to circuits downstream.

PTO RELIEF VALVE

The PTO relief valve is seated.

OIL FLOW

Neutral
(Tiller Off)



HYDRAULIC PTO VALVE

OIL FLOW

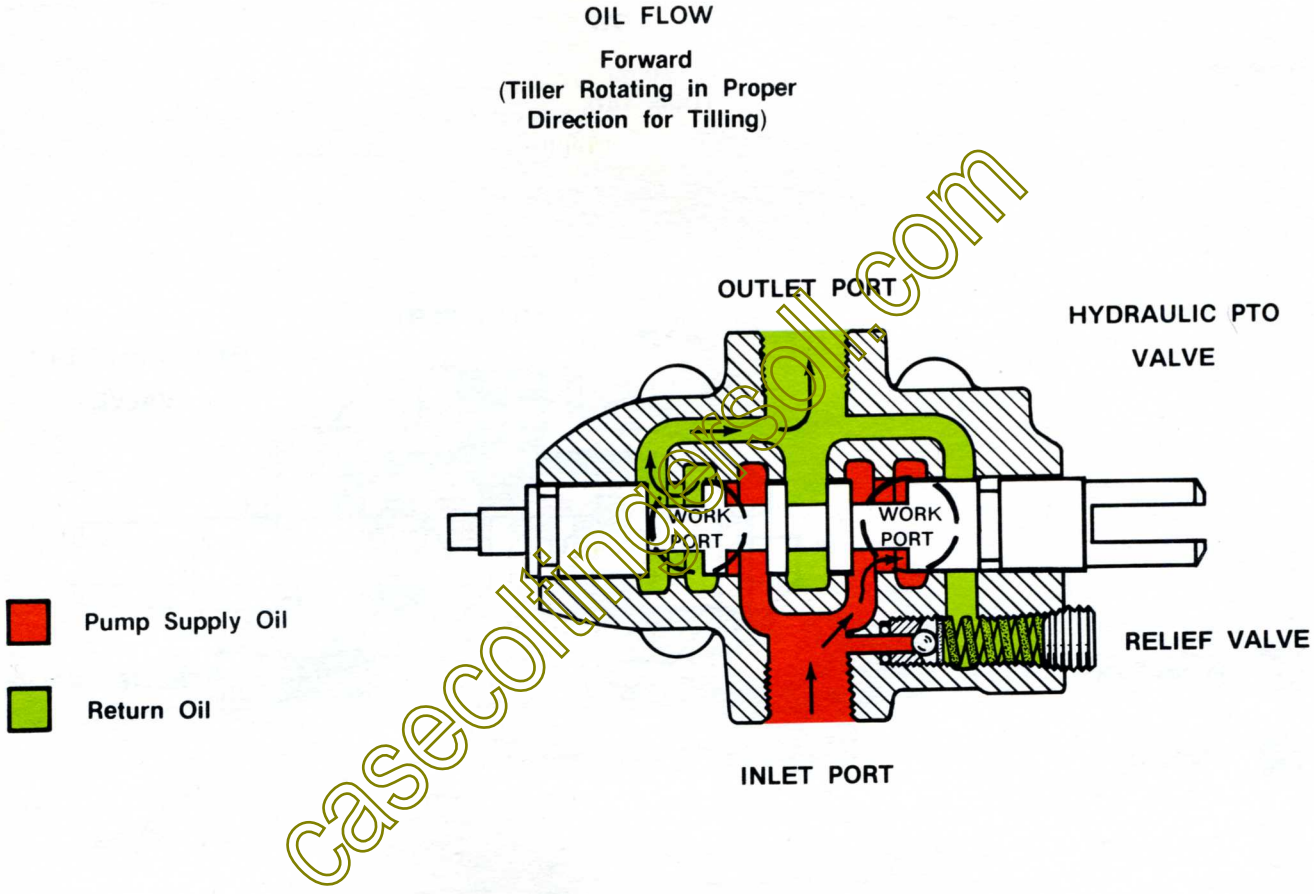
Forward (Tiller rotating in proper direction for tilling)

VALVE SPOOL

The valve spool is stroked out of the valve body. This closes the open center passage allowing pump supply oil to flow from the valve rear work port to the tiller hydraulic motor. Return oil from the hydraulic motor enters the valve front work port, flows into the return oil passage and out the valve outlet port.

PTO RELIEF VALVE

The PTO relief valve will remain seated as long as pressures generated in the tiller circuit remain less than the relief valve preset opening point.



HYDRAULIC FLOW CONTROL VALVE

OIL FLOW

Stop Flow Control

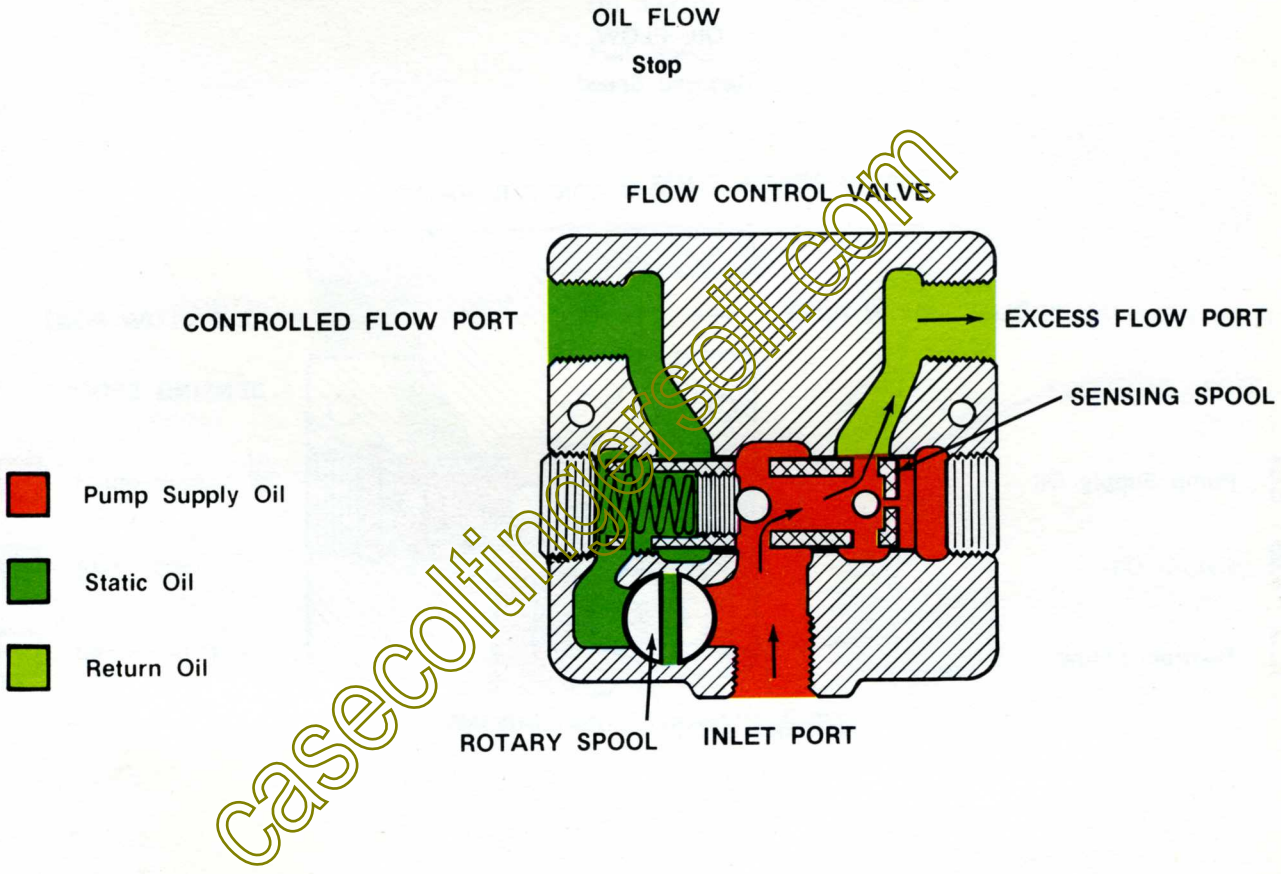
ROTARY SPOOL

The rotary spool is positioned by its handle in the off position.

SENSING SPOOL

The flow through the rotary spool is stopped. Oil flow on the controlled flow side of the sensing spool is static, pressure is zero causing the sensing spool to shift fully to the left, compressing the spring.

Supply oil flow on the excess flow side of the sensing spool flows freely through the excess flow port.



HYDRAULIC FLOW CONTROL VALVE

OIL FLOW

Reduced Speed Flow Control

ROTARY SPOOL

The rotary spool is positioned by its handle in a position less than full flow.

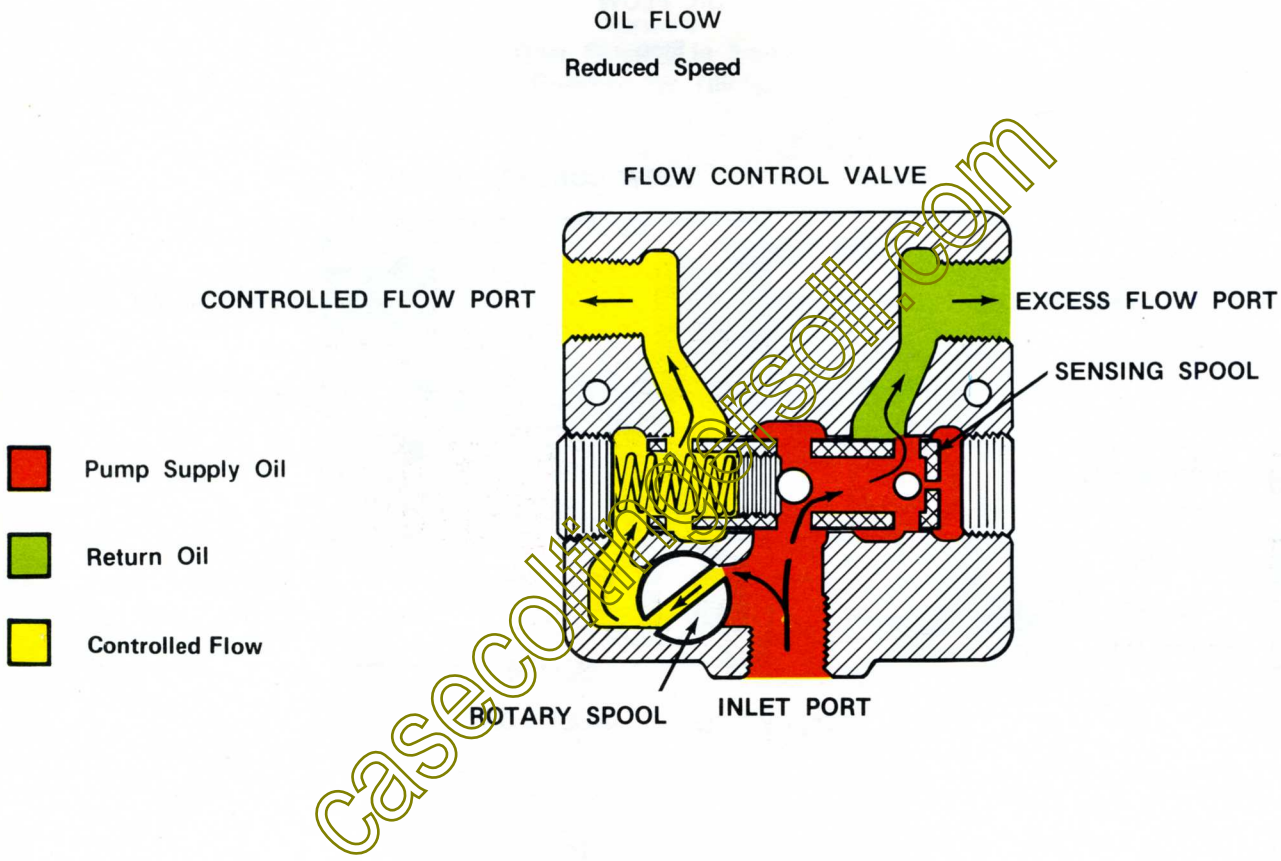
SENSING SPOOL

The flow through the rotary spool is restricted resulting in a pressure drop on the controlled flow side.

The resulting pressure differential (lower on controlled flow side, higher on excess flow side) causes the sensing spool to shift to the left partially compressing the spring.

This partially opens the flow to the excess flow port and reduces the flow to the controlled flow port.

The greater the restriction at the rotary spool, the further the spool will shift to the left and less oil will be available at the controlled flow port.



HYDRAULIC FLOW CONTROL VALVE

OIL FLOW

Full Speed Flow Control

ROTARY SPOOL

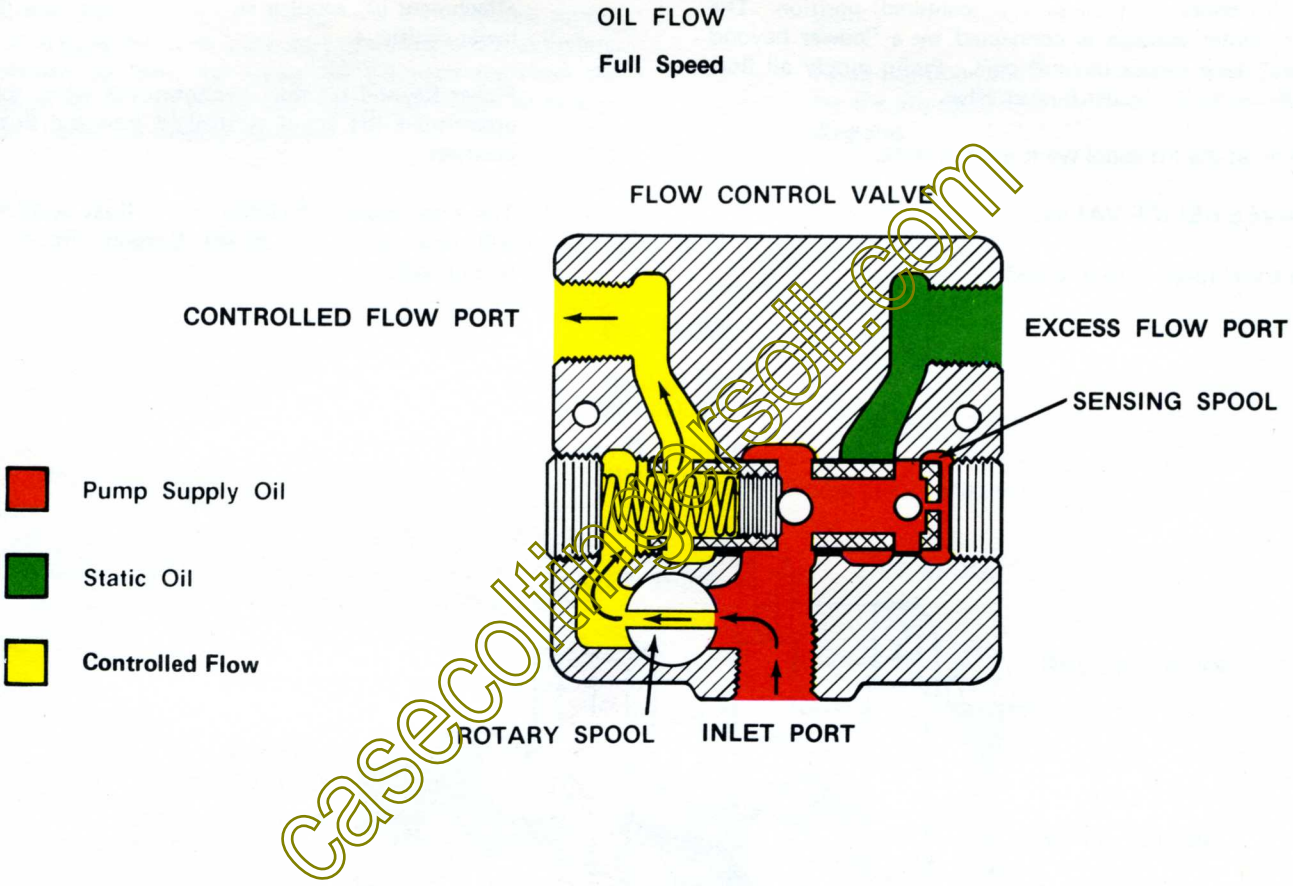
The rotary spool is positioned by its handle in the full flow position.

SENSING SPOOL

The flow through the rotary spool orifice is unrestricted resulting in negligable pressure drop on the controlled flow side. The spring holds the sensing spool fully to the right.

The controlled flow port is fully open.

The excess flow port is fully closed.



600 SERIES LOADER TRAVEL VALVE

OIL FLOW

Neutral Drive–Neutral Lift

TRAVEL SPOOL

The travel spool is in the neutral (centered) position. The open center passage to the lift spool supply passage is open.

The oil at the travel spool work ports is static.

LIFT SPOOL

The lift spool is in the neutral (centered) position. The open center passage is connected by a "power beyond sleeve" to a power beyond port. Pump supply oil flow continues to the loader bucket valve.

The oil at the lift spool work ports is static.

TRAVEL RELIEF VALVE

The travel relief valve is seated.

LIFT RELIEF VALVE

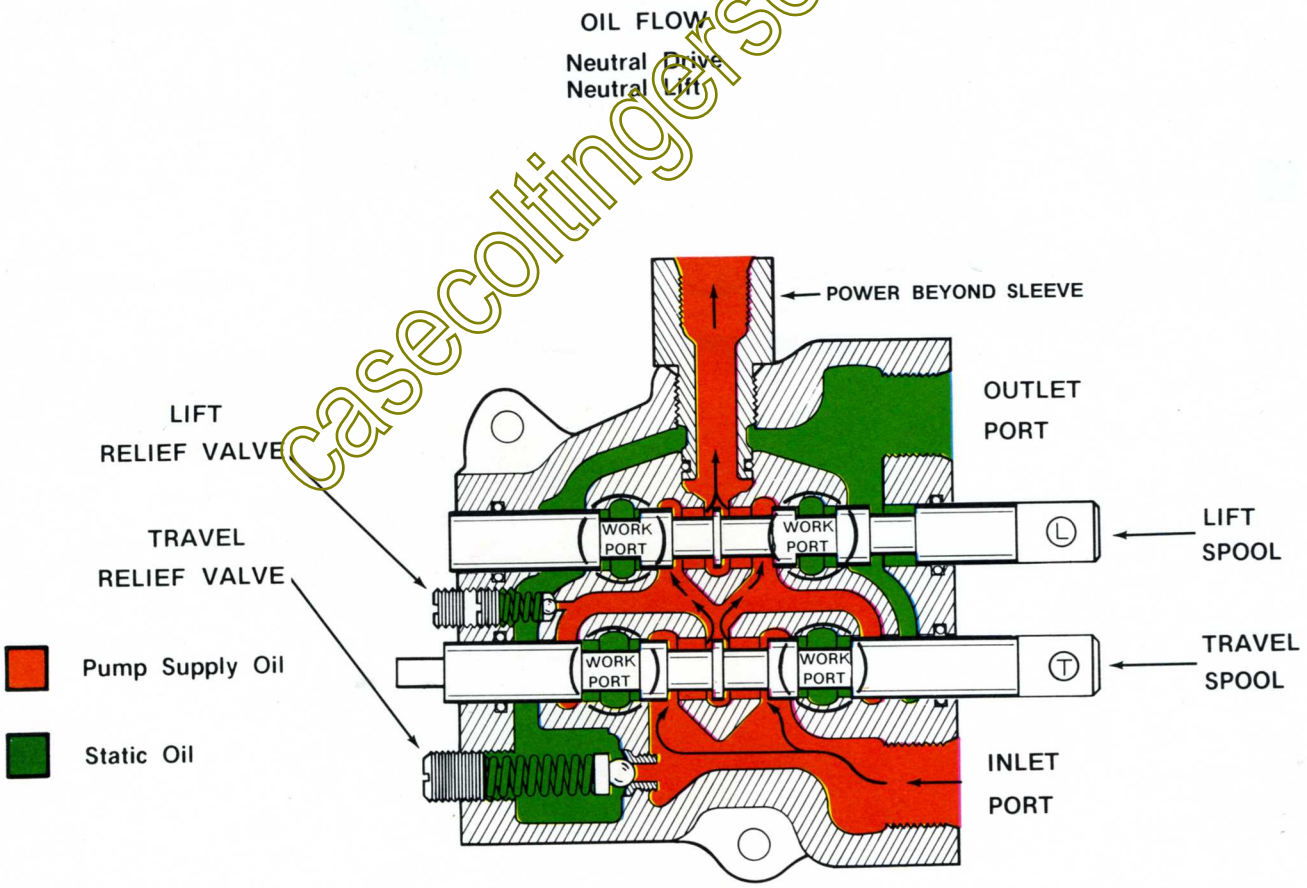
The lift relief valve will remain seated as long as pressures generated in the "power beyond" circuit remain less than the relief valve preset opening pressure.

NOTE: For forward, reverse, raise, lower and float oil flows refer to the tractor valve oil flows in this manual.

Power beyond oil flow is blocked when the attachment lift spool is stroked into the raise or lower positions.

Power beyond oil flow is continuous when the attachment lift spool is stroked into the float position.

The attachment lift circuit in the float position will raise when the power beyond circuit is pressurized.



LOADER BUCKET CONTROL VALVE

OIL FLOW

Neutral Tilt-Raise Lift

TILT SPOOL

The tilt spool is in the neutral (centered) position. The open center passage to the lift spool supply passage is open.
The oil in the tilt spool work ports is static.

LIFT SPOOL

The lift spool is stroked out of the valve body. This closes the open center passage and allows pump supply oil to leave the lower work port to the loader lift cylinders. Return oil from the loader lift cylinders can enter the upper work port of the valve, enters the return oil passage and leaves the valve outlet port.

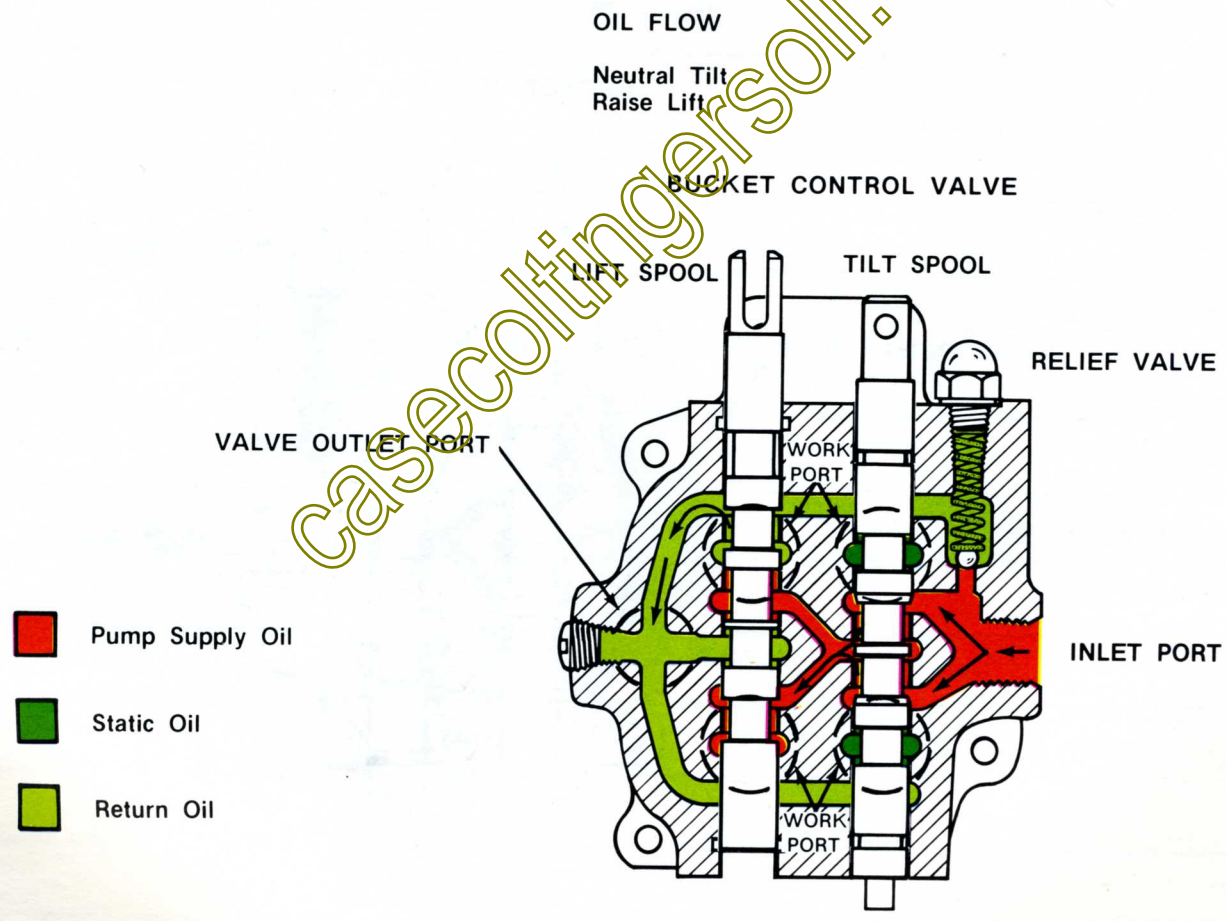
LOADER BUCKET RELIEF VALVE

The loader bucket relief valve will remain seated as long as pressures in the lift circuit remain less than the relief valve preset opening pressure.

Later production units may not be equipped with this relief valve. Relief protection is achieved at the attachment lift relief in the travel valve.

NOTE: Lower lift would be the opposite of the lift spool position described above.

Float position would be the same as described for the attachment lift cylinder spool in previous diagrams.



LOADER BUCKET CONTROL VALVE

OIL FLOW

Rollback Tilt- Neutral Lift

TILT SPOOL

The tilt spool is stroked into the valve body. This closes the open center passage and allows pump supply oil to leave the upper work port to the loader tilt cylinder. Return oil from the tilt cylinder enters the lower work port, enters the return oil passage and leaves the valve outlet port.

LIFT SPOOL

Oil supply to the lift spool is static.

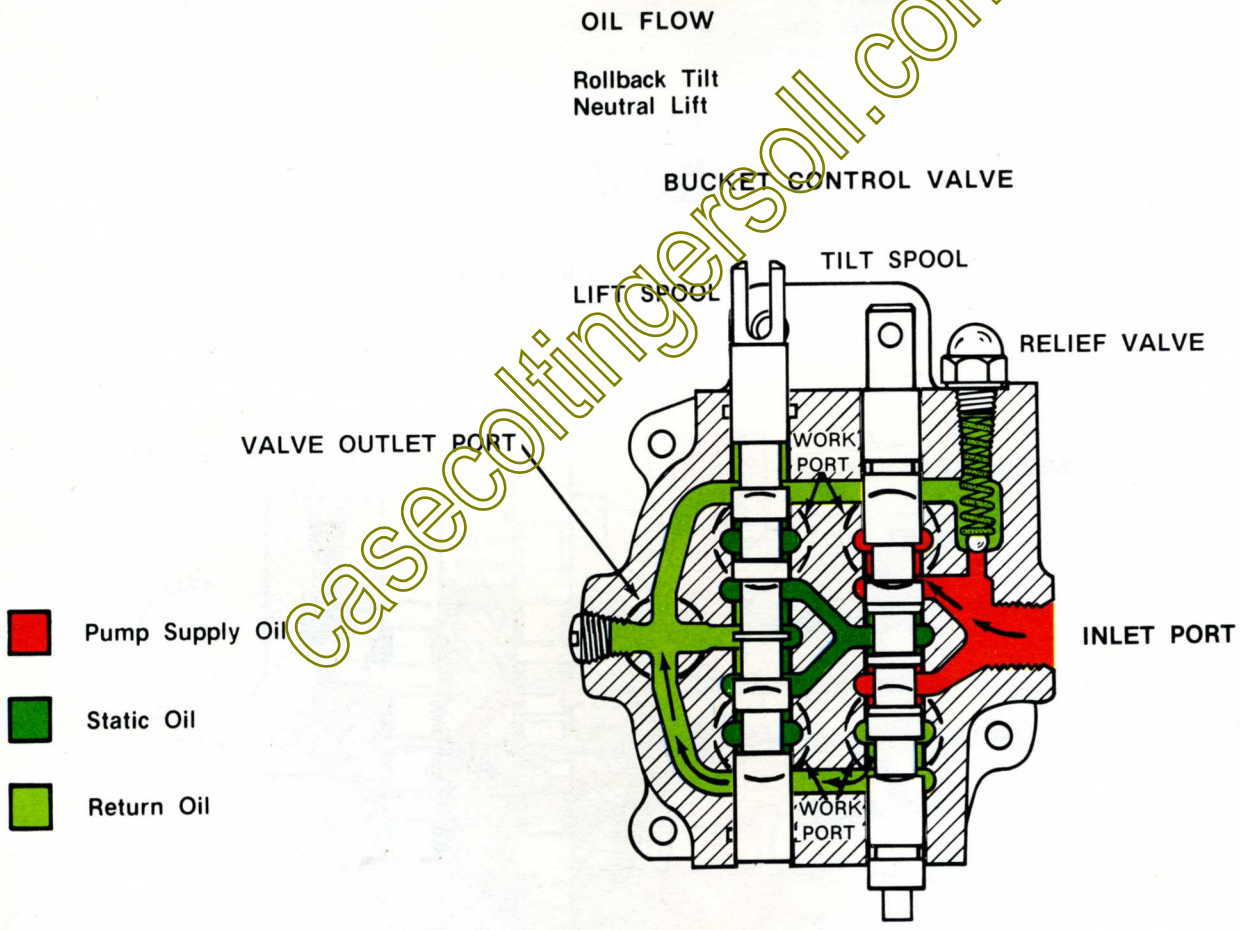
LOADER BUCKET RELIEF VALVE

The loader bucket relief valve will remain seated as long as pressures in the tilt circuit remain less than the relief valve preset opening pressure.

Later production units may not be equipped with this relief valve. Relief protection is achieved at the attachment lift relief in the travel valve.

NOTE: Tilt spool dump would be the opposite of the tilt spool rollback position described above.

Feathering the tilt spool will allow some supply oil to reach the lift spool allowing simultaneous operation of tilt and lift spools.



NOTES

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