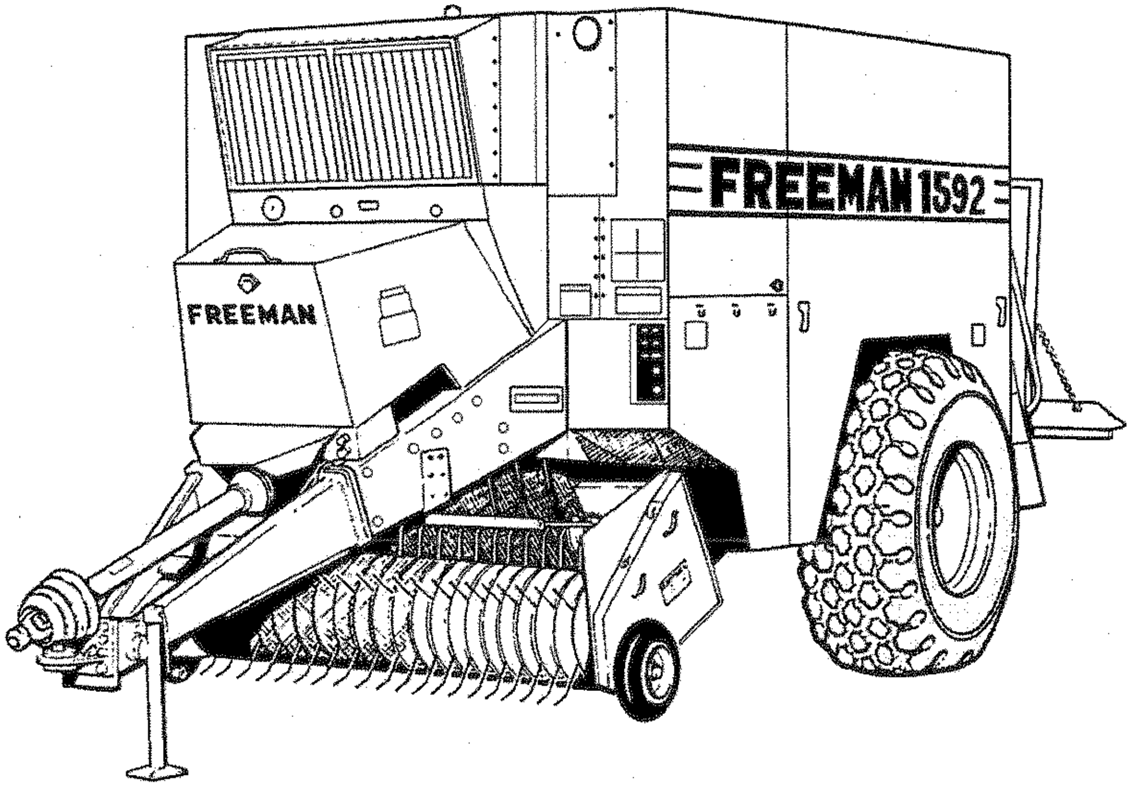
# FREEMAN




ELECTRICAL & HYDRAULIC SERVICE GUIDE

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CONTENTS

# SAFETY

J. A. Freeman & Son is greatly concerned with safety. The Freeman 1592 Baler is furnished with safety features. Even with these safety features, personal injury or death can still occur if the operator is careless, negligent, or thoughtless when maintaining, lubricating, operating, unclogging, or servicing the baler.

Your Freeman 1592 Baler has safety shields to help prevent personal injury. Do not operate the machine unless all shields are in place. Read and obey all **"CAUTION"**, **"DANGER"**, and **"WARNING"** decals on the baler.

Following is a list of precautions that must be taken to help prevent personal injury or death:

1. ALWAYS DISENGAGE TRACTOR PTO, SHUT OFF TRACTOR AND LOCK TRACTOR TRANSMISSION AND OR PARKING BRAKES BEFORE ADJUSTING, LUBRICATING, CLEANING OR SERVICING THE BALER.
2. KEEP HANDS, FEET, AND CLOTHING AWAY FROM MOVING POWER DRIVEN PARTS.
3. AVOID WEARING LOOSE FITTING CLOTHING WHICH CAN EASILY BE CAUGHT IN MOVING PARTS.
4. USE APPROPRIATE SIGNS, LIGHTS OR WARNING DEVICES WHEN OPERATING ON PUBLIC ROADS AND HIGHWAYS
5. MAKE CERTAIN EVERYONE IS CLEAR OF ANY PART OF THE BALER BEFORE STARING OR OPERATING THE BALER.
6. ALWAYS USE LIGHTS WHEN OPERATING AT NIGHT.
7. KEEP ALL SHIELDS IN PLACE AND IN SERVICEABLE CONDITION.
8. NEVER GO UNDER ANY RAISED COMPONENT UNTIL THEY ARE SAFELY BLOCKED OR SECURELY CHAINED IN POSITION.
9. AT ALL TIMES CARRY BOTH AN "ABC" RATED AND A WATER TYPE FIRE EXTINGUISHER ON THE MACHINE.
10. WHEN USING THE DIAGNOSTIC CONTROLLER ALWAYS KEEP THE CONTROL CABLE AWAY FROM MOVING PARTS. RUN THE PTO AT THE LOWEST POSSIBLE RPM TO AVOID EQUIPMENT DAMAGE.
11. REMEMBER "SAFETY" IS ONLY A WORD UNTIL IT IS PUT INTO PRACTICE.

J. A. Freeman & Son, Inc, 1592 Big Baler is the best hay baler on the market. This claim is supported by several features available on the 1592 which compares to none when baling hay. Unique self contained electrical over hydraulic controls offer a baling system that is gentle on the hay, and simple to maintain. All components are able to operate both forward and reverse by pushing a button and there are no shear bolts to replace on the flywheel, pickup, feeder, or feedfork. All major components are protected by relief valves instead of shear bolts. The knotter system twine finger drive does have shear bolts to prevent damage to the twine fingers.

These unique features are accomplished with the systematic operation of 13 limit switches, 14 relays, 4 hydraulic pumps, 6 relief valves, plus other secondary hydraulic valves, hydraulic motors and electrical wiring components.

At first an impression that maybe taken is "this system is very complicated for the average person". The purpose of this manual is to show you step by step how this system of electrical and hydraulic technology is accomplished, and how effortless to understand and maintain. To do this the operator needs to have a complete understanding of the baler and how it performs.

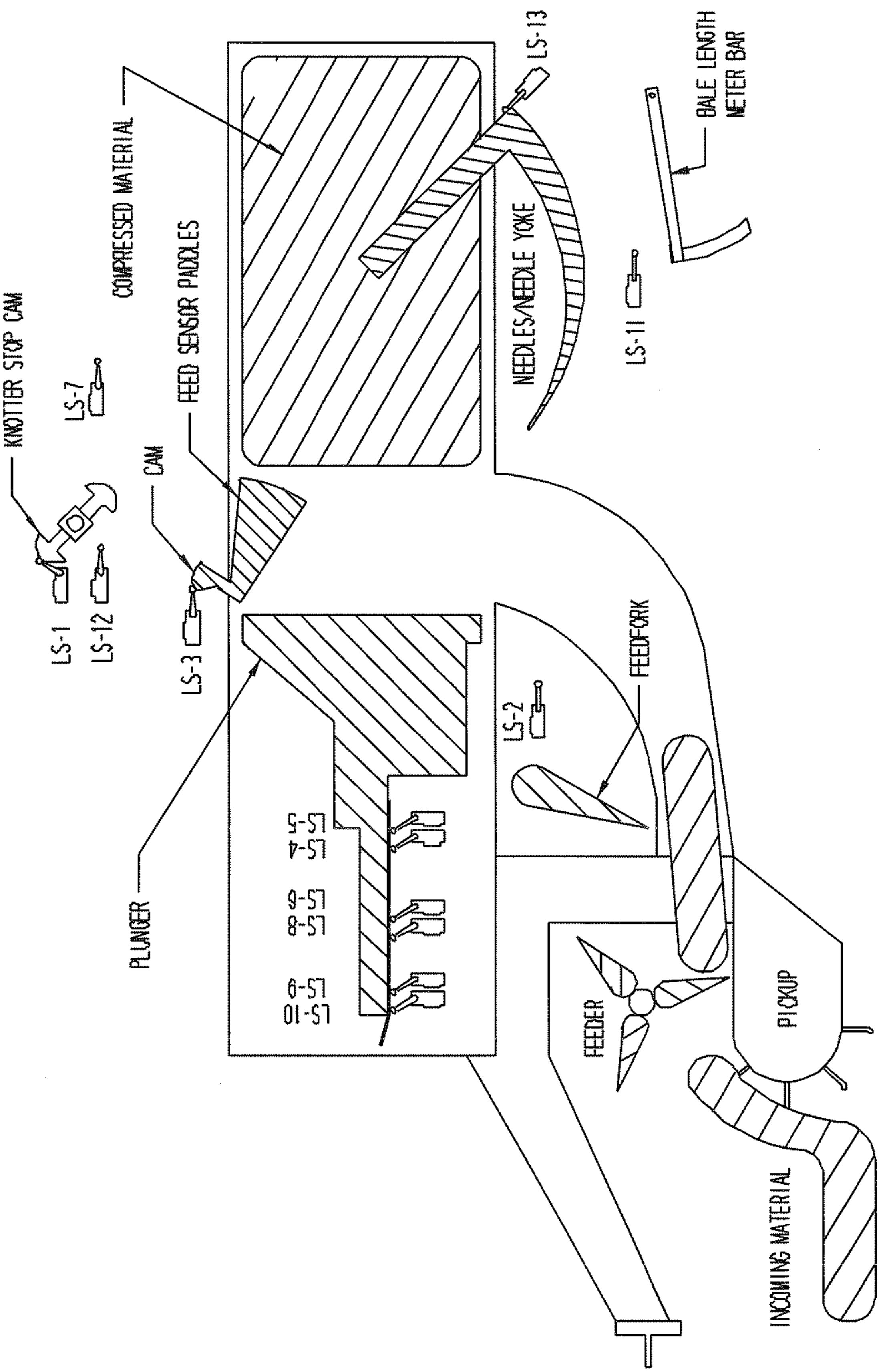
The electrical system controls all hydraulic functions on the baler. To clarify hydraulic functions they have been broken down into three categories.

1. Plunger Drive
2. Pickup/Feeder Drive - Feedfork /Knotter Drive
3. Tension Control System

The electrical system consists of a battery, alternator, 13 limit switches, 14 relays, 2 control boxes, a low hydraulic oil safety switch, a high hydraulic oil temperature thermostat, bale counter, diagnostic controller, and necessary wire harnesses to carry 12 Volts DC from one point to another. Limit switches serve to communicate position, or condition of the components on the baler to relays in the control box. Electrical logic then sends 12 Volts DC to the appropriate hydraulic control valve for a specific function to be completed.

The hydraulic system consists of 4 hydraulic pumps, 3 hydraulic motors, relief valves, directional control valves, and hydraulic cylinders. When the tractor PTO is engaged, the baler driveline and flywheel rotate and all 4 pumps begin to pump oil. This oil is simply circulated through hoses and valves and returned to the hydraulic reservoir until an electrical signal is sent to hydraulic control valves. Hydraulic control valves then shift and allow hydraulic oil to flow to the component which will then rotate (motor) or extend/retract (cylinder).

Electrical & hydraulic circuit schematics illustrate the path for electrical current and hydraulic oil flow, similar to a road map. If an area needs to be explored the road map shows the necessary turns stops and junctions that must be navigated to reach this area. To learn how to navigate the 1592 Big Baler system schematics, a person needs to learn a few things about the obstacles encountered at the junctions on this map. But first a complete understanding of the area being explored is necessary. As with navigating a road map, a complete understanding of the automobile being driven helps avoid collisions, confusion, and frustrations.


KNOTTER STOP CAM
CAM
FEED SENSOR PADDLES
COMPRESSED MATERIAL
LS-13
BALE LENGTH
METER BAR
NEEDLES/NEEDLE YOKE
LS-11
LS-7
LS-1
LS-12
LS-3
PLUNGER
LS-5
LS-4
LS-6
LS-8
LS-9
LS-10
LS-2
FEEDFORK
FEEDER
PICKUP
INCOMING MATERIAL

# 1592 GENERAL OVERVIEW

Tractor PTO engaged, operating at 1000 PTO RPM, power to the baler turned on; the J. A. Freeman & Son, Inc. 1592 Big Baler is operational.

When the PTO is engaged nothing happens until the operator turns the key switch to run and he puts the baler into automatic mode. At this time the pickup, feeder and feedfork start to rotate. The pickup and feeder operate continuously, delivering the crop to the feedfork. As the feedfork rotates, it pushes crop into the bale chamber until there is sufficient crop to raise the feed sensor paddles.

Crop pushes the feed sensor paddles upward which signal the feedfork to stop and the plunger to advance. The feedfork stops when it reaches its highest point in the chamber and the plunger cylinder extends and retracts, compressing the charge of crop in the process. As the plunger is retracting a signal from a limit switch starts the feedfork again. The plunger continues to retract to its home position, the feedfork delivers another charge of material into the bale chamber, and the process repeats. In most crops and conditions the feedfork will deliver enough crop to the bale chamber paddles so that the plunger will stoke on every feedfork rotation. But it does not need to; as the plunger will not advance until the feed sensor paddles are raised, thereby sending a signal for the feedfork to stop and the plunger to stroke. NOTE: <u>the plunger will only advance when the bale chamber is full and the feed sensor paddles are raised. This is one of the reasons the 1592 is gentler on the hay than any of the competitors.</u>

As this process repeats the bale advances out the discharge end of the baler. As it does so it rotates the bale length meter wheel and the bale length meter bar raises. The bale length meter bar monitors the length of the bale, and when the bale becomes a predetermined length, the bale length meter bar activates a limit switch which signals the knotter to cycle. The knotter cycle starts just as the plunger starts it's retract stroke. As the plunger retracts the knotter cycle completes forming a finished bale. The plunger continues to retract and the process repeats for the next bale.

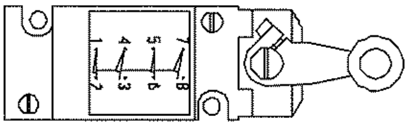
If any of the above sequence fails to happen, or a signal fails, we need to be able to investigate the problem area and determine where the problem lies. If this problem occurs in the electrical or hydraulic circuitry we need to be able to follow the correct path that leads to the problem area. To do so we need to learn;

1. The symbols and nomenclature called out on the schematics
2. The location of these same components on the baler
3. The circuitry path (schematics)
4. The sequence of functions

The symbols and nomenclature are next. Then we will learn where all these components are located on the baler and last, the schematics and sequence of functions will be combined as we follow the different electrical & hydraulic paths.

Figure 1

8 Post Limit Switch Released



Schematic Symbol

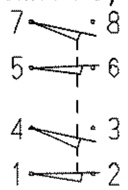
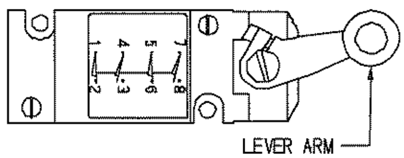



Figure 2

8 Post Limit Switch Activated




Schematic Symbol

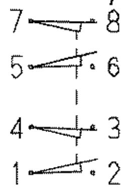
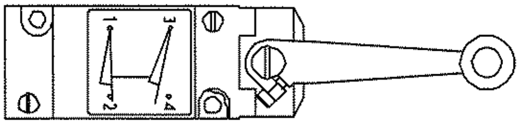



Figure 3

4 Post Limit Switch Released



Schematic Symbol

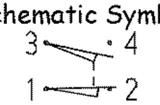
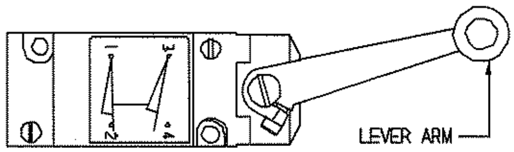
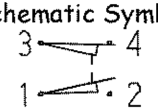



Figure 4

4 Post Limit Switch Activated



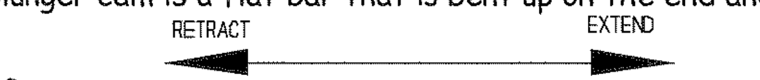

Schematic Symbol




13 limit switches are used on the baler to control and signal component locations. These switches are identified on the schematic as LS- and then a number. LS- Stands for limit switch and the number is the identifier. Five of the limit switches are 8 post limit switches and eight are 4 post switches. An 8 post switch has 2 sets of contacts that are normally open and 2 sets of contacts that are normally closed. A four post limit switch has only 1 set each of normally open and normally closed contacts. Normally closed contacts are closed when the switch is released and open when the switch is activated. Normally open contacts are open when the switch is released and closed when the switch is activated.

Each switch has a lever arm that will contact a cam to activate the switch. When the lever arm is not in contact with the cam the switch is released. Two lengths of lever arms are used, 3" & 1-1/2"; eleven of the limit switches use the 3" lever arm and only 2 switches (LS-3 and LS-11) use the 1-1/2".

A cam can be different in shape depending on the item it comes in contact with. The plunger cam is a flat bar that is bent up on the end and looks like this;

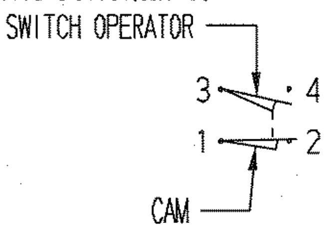



The plunger cam is welded onto the plunger and the limit switches are mounted onto the baler frame on the underside of the cam. As the plunger cylinder extends, the lever arms roll off the end of the cam and the switches are released.

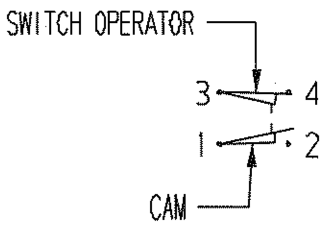
As the plunger retracts, the lever arms make contact with the cam and the switches are activated. We do not say the switch is open or closed, we prefer activated & released, as illustrated when a switch is activated the normally open contacts close, and the normally closed contacts open.

Figure 1 shows the symbol for an 8 post limit switch that is released, and figure 2 shows it activated. When the lever arm is moved approximately 1/2" the switch will make an audible "click". This clicking sound signals the position where the switch becomes either activated or released.

When looking at the schematic view how do we tell if the switch is activated or released? You have to pay close attention to the cam that is drawn on the switch operator on the schematic.




This is an electrical schematic symbol for a 4 post limit switch in the released position. If you were to push on the cam the switch operator can move. Contacts 1 & 2 can open and contacts 3 & 4 would close.




This is an electrical schematic symbol for a 4 post limit switch in the activated position. If you were to push on the cam the switch operator has no place to move to. Contacts 1 & 2 are already open and contacts 3 & 4 are closed. So pushing on the cam will do nothing. The only position this switch can go to is the released position by removing the cam activation.

When the plunger is in the home position (fully) retracted all six limit switches are activated by the plunger cam and are shown on the schematic in the activated position. As the plunger advances the cam releases the switches. When we start to follow the path of current on the electrical schematic one of the things you have to keep in mind; is the switch activated or released?

Figure 5
Standard Relay

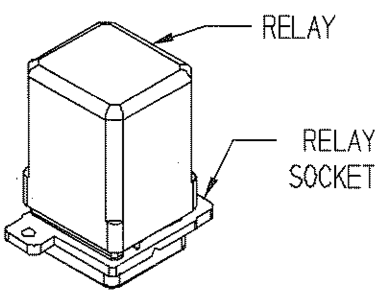



Figure 6
Standard Relay
Schematic Symbol
Shown Released

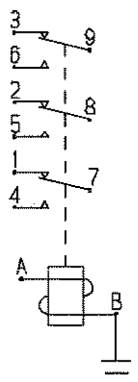



Figure 7
Standard Relay
Schematic Symbol
Shown Set

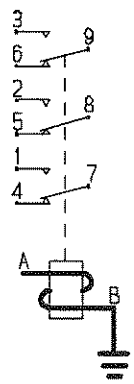


Figure 8
Magnetic Latching Relay

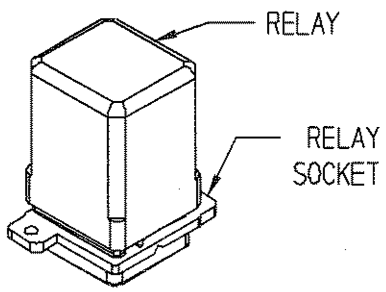



Figure 9
Magnetic Latching Relay
Schematic Symbol
Shown Released

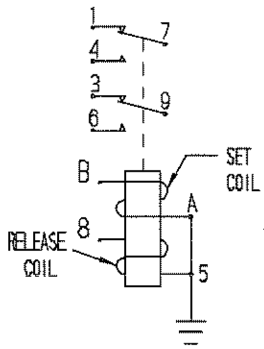
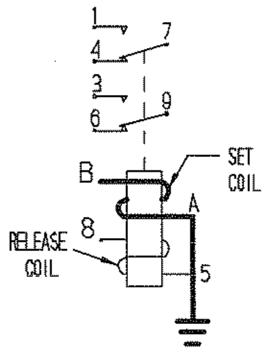



Figure 10
Magnetic Latching Relay
Schematic Symbol
Shown Set




The 1592 Big Baler uses 14 relays, 4 are magnetic latching, 2 are standard relays with 3 poles, and the other 8 are standard relays with a single pole. Figure 5, 6 & 7 show a triple pole standard relay and figure 8, 9, & 10 show a magnetic latching relay.

If you look at the magnetic latching relay and the 3 pole standard relay when they are mounted in the control box it is difficult to tell the difference. If you remove the relay from the socket; on close inspection you will see the magnetic latching relay has 2 coils and the standard relay has one. This is also the same on the schematic. A magnetic latching relay will have two coils and a standard relay has only one coil.

A coil is a wound spiral of insulated wire. When 12 Volts DC is applied to one end of the wire and a ground connected to the other end the flow of electrical current creates an electro-magnetic force. This magnetic force pulls a plunger in the center of the coil which switches the contact position in the relay.

In figure 6 the standard relay is shown in the released position (with relays we use the terms Set & Released). When the coil is connected to 12 Volts DC the contacts in the relay change positions. In figure 7 the heavy line running through the coil is meant to indicate that current is passing through it (in the upcoming pages of schematics heavy lines indicate that there is 12 Volts DC applied to the circuit).

In figure 6, contact 9 is connected to contact 3. If there were 12 Volts DC were connected to contact number 9 and a light was connected to contact number 3; the light will illuminate. When 12 Volts DC is applied to the A Terminal, and the B Terminal is connected to a ground source, (see figure 7) the relay sets and contact number 9 connects to contact number 6. The light would go out and if there was some other component attached to contact 6 it would receive 12 Volts DC. When the 12 Volts DC is removed from Terminal A the relay returns to its released position as shown in figure 6. A standard relay is like a coil activated switch; when 12 Volts DC are applied to coil the relay will set, when you remove the 12 Volts DC the relay releases.

In the upcoming pages you will see on the electrical schematic that all the relays except relays 4, 12 and relay 13 are always connected to ground and 12 Volts DC is either applied or removed from the coils to set or release the relay. Relays 4, 12, & 13 are always connected to 12 Volts DC and are controlled by either applying or removing the ground.

The magnetic latching relay (see figure 8, 9, & 10) operates almost the same as a standard relay with one exception. It requires 12 Volts DC to set it and 12 Volts DC to release it. If 12 Volts DC is applied to Terminal B (figure 10) and a ground is connected to Terminal A the magnetic latching relay sets, and will stay that way forever. An internal mechanical magnet keeps the relay set.

The only way for the magnetic latching relay to release is to remove the voltage applied to Terminal B and apply 12 Volts DC to Terminal 8 and a ground to Terminal 5 and vice versa. Only one terminal, either B or 8 can have 12 Volts DC applied to them at one time. If 12 Volts DC is applied to Terminal B and is not removed the relay will stay in the set position even when 12 Volts DC is applied to Terminal 8.

On most schematics the relays are always shown in the released position as it takes an action or 12 Volts DC to set a relay. All J. A. Freeman & Son, schematics that you receive with a new piece of equipment are illustrated as if the machine is at rest, with the power turned off. In the upcoming pages of this guide a heavier line running though the coil indicates that 12 Volts DC has been applied and the relay has changed to the set position. The schematics in this guide will have current paths highlighted which make it easier to follow the path, but the path is easier followed on the full size schematics that you received with your machine.

Figure 11
Standard Relay
Single Pole Set & Released

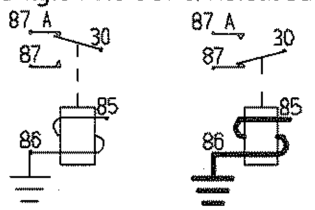
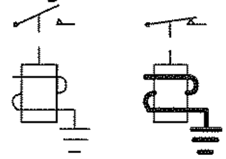



Figure 12
Standard Relay
Single Pole Single Throw; Set & Released



Figures 11 & 12 show other variations of a standard relay, these relays operate the same as all the standard relays. The difference between these relays is the number of usable contacts in the relay.

When we start to follow the path of current on the electrical schematic this is another item you have to store in the back of your mind. Has an action occurred (usually a limit switch being activated or released) that has added or taken away the voltage from a relay coil? If voltage has been applied then the relay changes position and becomes set, voltage removed releases the relay, if it is a standard relay.

In the upcoming pages when the circuit path is highlighted indicating 12 Volts DC is applied, the schematics in this guide will illustrate the relay as being set or released for clarity.

Figure 13
Adjustable Resistor

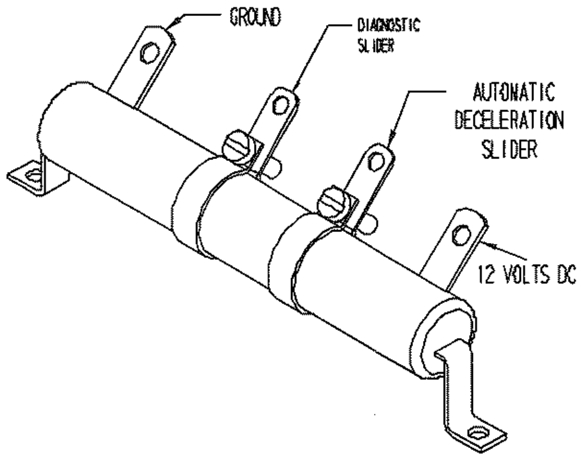



Figure 14
Adjustable Resistor
Schematic Symbol

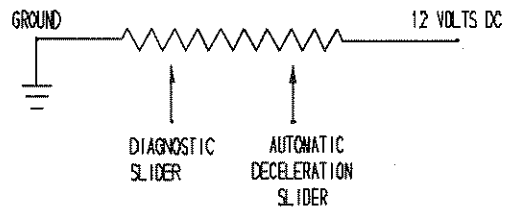



Figure 14 shows a schematic symbol for an adjustable resistor, one end is connected to 12 Volts DC and the other to ground. If you used your multi-meter with the negative lead on ground and the positive lead at the center of this resistor you would read 6 Volts DC. If you moved your positive lead to the automatic deceleration slider you would read approximately 10 Volts DC. If you moved your positive lead to the diagnostic slider you would read approximately 2 Volts DC.

The plunger cylinder on the 1592 Big Baler is extended and retracted by a variable displacement (hydrostatic) pump that pumps between 0 and 80 GPM (gallons of hydraulic oil per minute). <u>Controlling the amount of voltage that is supplied to the control coil of the pump determines how much oil is pumped into the plunger cylinder.</u>

The control coil on the hydrostatic pump is the only component on the baler that functions at less than 12 Volts DC. The hydrostatic pump will pump 80 GPM with 6 Volts DC applied to the control coil. As we approach the completion of the plungers 30" stroke; either extending or retracting, the voltage being supplied to the control coil is reduced which de-strokes the pump. This is turn slows down the speed of the plunger which allows a more controlled stop and return, we call this decel or deceleration. This will be explained in more depth in the upcoming pages.

Figure 15
Hydrostatic Pump Controller

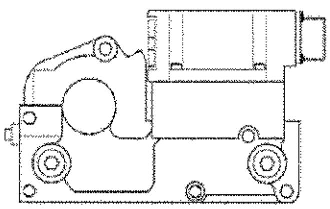


Figure 16
Hydrostatic Pump Controller Schematic Symbol

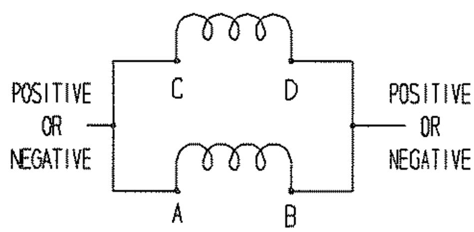


Figure 15 and 16 show the hydrostatic pump controller. The pump controller consists of two coils that act together to operate a small pilot valve in the controller. The more voltage that is applied to the coils, the stronger the magnetic field that pulls or pushes (bi-directional) on the pilot valve; which allows the pilot valve to open more and direct more hydraulic oil pressure to the pump servo cylinders. This in turn pumps more oil to the plunger cylinder.

The hydrostatic pump and controller will be discussed in more depth in the hydraulic section of this guide. For reading and understanding the electrical schematic we just need to know 3 things about the controller.

1. When voltage is applied to the controller the pump will go into stroke & pump oil.
2. The more voltage that is applied the more oil the hydrostatic pump will pump.
3. The controller is bi-directional. When the plunger extends Terminals A & C are positive and Terminals B & D are negative. This connection has a positive or pulling magnetic effect of the pilot valve in the controller. When the pilot valve is offset in the pulled direction the oil pressure is delivered to the servo cylinders and they are offset in the direction for the hydrostatic pump to deliver oil out the extend side. After the extend stroke is completed a relay is released and Terminals A & C become the negative connection for the controller coil, and Terminals B & D become the positive connection. With current flowing this direction the magnetic field is reversed and it has a reverse or pushing effect on the pilot valve in the controller. When the pilot valve is offset in this direction it directs oil pressure to the opposite end of the servo cylinders which offset in the direction for the hydrostatic pump to deliver oil out the retract side.

Figure 17
Hydraulic Oil Cooling Fan
Sequence Board

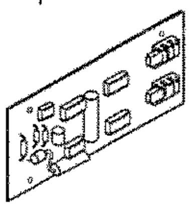
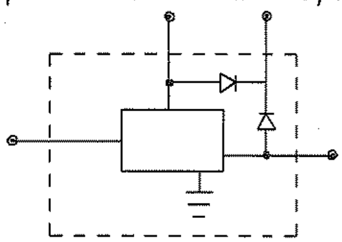


Figure 18
Hydraulic Oil Cooling Fan
Sequence Board Schematic Symbol



Figures 17 & 18 show the hydraulic oil cooling fan sequence board assembly. The board assembly is a printed circuit board (PCB). The hydraulic oil cooling fan on the baler cycles sequentially to pull air through the hydraulic oil cooler and then reverses to blow off any chaff accumulation from the grill screens that protect the hydraulic oil cooler. The fan will pull air through the cooler for approximately 6 minutes; it will shut down for approximately 15 seconds to allow the fan to stop rotating; it blows air back through the cooler for approximately 15 seconds; stops again for 15 seconds and starts the sequence again. The PCB controls this function with by providing a ground to the relays at the intervals that are programmed into the board.

Figure 19
Solenoid Operated Hydraulic Directional Valve

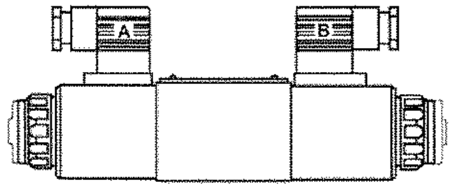



Figure 20
Solenoid Operated Hydraulic Directional Valve

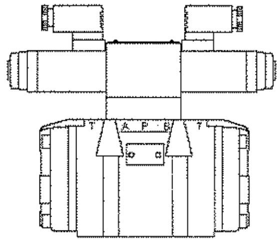


Figure 21
Solenoid Operated Hydraulic Directional Valve

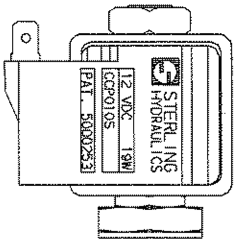



Figure 22
Solenoid Operated Hydraulic Directional Valve
Schematic Symbol

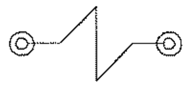
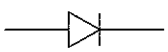
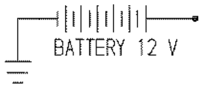


Figure 19, 20, & 21 show variations of a solenoid operated directional valve. They are different in outward appearance but all perform the same on an electrical system, and share the same schematic symbol. When the solenoid (coil) of these valves is energized they direct hydraulic oil flow to a component such as a motor (will rotate) or cylinder (will extend or retract). The schematic symbol will have a description of the function this symbol represents. IE: Feeder Forward - when 12 Volts DC is applied to this solenoid the feeder is going to rotate forward.

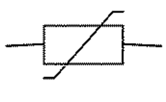
The remaining electrical symbols are rather simple. Each will have a brief explanation for to familiarize you with them. The diode and surge suppressor are not visible when you look for them on the machine. They are soldered or wired into the logic that makes up the relay panel. But when we start reading and following the paths on the electrical schematic you may need to know what some of these items are.



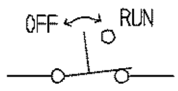
Diode: An electrical device that will allow current to pass through itself in one direction only. Current will pass through in the direction of the arrow. Similar to a check valve in a hydraulic circuit.



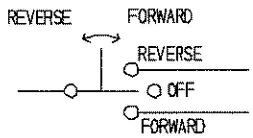

Battery: Most times it will be 12 volts unless otherwise noted.



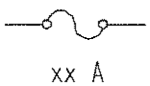
Surge Suppressor: Prevent pitting of relay contacts. When the contacts "break" (open) this suppressor limits the amount of arc that is emitted thereby reducing the pitting of relay contacts.




Two Positions Manually Operated Switch: This could be any number of switches to turn a function on or off.

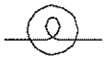



Three Positions Manually Operated Switch: This could be a number of switches to manually reverse, or retract or turn off a component.



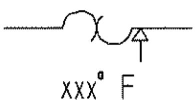

Fuse: xx will be replaced with the amp rating of the fuse.


Circuit Breaker: An automatic switch that stops the flow of electric current in a suddenly overloaded or otherwise abnormally stressed electric circuit. Somewhat like a fuse, only will reset itself when it cools down. The xx will be replaced with the amp rating of the circuit breaker.

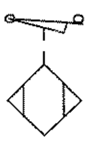


Light: When 12 Volts DC is connected to one end and a ground to the other, light will illuminate.

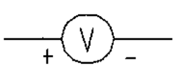

Electric Fan Motor: Knotter or hydraulic oil cooling fan. 12 Volts DC applied to one lead and a ground to the other, fan will rotate.



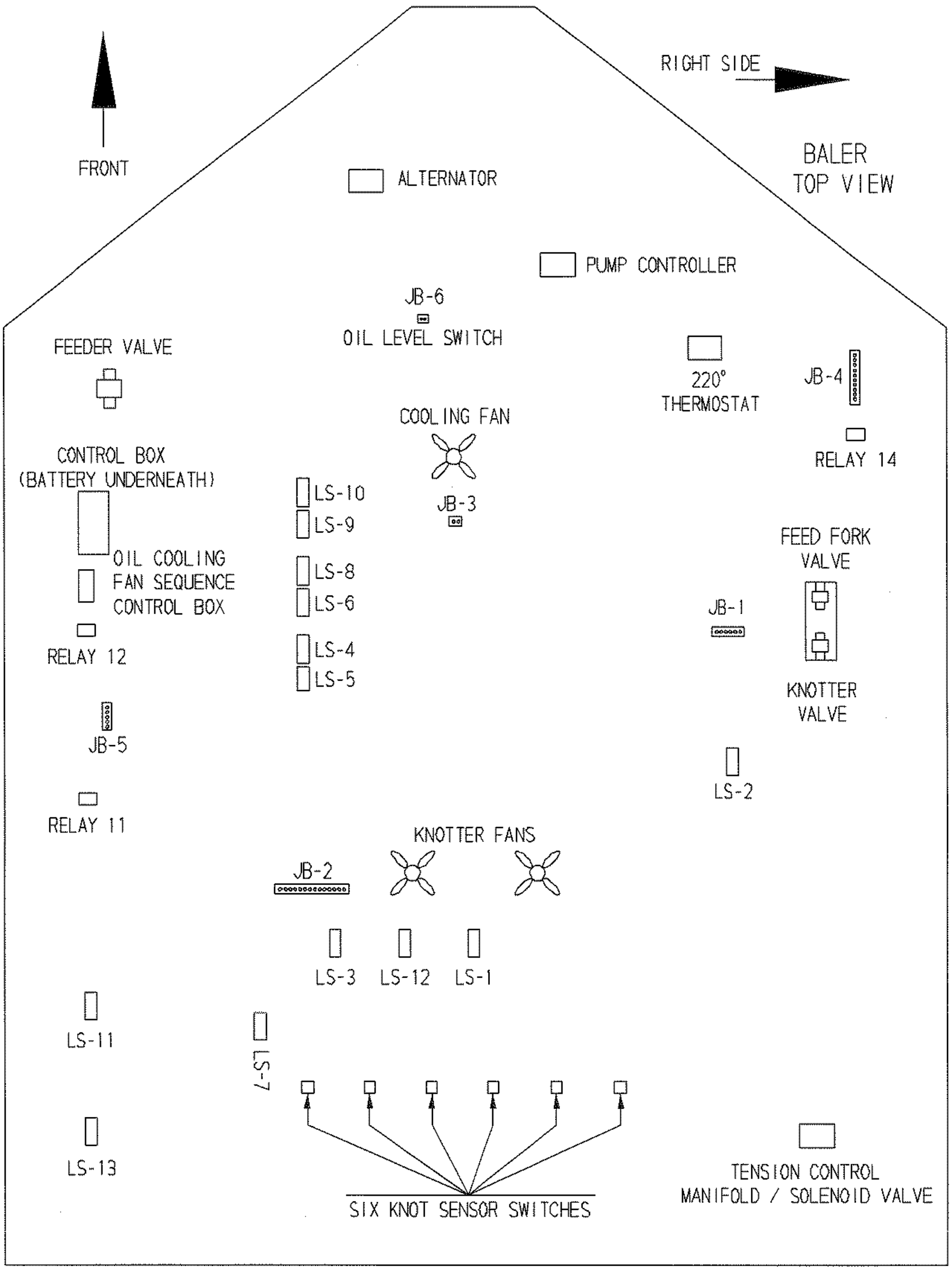

Thermostat: xxx would be replaced by the degree (220°) Fahrenheit that the thermostat would open. Depicted by the arrow pointing up (opens on rising temperature). As shown the contacts in the thermostat are closed and the oil temperature is below the opening setting of the thermostat.



Oil Level Switch: Switch is shown closed and baler would be full of oil. Switch will open on low oil. The oil in this case is the cam pushing on the switch operator.




Voltmeter: Measures the voltage being produced by the alternator, or stored in the battery.



FRONT
RIGHT SIDE
BALER
TOP VIEW
ALTERNATOR
PUMP CONTROLLER
JB-6
OIL LEVEL SWITCH
FEEDER VALVE
220°
THERMOSTAT
JB-4
COOLING FAN
RELAY 14
CONTROL BOX
(BATTERY UNDERNEATH)
LS-10
LS-9
JB-3
FEED FORK
VALVE
OIL COOLING
FAN SEQUENCE
CONTROL BOX
LS-8
LS-6
JB-1
RELAY 12
LS-4
LS-5
KNOTTER
VALVE
JB-5
LS-2
RELAY 11
KNOTTER FANS
JB-2
LS-3
LS-12
LS-1
LS-11
LS-7
LS-13
TENSION CONTROL
MANIFOLD / SOLENOID VALVE
SIX KNOT SENSOR SWITCHES

## ELECTRICAL COMPONENTS LOCATIONS

LS-1 - Knotter Stop / Plunger Safety Switch is located on top of the baler, forward of the knotter. This switch is an 8 post limit switch & has two functions; stops the knotter at the end of the knotter cycle & prevents the plunger from extending if the knotter is away from the home position (works in series with LS-13). LS-1 is shown on the schematic activated as the knotter is in the home position.

LS-2 - Plunger Delay Feedfork Stop Switch is located on the right-hand side of the baler, inboard of the feedfork driven sprocket. Shown on the schematic released as the feedfork has to rotate to its highest position in the chamber to activate it.

LS-3 - Full Charge Switch is located to the left of LS-1 on the top of the baler. It is activated by the feed sensor paddles when the chamber is full of hay. It works in conjunction with LS-2 to set relay one. When relay one is set the feedfork will stop and the plunger will extend. Shown on the schematic released as hay has to lift the feed sensor paddles to activate it.

LS-4 - Plunger Advance Stroke Deceleration & Knotter Arming Switch is located under the left-hand side of the plunger second from the rear. This switch is an 8 post limit switch & has two functions; slows the plungers advancing speed just before the plunger reverses direction & it ensures that relay 3 is set only when the plunger is at full extension. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-5 - Plunger Return Switch is located under the left-hand side of the plunger furthest to the rear. It signals the end of the plungers extend stroke. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-6 - Plunger Return Delay Switch is located under the left-hand side of the plunger and is the third switch from the rear. It prevents the plunger from completely retracting until the knotter has completed 1/2 of the knotter cycle. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-7 Knotter Reverse Safety Switch is located to the inside of the knotter driven sprocket on the top left-hand side of baler. It prevents the knotter from rotating in the reverse direction while the billhook is turning. This is the only limit switch out of the 13 that does not have an automatic function. It is shown on the schematic as released as the knotter has to rotate to activate it.

LS-8 - Feedfork Start Switch is located under the left-hand side of the plunger and is the fourth switch from the rear. It starts the feedfork when the plunger is retracted approximately half of the way home. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-9 - Plunger Retract Stroke Deceleration is located under the left-hand side of the plunger and is the fifth switch from the rear. It slows the plungers retracting speed just before the plunger comes to rest in the home position. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-10 - Plunger Return Stoke Stop Switch is located under the left-hand side of the plunger and is the most forward of the six switches. It stops the plungers retract stoke in the home position. Shown on the schematic activated as the plunger is at rest (fully retracted).

LS-11 – Knotter Trip Switch is located on the left-hand side of the baler just forward of the service ladder. This switch is an 8 post limit switch & has two functions; it signals the knotter to cycle as the bale has advanced to the predetermined length & it signals the knotter to stop if the meter bar has not reset. Switch is shown on the schematic released as the meter bar has to rise to activate it.

LS-12 – Knotter Cycle Plunger Start, Bale Count Switch is located on the top of the baler in between LS-1 & LS-3. It signals the plunger that the knotter has completed 1/2 of the knotter cycle and also signals the bale counter to advance one digit. Shown on the schematic released as the knotter activates it during the knotter cycle.

LS-13 – Needle Yoke Safety Switch is located to the rear of LS-11 on the left-hand side of the baler where the needle yoke pivots. This switch is an 8 post limit switch and prevents the plunger from advancing in both automatic and diagnostic modes if the knotter is out of the home position (works in series with LS-1). Shown on the schematic activated as the knotter is in the rest position.

## Junction Blocks

JB-1 – JB stands for junction block and the number 1 is the junction block identifier. Junction blocks are terminal connection points where various electrical components are connected to a single wire harness which is routed to the control box. JB-1 is the connection point for the feedfork & knotter solenoid valves. It is located to the rear of the hydraulic reservoir and to the left-hand side of the feedfork/knotter valves.

JB-2 is the connection point for LS-1, 2, 3 & 12. It is located to the left-hand forward side of LS-1, 12, & 3 on the top of the baler.

JB-3 is the connection point for the hydraulic oil cooling fan motor. It is located on the forward side of the hydraulic oil reservoir, behind the oil cooler.

JB-4 is the connection point for the low oil switch harness, 220° thermostat, and relay 14. It is located on the right-hand support mount for the oil cooler assembly.

JB-5 is the connection point for the work lights on the baler. It is located to the rear of the main control box.

JB-6 - is the connection point for the oil level switch. It is located on the front of the hydraulic oil reservoir.

## Externally Mounted Relays

Relays 1 - 10 are mounted in the main control box which is shown in the upcoming pages. There are four additional relays mounted elsewhere on the baler.

Relay 11 - Knotter Fan Relay is located to the rear of the control box below JB-5.

Relay 12 - Hydraulic Oil Cooling Fan Run Relay is located to the rear on the control box, above the hydraulic oil cooling fan sequence control box.

Relay 13 - Hydraulic Oil Cooling Fan Direction Relay is mounted inside of the hydraulic oil cooling fan sequence control box.

Relay 14 - Shut Down Relay is mounted to the rear of JB-4 on the left-hand side of baler forward of the hydraulic oil reservoir.

## Solenoid Operated Hydraulic Valves

The feeder directional control valve is located on the left-hand side of the machine inside the shield to the front on the twine box.

The hydrostatic pump controller is located under the drive unit shied at the front of the baler on the right-hand side of the pump.

The feedfork and knotter directional control valves are both attached to the feedfork/knotter hydraulic manifold. This manifold mounts to the top right-hand frame angle just behind the twine box.

The tension control solenoid valve is located at the right-hand rear corner in the tension control manifold assembly.

## Miscellaneous Components

The baler control box and the cooling fan sequence control box are located on the left-hand side of the baler below the twine box.

The battery is mounted directly below the control boxes.

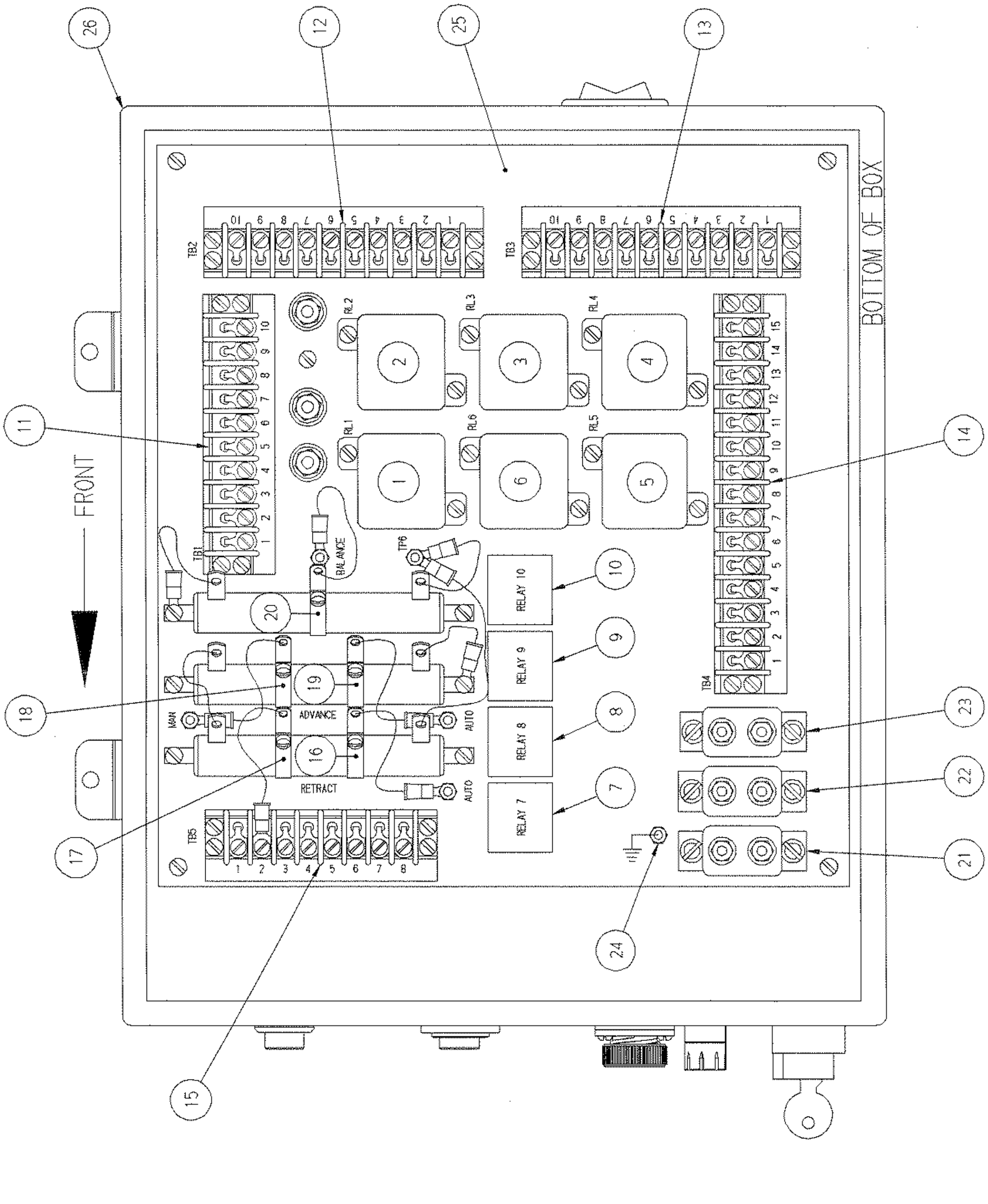
The oil level switch is located on the front of the hydraulic oil reservoir.

The 220° oil thermostat is located on the bottom of the hydraulic oil reservoir on the lower right-hand side.

The hydraulic oil cooling fan is located on the front side of the hydraulic oil reservoir, behind the oil cooler.

The knotter cleaning fan and the six knot sensor switches are on top of the baler above and to the rear of the knotter assembly.

# BALER CONTROL BOX



## BALER CONTROL BOX COMPONENTS

When you open the cover on the baler control box it will look similar to the picture to the left. The wires that enter the control box and connect to the various components have been omitted for clarity. The control box components in the picture are numbered 1 - 24 and are described below.

The electrical schematic (received in the document package with your baler) is labeled in the lower right-hand corner with a part number: DOC036188E. The electrical schematic drawing has a series of numbers and letters arranged on the outer edges of the sheet, similar to a map. These numbers and letters define coordinates that will allow us to pinpoint components for you and make them easier to find. In parentheses below are the coordinate locations for the components.

Example: to find relay 1 (F3) on the schematic go across the top from left to right and find F (A is on the left). On the left-hand side of the schematic go down to 3 (1 is on the top). If you were to draw a line down the schematic from F and a line across from 3 the lines would cross in the vicinity of relay 1.

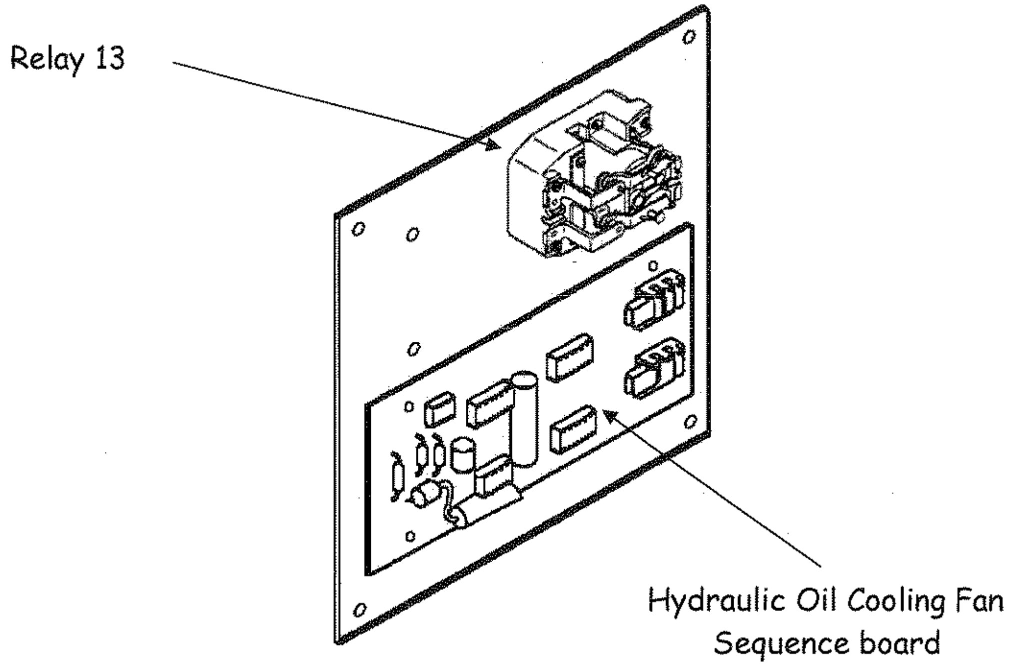
1. Relay 1 (F3) - magnetic latching relay. When this relay is set the feedfork will stop and the plunger will advance. When it is released the plunger will retract. This relay must be released for the feedfork or knotter to function.
2. Relay 2 (E3) - magnetic latching relay. This relay is used only during a knotter cycle. When it is set the plunger will retract approximately 9", stop, and wait for the knotter to complete half of its cycle. Halfway through the knotter cycle relay 2 is released and the plunger retracts to the home position.
3. Relay 3 (E6) - magnetic latching relay. This relay is also only used when the knotter cycles. When relay 3 is set the knotter will cycle, and when it is released the knotter stops.
4. Relay 4 (C2) - standard relay (triple pole). When this relay is set the plunger will retract at full speed. When it is released the plunger retract speed slows down to the decelerated speed setting.
5. Relay 5 (G2) - standard relay (triple pole). When this relay is set the baler is in the automatic mode. When it is released the baler is in the manual mode. The plunger will retract and extend using the diagnostic controller or the manual plunger extend & retract switch on the remote control box located in the tractor.
6. Relay 6 (F4) - magnetic latching relay. When this relay is set the tension control solenoid valve is energized. The valve closes and applies hydraulic oil pressure to the tension cylinders that then restrict the bale from advancing out of the bale chamber. When the relay is released the valve opens; hydraulic pressure in the tension cylinders is maintained but no pressure is added.
7. Relay 7 (K1) - standard relay (single pole). When this relay is set the work lights on the baler illuminate, released they are turned off.
8. Relay 8 (G6) - standard relay (single pole). When this relay is set the feeder rotates forward, when it is released the feeder rotation stops.

9. Relay 9 (G7) - standard relay (single pole). When this relay is set the feeder rotates backward, when it is released the feeder rotation stops.
10. Relay 10 (G4) - standard relay (single pole). This relay performs the same as relay 6, but only when the plunger is manually operated from the remote control box. It does not function in the automatic mode.

TERMINAL BLOCKS

11. TB-1, TB stands for terminal block and the number 1 is the terminal block identifier. Terminal blocks are similar to junction blocks in function, but are different in appearance and location. Junction blocks are located external of a control box and terminal blocks (TB) are an internal connection point for components in the control box to the wire harnesses that are receiving or delivering signals to the components on the baler. If you look in coordinate A-1 you will see the Sundstrand pump controller with a line connection point of TB1-1. In the baler control box this connection point is on the top terminal block labeled TB-1 and would be the first terminal on the left. TB-1-2 (B1) would be the connection point to the right of TB-1-1 on the terminal block in the baler control box. The TB and JB connection points that are called out on the schematic are convenient test points to tell if voltage is being sent to and or received by the various components on the baler. 95% of all electrical troubleshooting testing can be accomplished using the TB connection points.
12. TB-2 - terminal block number 2, TB2-1 is on the bottom and TB-2-10 is on top.
13. TB-3 - terminal block number 3. TB3-1 is on the bottom and TB-3-10 is on top.
14. TB-4 - terminal block number 4. TB4-1 is on the left and TB4-15 is on the right.
15. TB-5 - terminal block number 5. TB5-1 is on the top and TB-5-8 is on the bottom.
16. Plunger automatic mode; retract stroke decelerated speed (voltage) adjusting slider.
17. Plunger manual/diagnostic mode; retracting speed (voltage) adjusting slider.
18. Plunger manual/diagnostic mode; extending speed (voltage) adjusting slider.
19. Plunger automatic mode; extend stroke decelerated speed (voltage) adjusting slider.
20. Hydrostatic pump 6 Volt DC supply source. One side of the hydrostatic pump controller is always connected to this resistor (TB-1-1). Remember the hydrostatic pump controller is the only component on the baler that operates at less than 12 Volts DC. This 6 Volts DC supply source is preset from the factory and should never have to be adjusted.
21. Baler work lights 30 Amp circuit breaker.
22. Knotter blower fan 30 Amp circuit breaker.
23. Hydraulic oil cooling fan 30 Amp circuit breaker.
24. Ground connection point for components mounted on the control panel assembly.
25. PNL036047E - Control Panel Assembly.
26. BOX036050E - Baler Control Box Assembly.

# HYDRAULIC OIL COOLING FAN SEQUENCE CONTROL BOX




The hydraulic oil cooling fan control box contains two major components. The cooling fan sequence board and relay 13. Relay 13 is a standard relay (double pole). When it is released the cooling fan rotates forward and pulls air through the cooler. When it is set the fan reverses and blows chaff and debris off the grill screens. The wires and connection points have been omitted in this picture for clarity. See DOC036186E - Baler Control Wiring Diagram (coordinates B, C, & D - 7, 8 & 9) for wire locations and connections.

Remote Control Box, Tractor Mounted

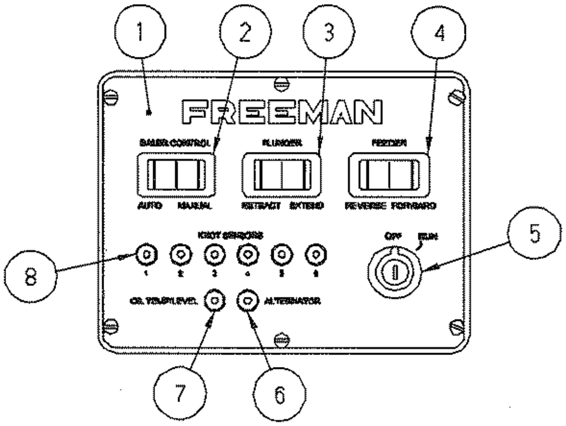



Figure 23

1. Remote Control Box, BOX036041E
2. Baler Control; Automatic/Manual
3. Manual Plunger Control; Advance/Retract
4. Feeder Control; Forward/Neutral/ Reverse
5. Key Switch; Off/Run
6. Alternator Warning Light
7. Low Oil level /Oil Over Temperature Warning Light
8. Knot Monitor Indicator Lights (6)

Baler Control Box, Baler Mounted

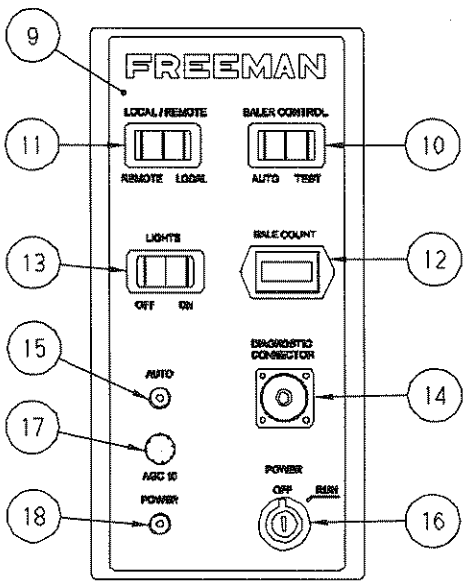
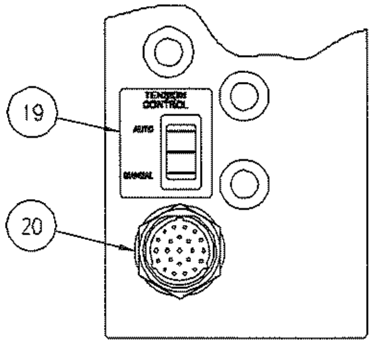



Figure 24

9. Baler Control Box, BOX036050E
10. Baler Control; Automatic/Test
11. Local Control (baler) or Remote (from Tractor)
12. Bale Counter
13. Work Lights; On/Off
14. Diagnostic (test) Controller Connector
15. Automatic Functions Indicator Light
16. Power Key Switch; Off/Run
17. 10 Amp Control Circuit Fuse
18. Power On Indicator Lamp

Rear View of Baler Control Box (above)



19. Tension Control; Automatic/Manual
20. Remote Control Box Harness Connection Plug

Figure 25
Diagnostic (test) Controller

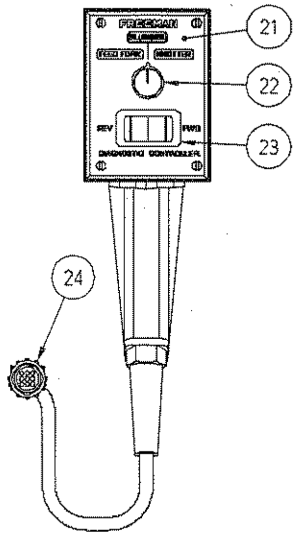



Figure 26

21. Diagnostic (test) controller, BOX0035238
22. Function Selector Switch ; Knotter, Feedfork, Plunger
23. Direction Switch; Forward, Neutral, Reverse
24. Diagnostic Controller Connection Plug

Baler Controls

Starting with 1592 Baler S/N: 0616 the baler is able to operate without the remote control box, (figure 23); some of the functions are limited, but you are able to bale until the necessary repairs are made. On balers S/N: 0500 - 0615 the remote box was required for the baler to operate in automatic, diagnostic or manual.

With the tractor mounted remote control box connected to the baler control box via the remote control box harness follow the sequence below to operate the baler using the remote control box;

1. Figure 25, item # 19 Tension Control; set to automatic (located on rear of box).
2. Figure 24;
    a. Item # 10, Baler Control, set to automatic
    b. Item # 11, Local/Remote, set to remote
    c. Item # 16, Key Switch, set to run. At this time the power indicator (item # 18) should be illuminated.
3. Start the tractor and engage PTO at the lowest engine RPM possible.
4. Figure 23;
    a. Item # 5, Key Switch, set to run
    b. Item # 4, Feeder Control, set to forward.
    c. Item # 2, Baler Control set to automatic, at this time the automatic indicator light (item # 15, figure 24) should be illuminated.

The baler is now functioning in the automatic mode; the pickup, feeder, and feedfork are rotating; operate the baler as described in the owner's operator manual.

The feeder is reversible using the feeder control switch (item # 4, figure 23) mounted on the remote control box. The feeder control switch is a three position switch; Forward is maintained, neutral (switch centered) is maintained, & reverse is momentary. If the pickup and feeder stop rotating (plugged from overfeeding) press and hold the feeder control switch in the reverse position. At this time the feeder will reverse and the material that was plugging the feeder will be ejected forward onto the pickup. When the feeder control switch is released it will return to neutral and all feeder motion stops. Set the feeder control switch to the forward position. The feeder will then once again rotate forward and the crop should enter the feedfork area. NOTE: It is not necessary to switch the remote control box to manual to operate the feeder in reverse. The manual function on the remote control box is only for the plunger operation.

If the feedfork has become plugged and reversing the feeder did not clear the plug; the plunger can be advanced and retracted using the remote control box. Set the baler control switch (item # 2, figure 23) to manual. This stops all movement of the feeder and feedfork. Press and hold the manual plunger switch (item # 3, figure 23) in the advance position. The plunger will advance and clear the bale chamber of material. Release the manual plunger switch; set the baler control switch back to automatic. The plunger will retract, and the pickup, feeder, & feedfork will all start and in most cases operation can be resumed.

If the above procedures did not solve the problem it may be necessary to inspect an individual baler operation using the diagnostic controller (item # 21, figure 26)

**CAUTION: When using the diagnostic controller take extreme caution. Stay clear of all moving, and rotating parts. Please!**
**In addition; before you cycle the knotter using the diagnostic controller extend the plunger first to clear the chamber of hay. If the needles are cycled and they encounter material in the chamber, they can be deflected and possibly damaged.**

When using the diagnostic controller always try to run the PTO at the lowest possible RPM to avoid equipment damage. This is extremely important when moving the knotter/needle yoke. Slower RPM provides less oil flow to the knotter hydraulic motor, giving smoother operation and control, and lessens the chance of breaking a needle.

The diagnostic controller plugs into the diagnostic controller connector (item # 14 on the baler control box, figure 24). Rotate the connector cover counter clockwise to remove, and attach the diagnostic controller connection plug (item # 24, figure 26). Turn the connector nut clockwise onto the connector on the baler control box. Set the local/remote switch (item # 11, figure 24) to local. Set the baler control switch (item # 10, figure 24) to test.

Rotate the function selector (item # 22, figure 26) to the desired component; Feedfork, Knotter or Plunger. Depress and hold the direction switch (item # 23, figure 26) in the direction the component needs to rotate. Releasing the direction switch stops the component in that location. If a precise location is necessary, press and release the direction switch either forward or reverse; quickly until position is achieved. This method of movement may be necessary when performing knotter adjustments, specifically the twine fingers. NOTE: When "jogging" the knotter into a specific location, rest long enough between pressing the direction switch until all needle vibration has stopped.

To resume baling remove the diagnostic controller from the baler control box and store it in the tool box of the baler. Reattach the diagnostic connector cover on the baler control box. Set the local/remote switch (item # 11, figure 24) to remote. Set the baler control switch (item # 10, figure 24) to automatic and resume baling.

The remote control box also contains indicator lights for the knotter, alternator and low oil level/oil over temperature (items # 6, 7, 8, figure 24).

The alternator indicator light (item # 6) will illuminate when the alternator is providing less than 8 volts. The baler requires 12 volts to operate at peak efficiency.

If the hydraulic oil level drops below a safe operating zone, or if the oil temperature raises above 220° the low oil level/oil over temperature indicator light (item # 7) illuminates. At this time all functions; automatic, manual & diagnostic will cease to function. The operation and function of this safety feature is discussed in more depth in the upcoming pages of this manual.

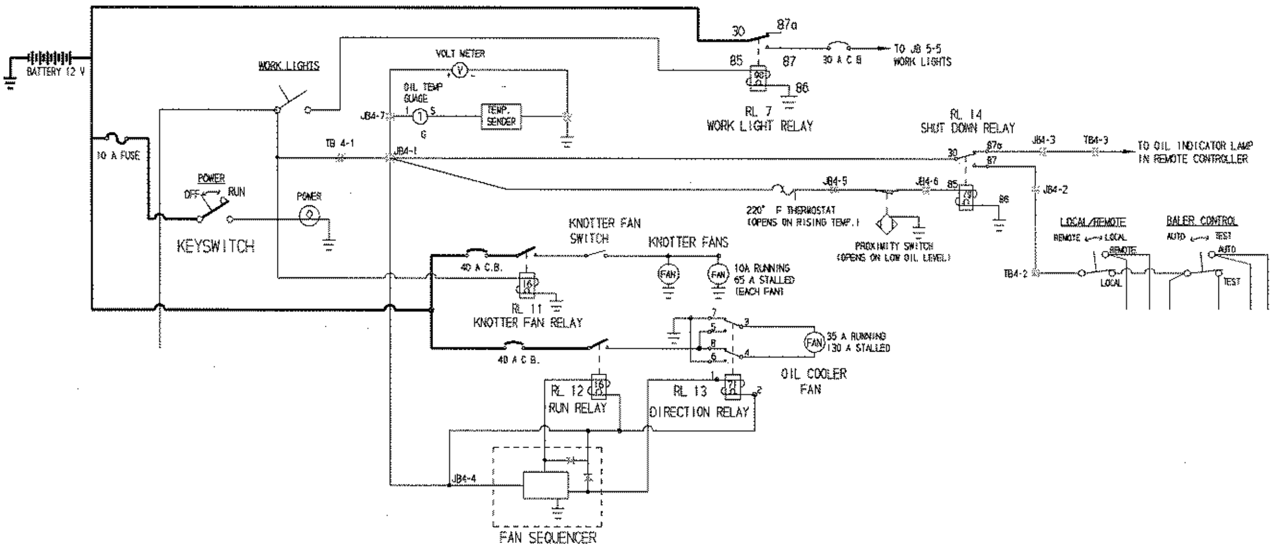
Each time the knotter cycles the six knot sensor indicator lights illuminate (item # 8). As the bale is moved by progressive plunger stokes, a successfully tied knot trips the knot sensor switch which will turn the individual indicator light off. An indicator light that remains on after several plunger stokes indicates a missed or poorly tied knot that needs to be investigated. Each knot sensor light is numbered one through six. The knotters are numbered on the baler with number one on the left-hand side.

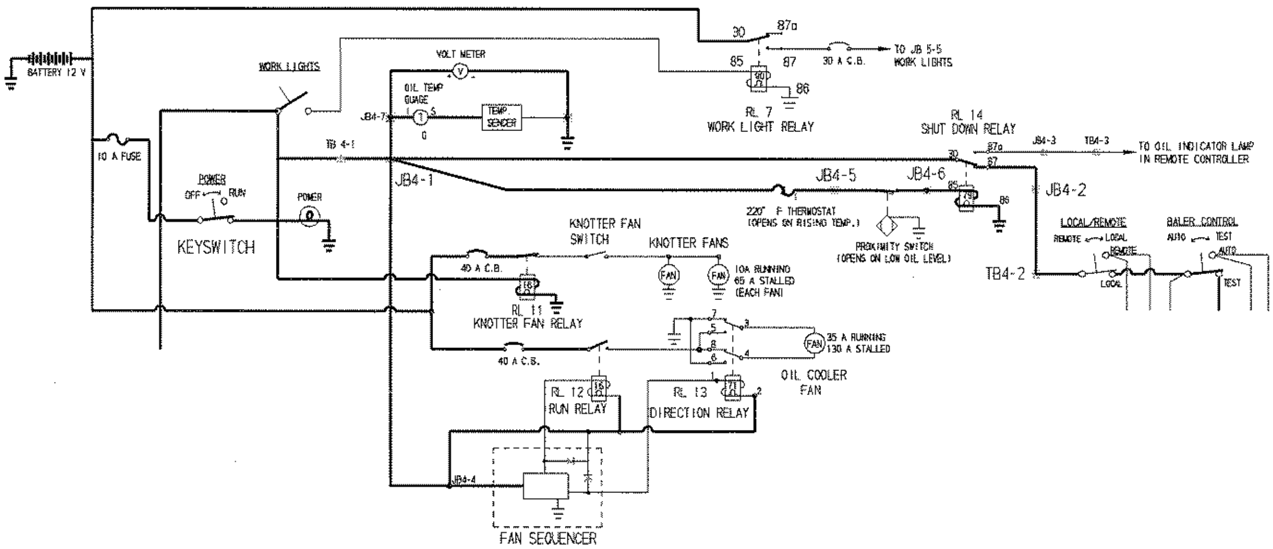
If the remote control box is damaged or is unavailable the baler will operate as described above, but; there would be no manual reversing control of the feeder, no knot sensor, and no alternator monitoring. The low oil level & the oil over temperature safety features are still operational, and if either of these conditions arises the baler will still shut down. To operate without the remote control box switch the local/remote switch to local and the baler control switch to automatic (items # 10 & 11, figure 24) and operate the baler until the problem with the remote control box is rectified.

On the rear of the baler control box, figure 25, is the Tension Control Switch. Starting with 1592 Baler S/N: 0616, the electrical control of the tension control system has changed; it is now necessary to apply 12 volts to energize the tension control solenoid valve. On baler S/N: 0000 - 0615, 12 volts was removed from the tension control solenoid valve which would then close the valve and allow hydraulic pressure to squeeze the rear tension rails.

The tension control switch is provided as a troubleshooting device and during normal baling operation will be in the automatic setting. The operation and function of the tension control system is discussed in more depth in the upcoming pages of this manual. When testing or troubleshooting the tension system keep the baler PTO above 500 RPM to avoid damage to the tension pump.

# BATTERY CONNECTED / POWER SWITCH TURNED ON



## BATTERY CONNECTED / POWER SWITCH TURNED ON

Note: the pictures to the left are partial areas of the electrical schematic for clarity. Use the full size documents you received with the baler to follow circuit paths. The pictures to the left are taken from the schematic to the right of G and above 5 (G5) coordinates.

The top picture shows the current path when the battery is connected and the power switch has not been not turned on. You can see that there are 12 volts available to relay 7 post 30, but the lights will not come on because the work light switch is open and is not providing 12 volts to the coil of relay 7. This is also the case with relay 11 (knotter fan) and relay 12 (cool fan). 12 volts is available to the relay contacts but the relay will not set and start the function until 12 volts is applied to the coil.

The bottom picture shows the same part of the circuit as the top, except now the baler operator (you) has turned on the power switch on the baler control box.

Now 12 volts is available to the work light switch. If the operator turns the work light switch on 12 volts will activate the coil of relay 7, the relay will set and there will be 12 volts at contact 87 of relay 7, and the lights illuminate.

12 Volts DC is also available at TB4-1 which is connected to JB4-1. Current has to pass through the 220° thermostat, the oil level switch, energize the coil of relay 14, and return to the control box to provide 12 volts to the local / remote switch so the baler can operate.

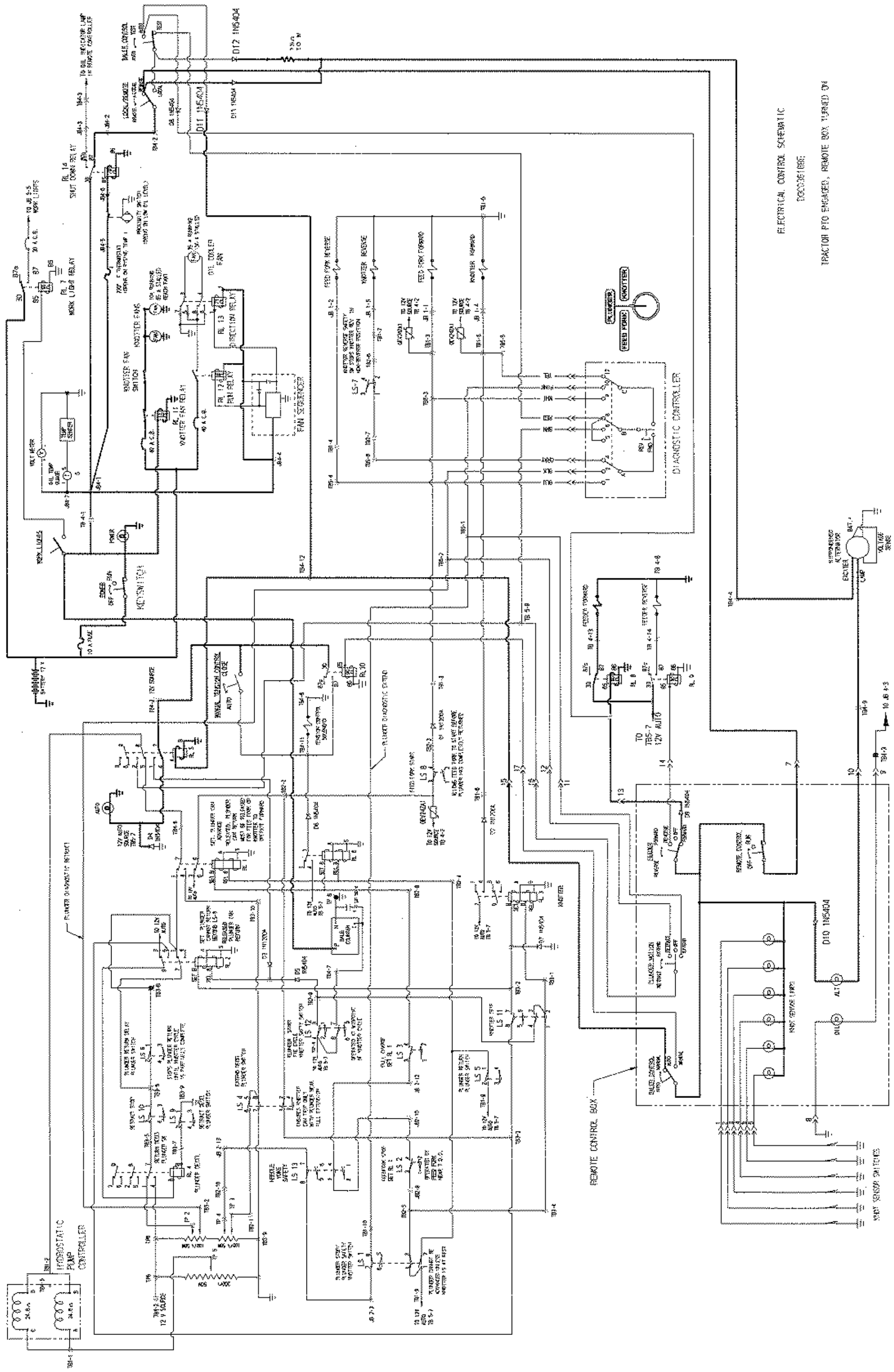
If the oil temperature is above 220° the thermostat would open and there would be no voltage available at JB4-5 and JB4-6 to energize the coil of relay 14. Likewise if the oil level drops to an unsafe level; the voltage path would stop at JB4-6 and relay 14 would not set.

If you suspect a problem with the oil level switch or the 220° thermostat the first point to check is TB4-2 in the baler control box. The baler PTO does not need to be engaged. Turn the power on at the control box. Using your 12 volt multi-meter; with the negative lead on a ground source and the positive lead TB4-2, the meter should read 12 volts.

If you find 12 Volts DC at TB4-2, relay 14 is set and the oil level switch and 220° thermostat are performing as they should. If you have no voltage at TB4-2 you will need to check voltage at JB4-5, JB4-6 and JB4-2 to determine which component is faulty. If there is no voltage at JB-4-5 the thermostat is open. If JB4-5 has voltage but there is no voltage at JB4-6 the oil level switch is open. If both of these have voltage but there is no voltage at JB4-2, relay 14 has not set. Possibly a defective coil or the contacts in the relay have failed. If you have voltage to JB4-2 but not at TB4-2 the problem is in the harness running from junction block # 2 back to the control box or possibly the connections.

There must be 12 Volts DC at TB4-2 for the automatic, manual, or the diagnostic functions on the baler to work.

# BALER PTO ENGAGED REMOTE CONTROL BOX ON



# BALER PTO ENGAGED REMOTE CONTROL BOX ON

In this view to the left the operator has switched the baler control box to remote, turned the remote control box on and switched it into automatic, has engaged the PTO and has set the feeder switch to forward.

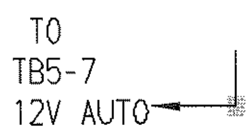
If you look at the local/remote switch (coordinate M2) when it was switched to remote there are two paths that voltage was applied. One path provides 12 volts to the remote control box and the other path connects to a third path. As you look at this third path the voltage does not travel back up to the baler control switch as diode 12 is preventing the voltage from passing through it. A diode will only allow voltage to pass through it in the direction of the arrow.

As you follow this path it goes through TB4-4 to the alternator, the PTO has been engaged and the alternator is producing in excess of 12 Volts DC. If you look at the alternator indicator light (coordinate D9) you will see it is not illuminated. This is because the alternator is providing 12 Volts on one side of the light and the other side of the light is connected to 12 Volts coming from the power switch of the remote control box. The alternator does not have a ground so it can not illuminate. If the alternator starts to fail and produce less then 12 Volts DC the light will start to illuminate and when the alternator is producing no voltage at all the light has a solid ground and will illuminate fully.

The knot sensor lights (coordinate D & E 8) are not illuminated as the knotter has not cycled to activate the knot sensor switches. When the knotter cycles the switches activate providing a ground for the lights and the lights illuminate. As the bale advances out the rear the twine will pull and release the knot sensor switch which removes the ground from the light and the light goes out.

When the remote control box automatic/manual switch (coordinate C7) was switched to automatic it provided 12 Volts DC to relay 5 (coordinate G3). The coil of relay 5 is energized and the relay sets turning on the automatic light (F2) on the front of the baler control box. When relay 5 sets it also connects the hydrostatic pump controller to the automatic circuit, versus the manual circuit. The pump will not go into stroke just yet as we have not loaded hay into the chamber to activate LS-3 and LS-2.

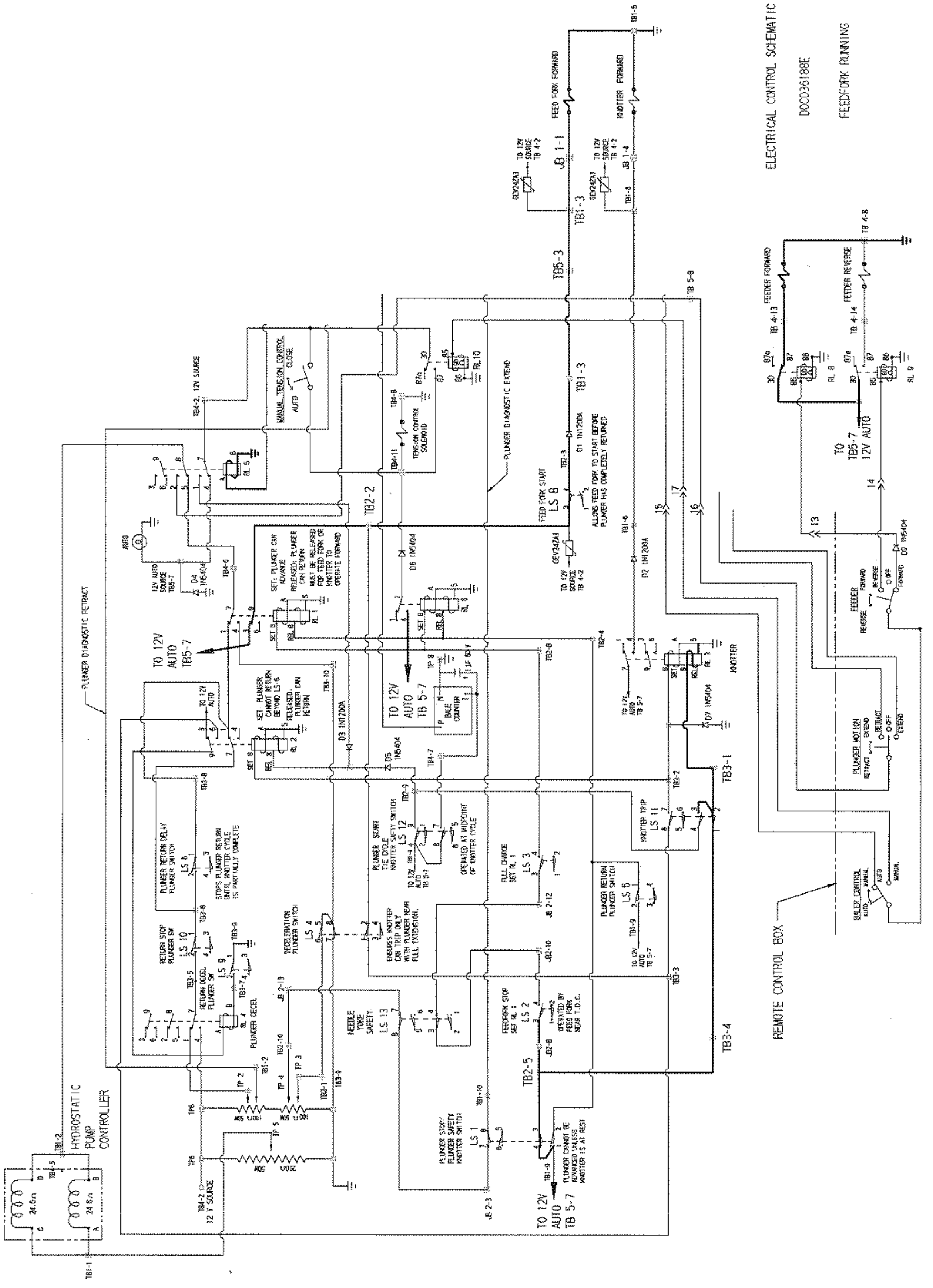
Look in the vicinity of G7 you will see relay 9 and this:




This means that this connection is at TB5-7. Instead of running additional lines on the schematic which would further clutter it we use this short cut. You will also see; TO TB4-2, 12 volt source. This is another short cut saying this connection is at TB4-2.

When relay 9 coil is energized by the feeder switch, 12 Volts DC was applied to the feeder forward solenoid valve and the feeder is operating forward.

# FEEDFORK RUNNING LOADING THE CHAMBER



# FEEDFORK RUNNING LOADING THE CHAMBER

In this view some of the earlier highlighting has been removed to simplify the circuit paths. In the upcoming sequence of functions the components we have discussed in the last 4 - 5 pages are still on and working. The baler is full of oil, the temperature is below 220°, and the alternator is producing 12 Volts DC. As we look at the function paths in the upcoming pages there will always be items you have to remember in the back of your mind; is this relay set or released, is this switch activated or released, is this coil energized and so on. The highlighting of the circuits will help you to remember but it may be necessary to turn back a few pages from time to time to refresh your memory.

The feeder is always running (relay 8 set) stuffing hay into the in-feed chute and the feedfork is running delivering hay into the bale chamber. The feedfork circuit path starts at relay 1 (coordinate F3). Contact 3 of relay 1 is connected to the 12 volt automatic source TB5-7. Relay 1 is released allowing the current to flow to TB2-2; out to LS-8 which is activated as the plunger is fully retracted and on down the path to the feedfork forward solenoid valve (coordinate k5). The solenoid valve is energized and hydraulic directional valve is delivering hydraulic oil to the feedfork motor.

This action will continue until there is sufficient crop gathered that the feedfork delivering this crop pushes up on the feed sensor paddles activating LS-3.

In this view we are only concerned with a few items, but they are extremely important. The knotter is at rest activating LS-1 (coordinate B4), and also activating LS-13 (coordinate C4). Both of these switches must be activated to provide a current path for 12 volts to energize relay 1.

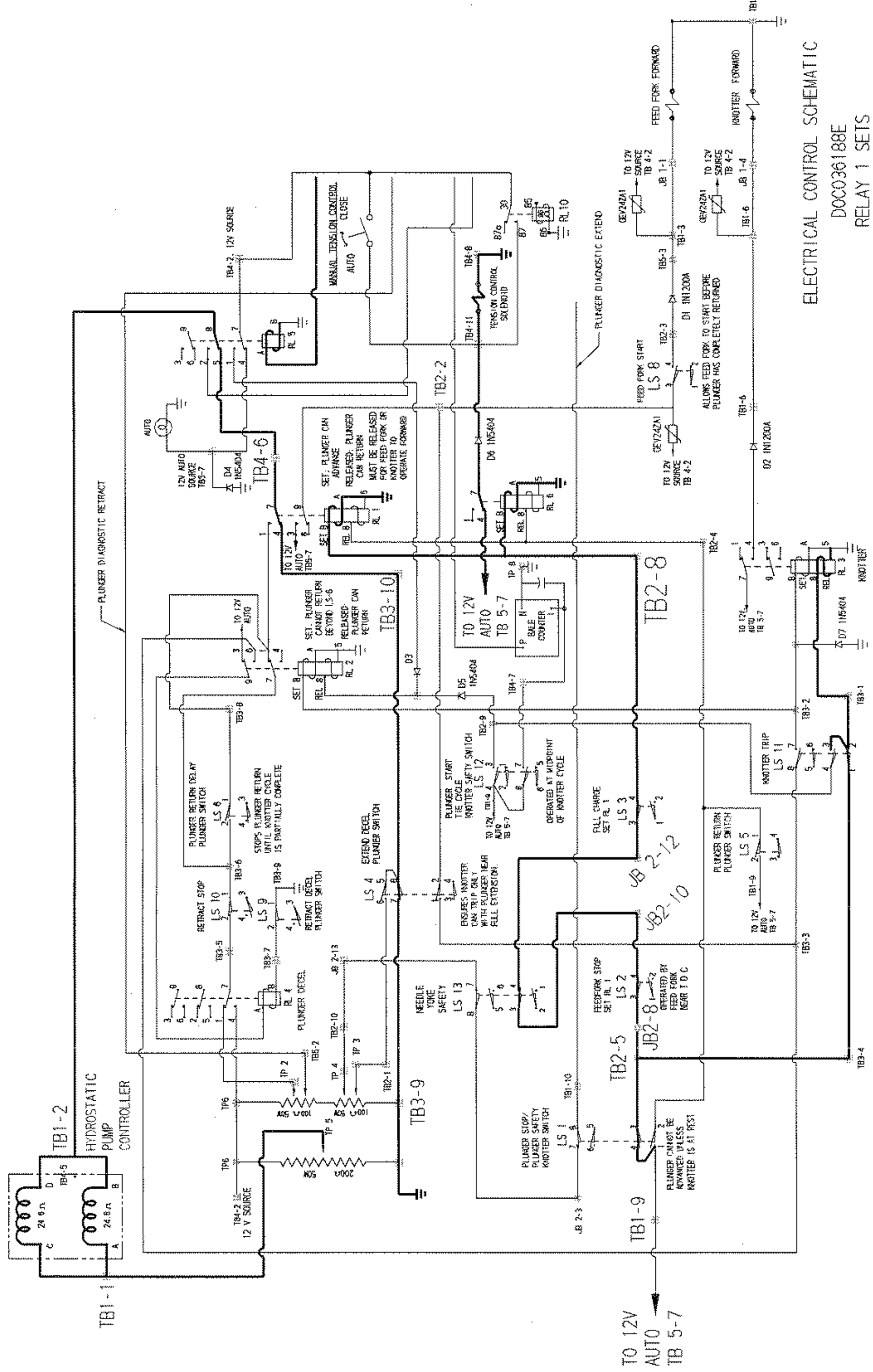
As you follow the path from LS-1 it splits at TB2-5. From TB2-5 is goes to LS-2, the feedfork is operating but is not at its highest point in the chamber so this switch is released and this path stops. The path from TB2-5 also goes down to TB3-4, out to LS-11, and is activating the coil of relay 3 keeping this magnetic latching relay released. This is not really necessary as relay 3 should not set until 12 volts is applied to the set coil, but this gives added safety to prevent relay 3 from inadvertently becoming set and the knotter cycling.

Remember that 95% of all troubleshooting can be performed with the tractor PTO disengaged, from the baler control box with power to the baler turned on, in the automatic mode.

If the feedfork would fail to operate in this condition follow this troubleshooting sequence:

1. Using your 12 Volts DC multi-meter attach the negative lead to a ground source, the positive lead on TB2-2. If no voltage at TB2-2 the problem could be relay 1 is set and the plunger did not extend. Relay 1 contacts are bad and not delivering voltage.
2. If voltage is found at TB2-2; keep you negative lead on ground and move the positive to TB-2-3. If no voltage is found here LS-8 is released or has failed.
3. If voltage is present at TB2-3 check the junction block number 1; located up by the feedfork valve. If voltage at TB2-3 but not at JB1-1 the problem is in the harness.
4. If voltage is present at JB1-1 and the feedfork still fails to operate the problem is with the coil or the valve itself. See the hydraulic section for information on the manual operation of this valve.
5. See DOC036187E - Baler Control Wiring Diagram (page 2) for wire connection details.

# RELAY 1 SETS / PLUNGER EXTENDS



## RELAY 1 SETS / PLUNGER EXTENDS

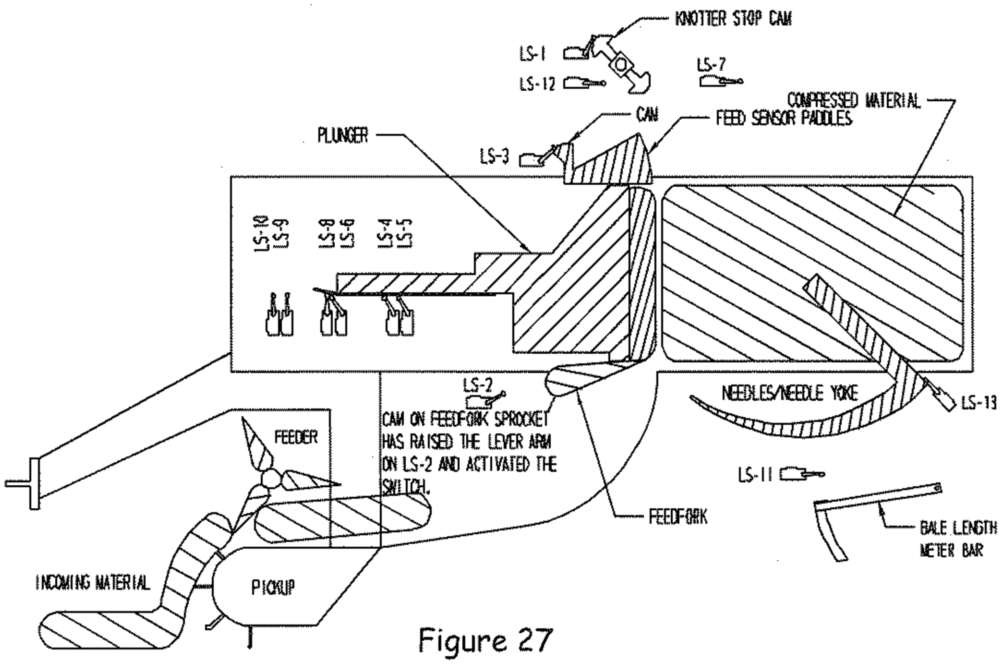



Figure 27

Compare figure 27 to the picture on page 4 you can see that the feedfork has brought the crop into the bale chamber which raised the feed sensor paddles. The feed sensor paddles have activated LS-3 and the feedfork has come up and activated LS-2.

Look at the electrical schematic and start at LS-1 (coordinate B4). Notice there is 12 Volts available from the TB5-7 automatic source. The knotter is in the home position which is activating LS-1. Current passes through contacts 4 & 3 of LS-1 and moves down to LS-2 which is now activated (feedfork at high point in chamber). The current passes through and moves down to JB-2-10, through LS-13 (knotter in home position), and passes through JB-2-12. Material in the chamber is holding the feed sensor paddles up and activating LS-3 which allows the voltage to be applied to TB2-8.

When the 12 Volts DC is applied to TB2-8, relay 1 coil (coordinate F3) and relay 6 (coordinate F4) coil are energized and both relays set. When relay 6 sets current flows to the tension control solenoid valve and the valve shifts closed and hydraulic pressure is applied to the tension cylinders (this will be discussed in more depth in the hydraulic section). If the tension control valve fails to close there is no restriction created for the plunger to compress the charge of material against. A sign that the tension control solenoid valve is not energized would be a sudden drop of plunger pressure on the hydraulic gauge on the front of the baler. To check and see if the tension control solenoid valve is receiving 12 volts to energize you should have 12 volts on TB4-11 when relay 6 is set. The negative lead of your 12 Volts DC multi-meter would be on ground and the positive lead on TB4-11.

When relay 1 sets it removes the voltage from the feedfork solenoid valve and the feedfork stops (there is no connection on relay 1, contact 6). Also contact 7 connects to contact 4 which connects a ground to the hydrostatic pump controller causing the pump to go into stroke.

The path connecting the hydrostatic pump controller to ground is a bit confusing at first, so we will go through it step by step. If you look at the pump controller (coordinate A1) and follow the path down to the balance resistor (item # 20 on page 18) you can see that one side of the hydrostatic pump controller is always connected to this resistor (preset from the factory at 6 Volts). Look at coordinate A3; this is the ground connection for the pump controller. If you follow this path is passes through TB3-9 out to LS-4 (which is activated as the plunger is fully retracted).

The ground continues through TB3-10 and up to contact 4 of relay 1. When relay 1 sets, it connected the ground to contact 7, and the ground continues through TB4-6 on through relay 5 (coordinate G2; set on page 29) and the ground continues through TB1-2 and out to the hydrostatic pump controller.

TB1-1 is the positive connection and TB1-2 is a negative connection. This connection creates a positive or pulling magnetic effect of the pilot valve in the controller. When the pilot valve is offset in this direction oil pressure is delivered to the servo cylinders and they are offset in the direction for the hydrostatic pump to deliver oil out the extend side.

If you need to verify that the hydrostatic pump controller is receiving voltage and relay 1 is set; using the 12 Volts DC multi-meter connect the negative lead to TB1-2 and the positive lead to TB1-1. You should read approximately 4.75 volts if relay 1 is set and the plunger is fully retracted (LS-4 activated). This is a result of the hydrostatic pump controller coils resistance to current flow (would expect we would have 6 volts during at this point). The baler PTO does not need to be engaged to perform this check. Simply turn power on to the control box and put the baler in the automatic mode.

If relay 1 is not set, you can set it manually with the following procedure. Connect a temporary jumper wire with to a 12 volt source, touch the other end of the jumper wire to TB2-8, and relay 1 should click and set. To release relay 1 leave the jumper wire on the 12 volt source and touch the other end to TB2-4, relay 1 should now click to release.

NOTE: if you failed to release relay 1 and engaged the tractor PTO the plunger would extend with no signal from LS-2 or LS-3. When troubleshooting always release relays if they have been manually set using a jumper wire.

If relay 1 fails to set in the automatic mode you can check the circuit path using the 12 Volts multi-meter. In this sequence of testing the negative lead of the multi-meter is always connected to ground & the baler PTO does not need to be engaged.

To check to see that voltage is getting to LS-2 verify that you have 12 volts at TB2-5. Voltage at TB2-5 tells you that the knotter is in the home position and LS-1 is activated as it should be.

With a string or twine, tie up the lever arm on LS-2 & LS-3 to activate the limit switches. Now you should have 12 volts at TB2-8. If you do not then you need to check the voltage at the junction block, JB–2. If you have 12 volts at JB–2-10, LS-2 is good.

If you have 12 volts at JB–2-12, LS-13 is good and the problem must be with LS-3 or the harness returning voltage to the control box. Using the process of elimination a limit switch problem is easily traced and identified.

Look at figure 27 on the previous page. You will also notice along with the feedfork activating LS-2 and the feed sensor paddles activating LS-3 which sets relay 1, the plunger has left the home position and is starting to compress the hay.

As the plunger extends it releases the limit switches that control the plunger action. On the electrical schematic on page 32 you can see that the plunger has extended far enough to release LS-10, LS-9 and LS-8 (the switches have been released in this view, but on your full size documents you have to remember that as the plunger extends it releases the six limit switches). The figure 27 on page 33 also shows the same.

As the plunger continues its extend stroke, somewhere between releasing LS-6 and releasing LS-4 the crop that is holding the feed sensor paddles up will be cleared by the plunger and the feed sensor paddles will drop. When this happens LS-3 will release, and the voltage path to TB2-8 is broken. This has no effect on relay 1 as it is a magnetic latching relay and will stay set until voltage is applied to the release coil. If the feed sensor paddles did not drop there would be a problem, as relay 1 will not release when voltage is applied to the release coil, until voltage has been removed from the set coil.

The plunger will continue the extend stroke; next LS-6 releases. As the plunger extends, LS-10, LS-9, LS-8, and LS-6 are released with no effect to the circuit (aside from the switches releasing). On the plungers extend stroke these limit switches have no effect. They are simply releasing in readiness for the plungers retract stroke.

This is not true for LS-4, which has two functions (the other function is covered during a knotter cycle). As the plunger releases LS-4 the voltage to the hydrostatic pump controller is reduced. This lessens the magnetic pull on the pilot valve in the controller and hydraulic pressure to the servo cylinders is reduced. This allows the swash plate to move to a more vertical position which will pump less oil.

In figure 28 on the next page is a cross section of the hydrostatic pump. All hydraulic oil pumps generate an increasing volume at the suction side and a decreasing volume at the pressure side. In this view (figure 28) the swash plate is at its full travel (full speed, maximum voltage).

The hydrostatic pump basically consists of 9 pistons, a rotating cylinder barrel, and a swash plate. The cylinder barrel is fastened to the drive shaft that rotates at approximately 3,125 RPM. If the swash plate (which does not rotate) is in neutral, perfectly straight up and down there is no increasing or decreasing area created by the pistons. In figure 28 the swash plate has been rotated approximately 30° counter clockwise. This is the position the swash plate goes to when the full 6 volts is applied to the controller.

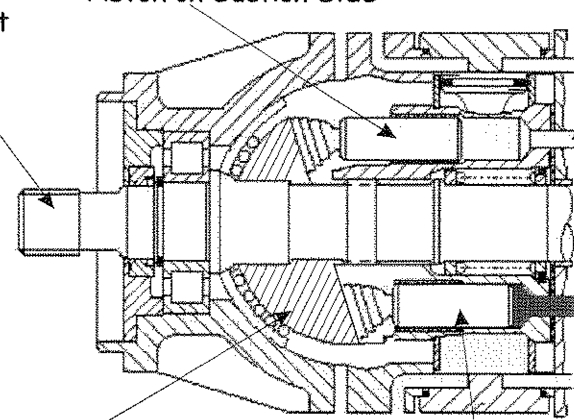



Figure 28

As the drive shaft rotates the cylinder barrel and the pistons follow the surface of the swash plate. The swash plate is at an angle and the pistons reciprocate within the bore of the cylinder barrel. In one half of the circle of rotation the piston moves out of the cylinder barrel (suction) and creates an increasing volume.

In the other half of the circle of rotation this piston moves into the cylinder barrel and generates a decreasing volume. When the swash plate is at its maximum tilt the pistons are displacing the maximum amount of oil which is 80 GPM (gallons per minute). If the swash plate is relaxed and allowed to rotate 15° clockwise the volume of oil that each piston displaces is cut about in half.

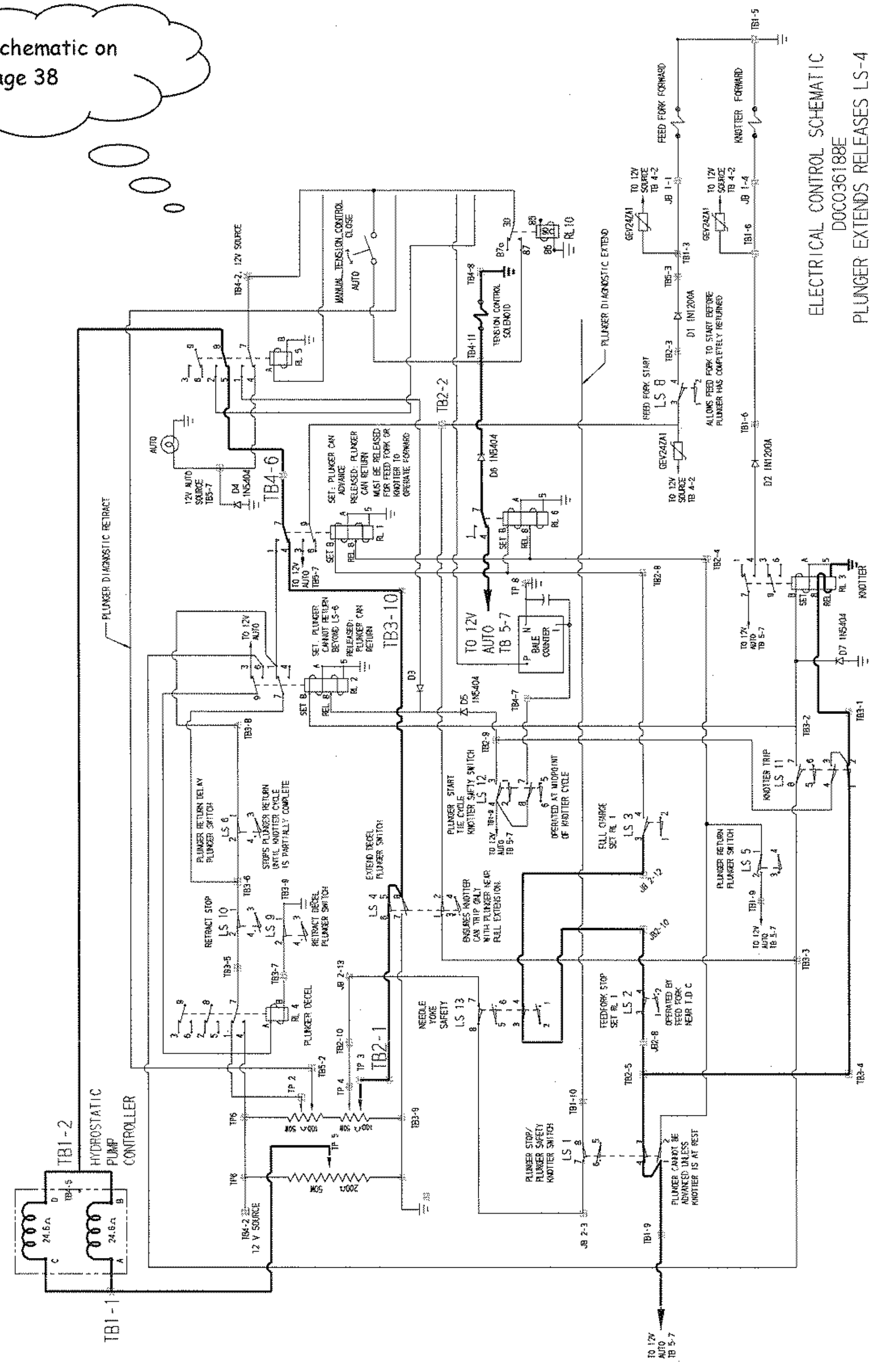
When LS-4 is released by the plunger on the extend stroke the voltage to the hydrostatic pump controller is cut approximately in half. As stated earlier, this weakens the magnetic pull on the pilot valve in the controller, and hydraulic pressure to the servo cylinders is reduced.

The servo cylinders are connected to the swash plate and keep it in the desired position depending on the amount of charge pressure applied to them. As the cylinder barrel rotates the pistons are able to withstand pressures up to 6,500 PSI and are constantly trying to force the swash plate back to the neutral position. When the pressure applied to the servo cylinders is reduced the swash plate is able to relax somewhat, until it comes up against the force of the servo cylinders again, unless the pressure is completely removed and the swash plate is allowed to tilt straight up to the neutral position.

The angle of the swash plate does not affect the PSI that is generated downstream. The angle of the swash plate only affects the amount of oil displaced by the pistons on each revolution of the drive shaft.

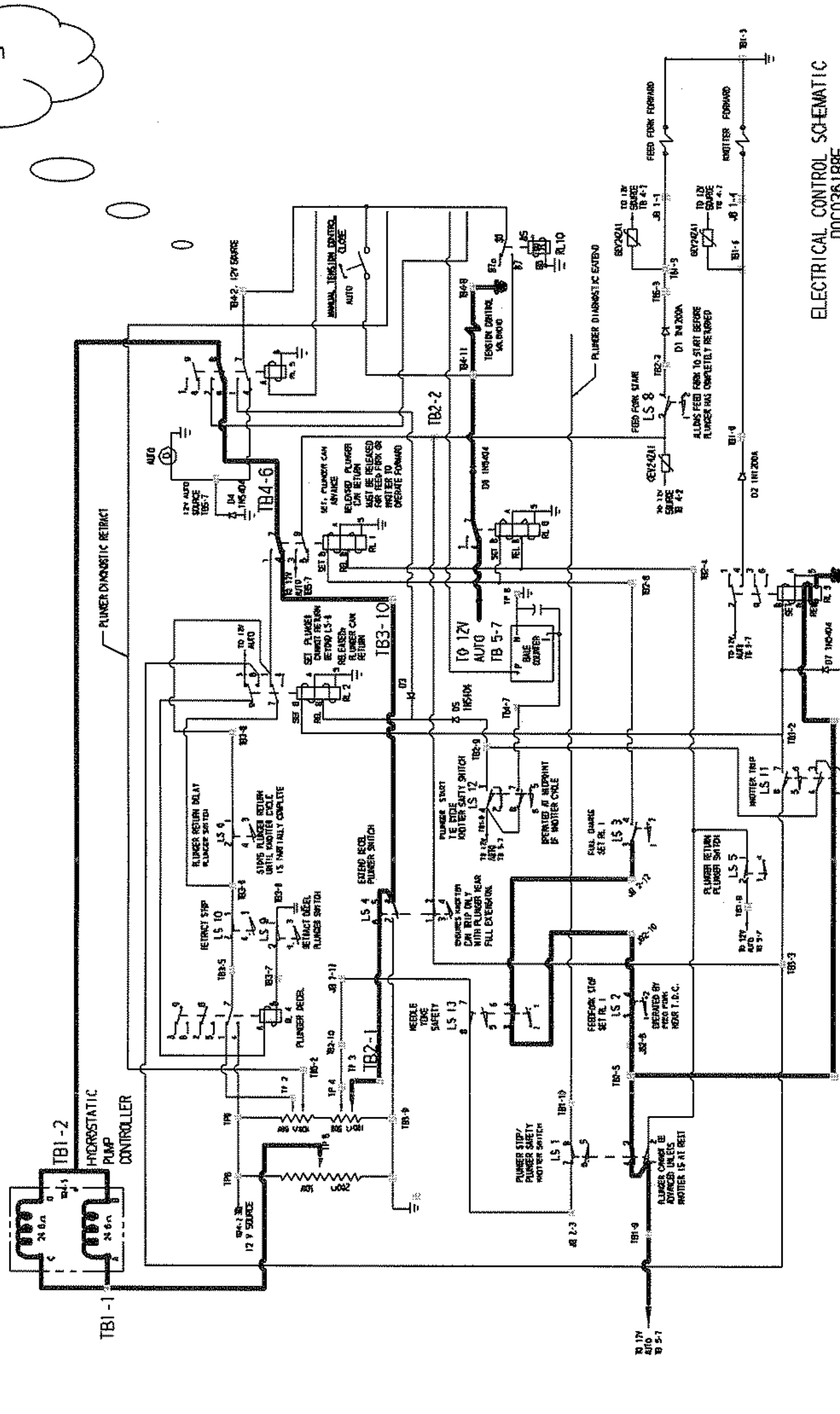
# PLUNGER EXTENDS AND RELEASES LS-4

Same Schematic on Page 38



# PLUNGER EXTENDS AND RELEASES LS-4

Same Schematic on Page 37



## PLUNGER EXTENDS AND RELEASES LS-4

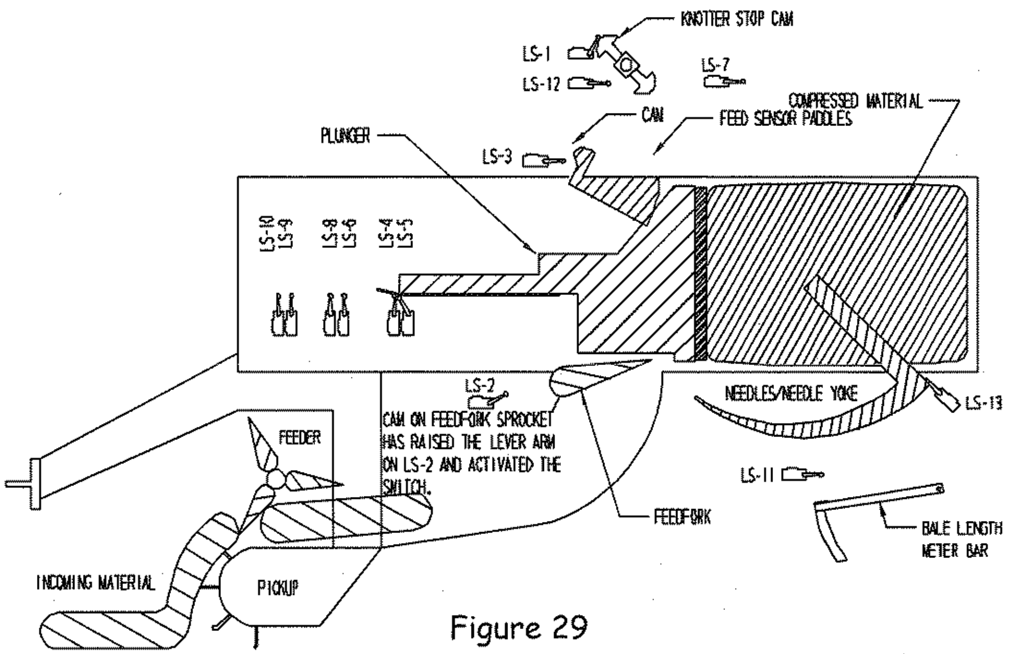
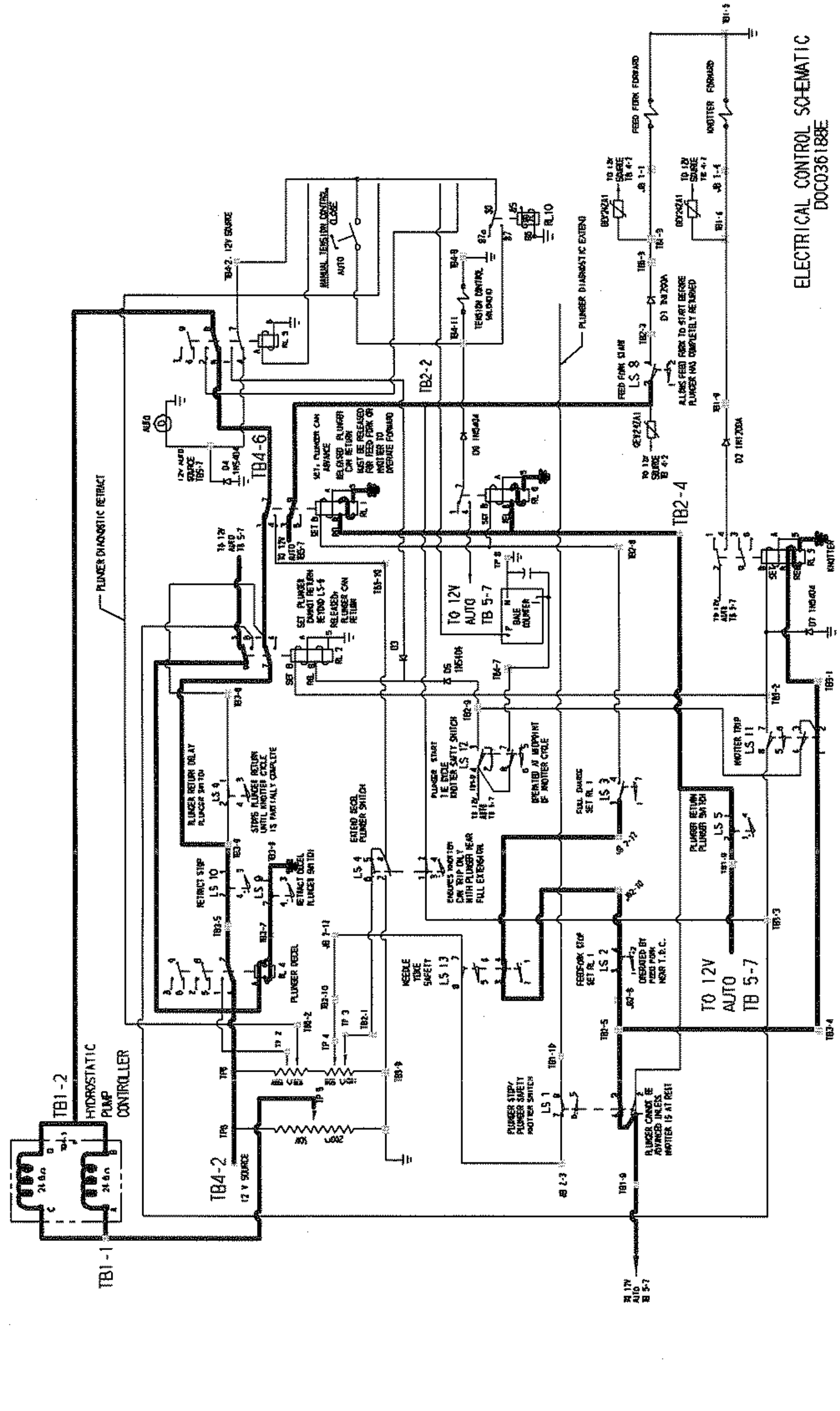



Figure 29

The plunger has now advanced far enough to release LS-4. Five of the six limit switches under the plunger are now released (also shown released on the schematic to the left). None of the switches released to this point affect the plunger as it advances, but LS-4 is different in that it signals the plunger to slow down near the end of its stroke. As the plunger has advanced it has cleared the crop from under the feed sensor paddles and they have dropped to their home position, releasing LS-3. As you can see on the electrical schematic to the left, this has broken the current path to TB2-8 but relay 1 stays set as it is a magnetic latching relay. The feedfork is still at the highest point in the chamber but LS-2 has no effect at this point.

When LS-4 was released, contacts 7 & 8 opened and 5 & 6 closed. When this occurred the current path was broken from the TB3-9 connection and was picked up at the TB2-1 connection. You can see on the schematic that TB3-9 is ground, and TB2-1 is connected to the deceleration slider positioned part way up the resistor. This means there is now added resistance to the path for current passing through the pump controller. Remember the balance slider is always connected to 6 volts, but now instead of going directly to ground the pump controller is connected to the deceleration slider on the resistor which results in decreased voltage across the controller coils. Less voltage at the coils means less current flowing though the coils, which lessens the pull on the pilot valve, de-strokes the swash plate, and ultimately reduces the pump flow.

If you look in the owner/operator manual on page 25 you will find the procedure for setting the plunger advance decelerated speed. This procedure is used to set the position (voltage) of the plunger advance speed deceleration slider (item # 19 on page 18). Using this procedure the decelerated speed is approximately 2.4 - 2.8 seconds for the plunger to extend 30".


ELECTRICAL CONTROL SCHEMATIC
HYDROSTATIC PUMP CONTROLLER
TB1-1
TB1-2
TB4-2
TB4-6
TB2-2
TB2-4
TO 12V AUTO TB 5-7

## PLUNGER EXTENDS AND RELEASES LS-5

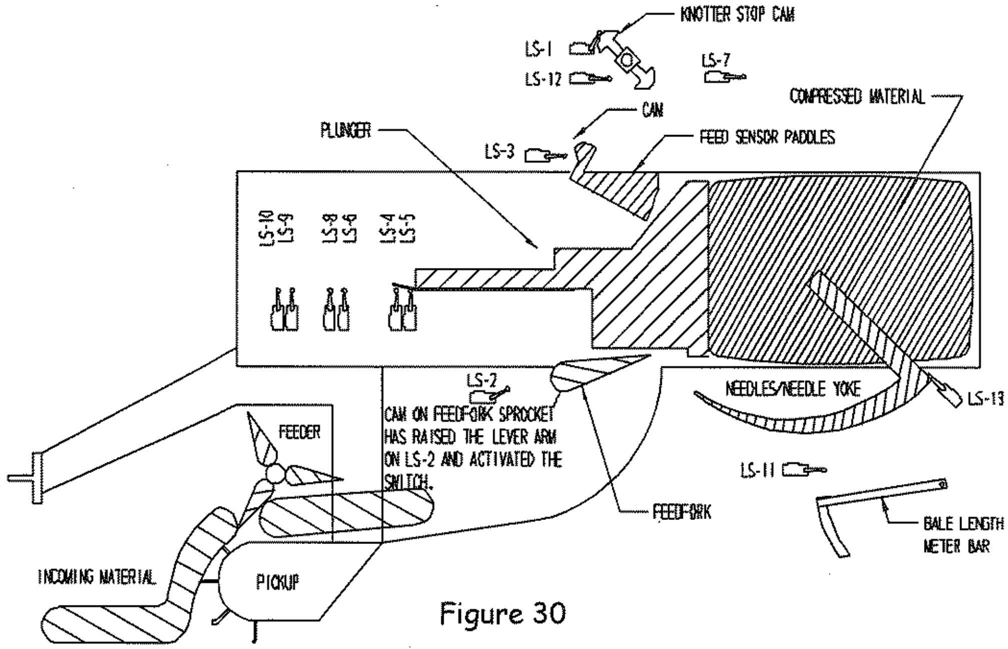



Figure 30

Once LS-4 is released the plunger will slow down for approximately the last 2 inches of travel. The swash plate is headed to the neutral position and as soon as the plunger releases LS-5 it will rotate up to neutral and approximately 30° clockwise to start the plunger retracting at full speed.

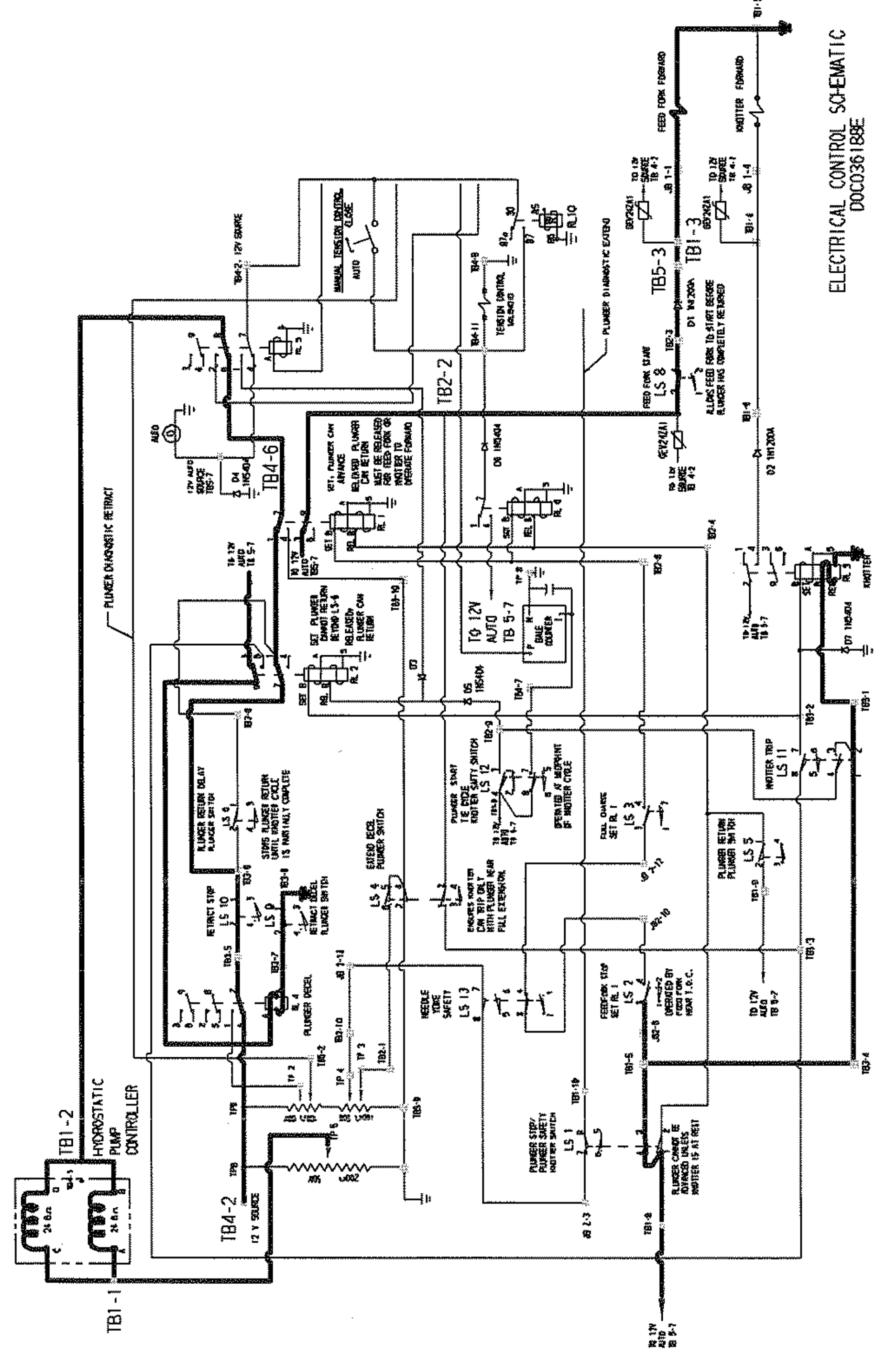
Find LS-5 (coordinate D5) on the schematic; contact number 2 is connected to the 12 volt automatic source (TB5-7). When the plunger releases LS-5, 12 volts is applied to the release coil of relay 1 (coordinate F3) and to the release coil of relay 6 (F4). For relay 1 and relay 6 to release, there can be no voltage at TB2-8, and 12 volts must be applied to TB2-4.

When relay 6 is released the tension system solenoid valve is de-energized and the valve opens. Hydraulic oil pressure is maintained in the tension cylinders, but with the valve open, no additional pressure is added (see hydraulic section for more information).

When relay 1 is released it interrupts the current flow and reverses the flow of current going to the hydrostatic pump controller. Look at the schematic at TB4-2 (coordinate A2). This is a 12 volt connection for both the balance resistor and the retract resistor, remember that the balance resistor slider is preset at 6 volts.

The current flows through relay 4 (standard relay) and continues through LS-10, LS-6 (both of these were released on the extend stroke), relay 1 (released) and ends up back at TB1-2. Now TB1-2 is the positive connection and TB1-1 is the negative connection. With current flowing this direction the magnetic field is reversed and it has a reverse or pushing effect on the pilot valve in the controller. When the pilot valve is offset in this direction it directs oil pressure to the opposite end of the servo cylinders which tilt the swash plate opposite of full speed extend and oil flow is reversed, retracting the cylinder at full speed. The hydrostatic pump controller is still receiving 6 volts, as the positive connection is 12 volts and the negative connection is 6 volts.

# PLUNGER RETRACTS AT FULL SPEED, FEEDFORK STARTS



## PLUNGER RETRACTS AT FULL SPEED, FEEDFORK STARTS

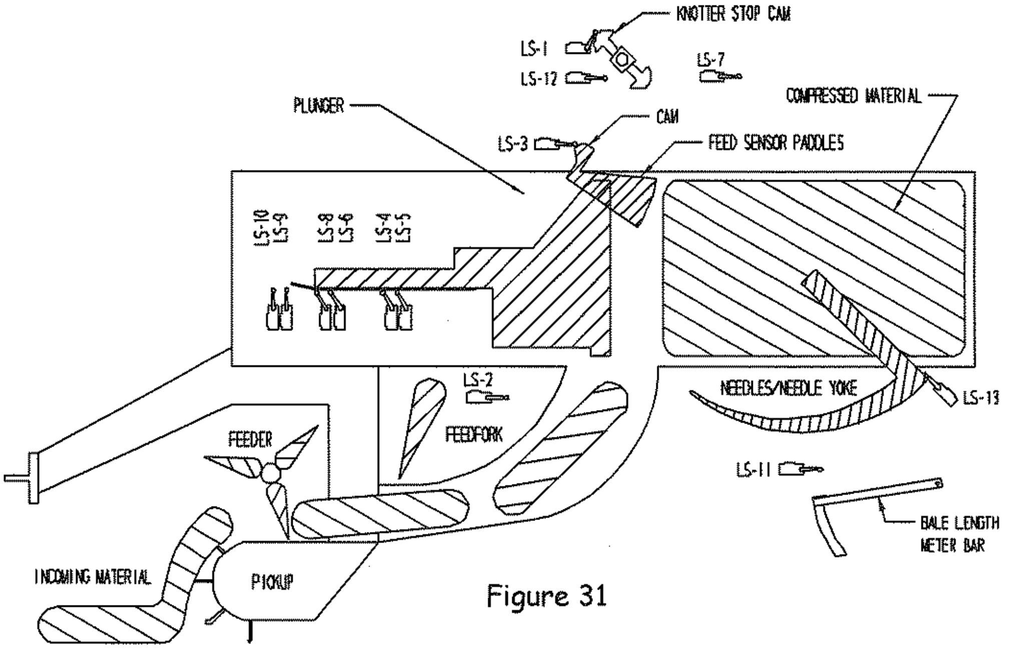



Figure 31

When LS-5 releases relay 1 the plunger immediately begins retracting at full speed, re-activating LS-5. As the plunger retracts it activates LS-4 and LS-6 (LS-6 is used only on a knotter cycle) which have no effect on the retract stroke (unless the knotter is cycling).

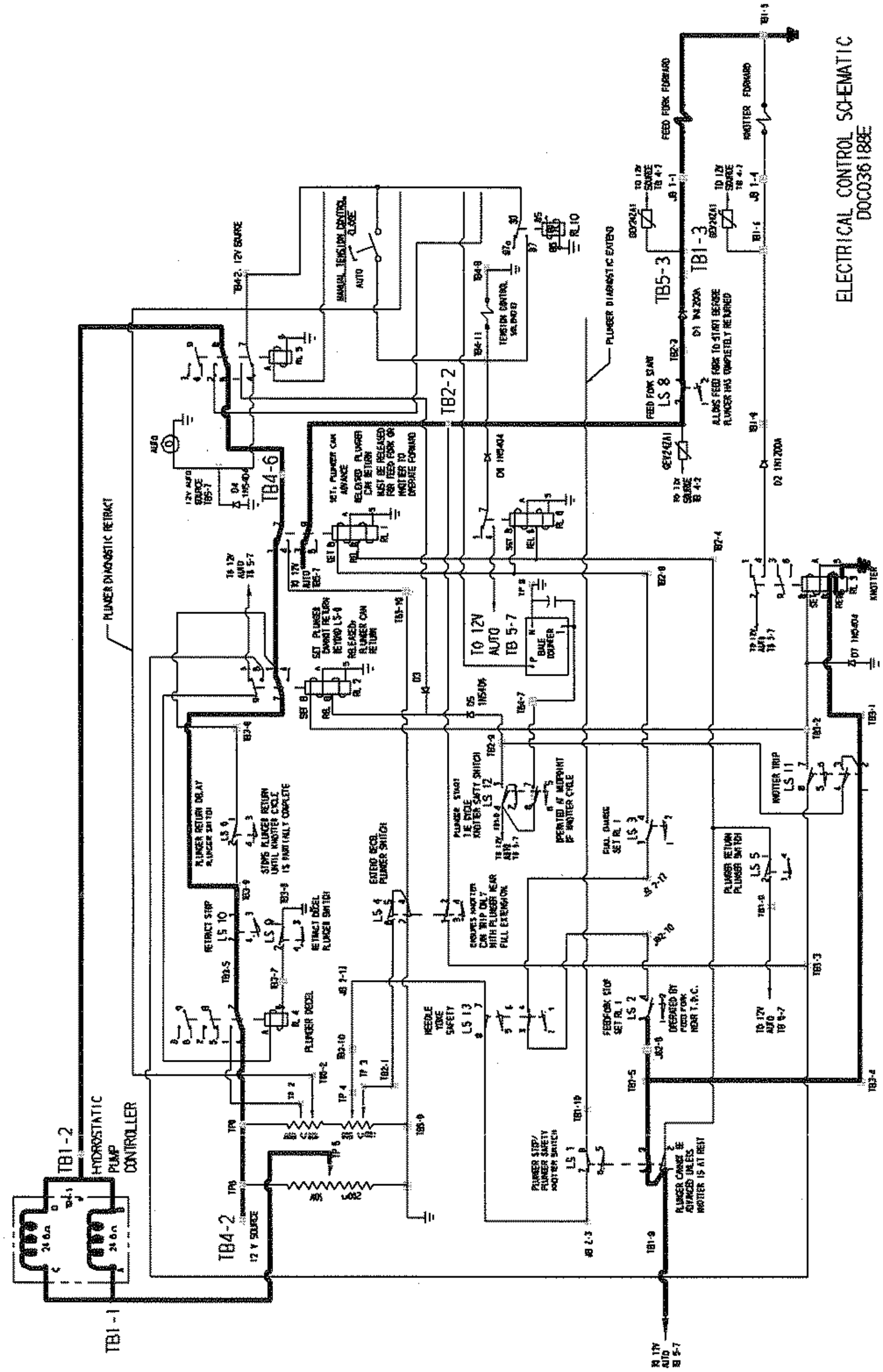
As the plunger has been extending and now partially retracting the feeder has been continuously running and moving crop into the feed chute. The feedfork needs to get started or the feeder will plug.

If you look at the schematic on page 40 you will see that when relay 1 was released besides retracting the plunger it also made a 12 volt connection to TB2-2 (coordinate F3). If you follow the path it goes down and stops at LS-8. The feedfork will not start until the plunger retracts approximately half ways and activates LS-8 as shown on the schematic to the left. As soon as the plunger retracts far enough to activate LS-8 the feedfork starts again.

The plunger continues retracting home and about the time the plunger reaches the home position, the feedfork is delivering another charge of material to start the extend process again. If necessary the feedfork will continue to rotate until there is enough crop to raise the feed sensor paddles.

Remember the plunger will not extend unless the bale chamber is full of material and the feed sensor paddles have raised and activated LS-3. But, before this can happen the plunger needs to fully retract so the feed chute is completely open to receive more material.

# PLUNGER RETRACTS TO LS-9 AND SLOWS DOWN



## PLUNGER RETRACTS TO LS-9 AND SLOWS DOWN

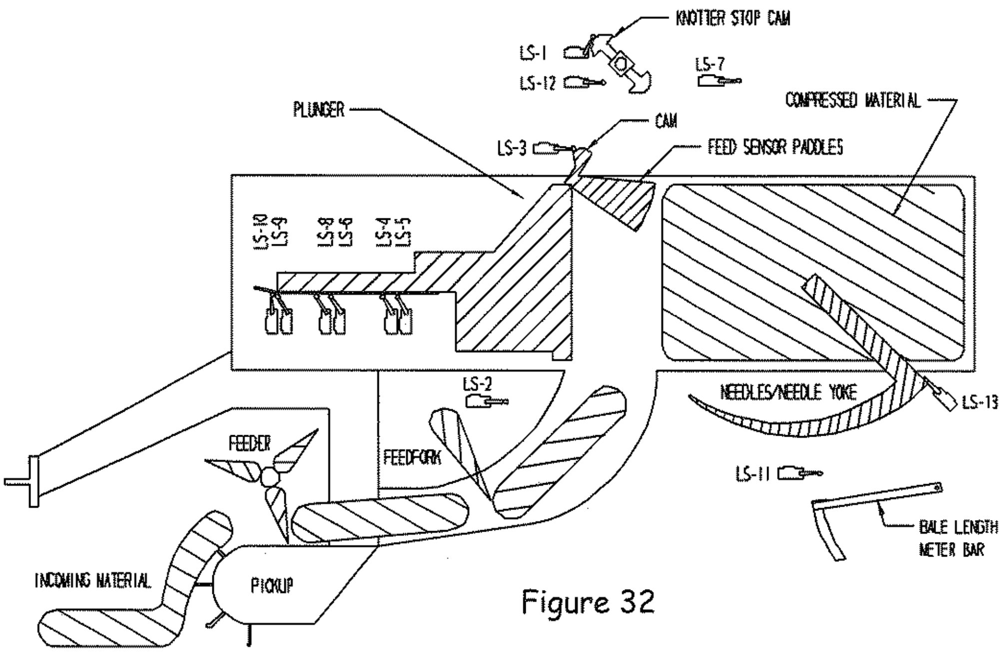



Figure 32

In this view the plunger has retracted far enough to activate LS-9. It has almost finished one complete stroke. When LS-9 is activated the voltage to the hydrostatic pump controller is reduced which slows the plunger down at about half speed. It retracts the last couple inches at the decelerated retract speed until LS-10 is activated. Retract decel is almost the same as the advance decel procedure on page 39. When relay 4 is released the controller is connected to the retract decel slider (see page 18 item # 17).

Relay 4 (C2) is a standard relay, so as soon as the plunger activated LS-9, relay 4 no longer has a ground to complete the circuit path through the coil. This is one relay that is connected to 12 volts and is set by applying a ground. Remember, relay 4 is a standard relay. When the coil is energized the relay will set, and when voltage is removed the coil is de-energized and the relay instantly releases. It has only one coil and does not require 12 volts to release it.

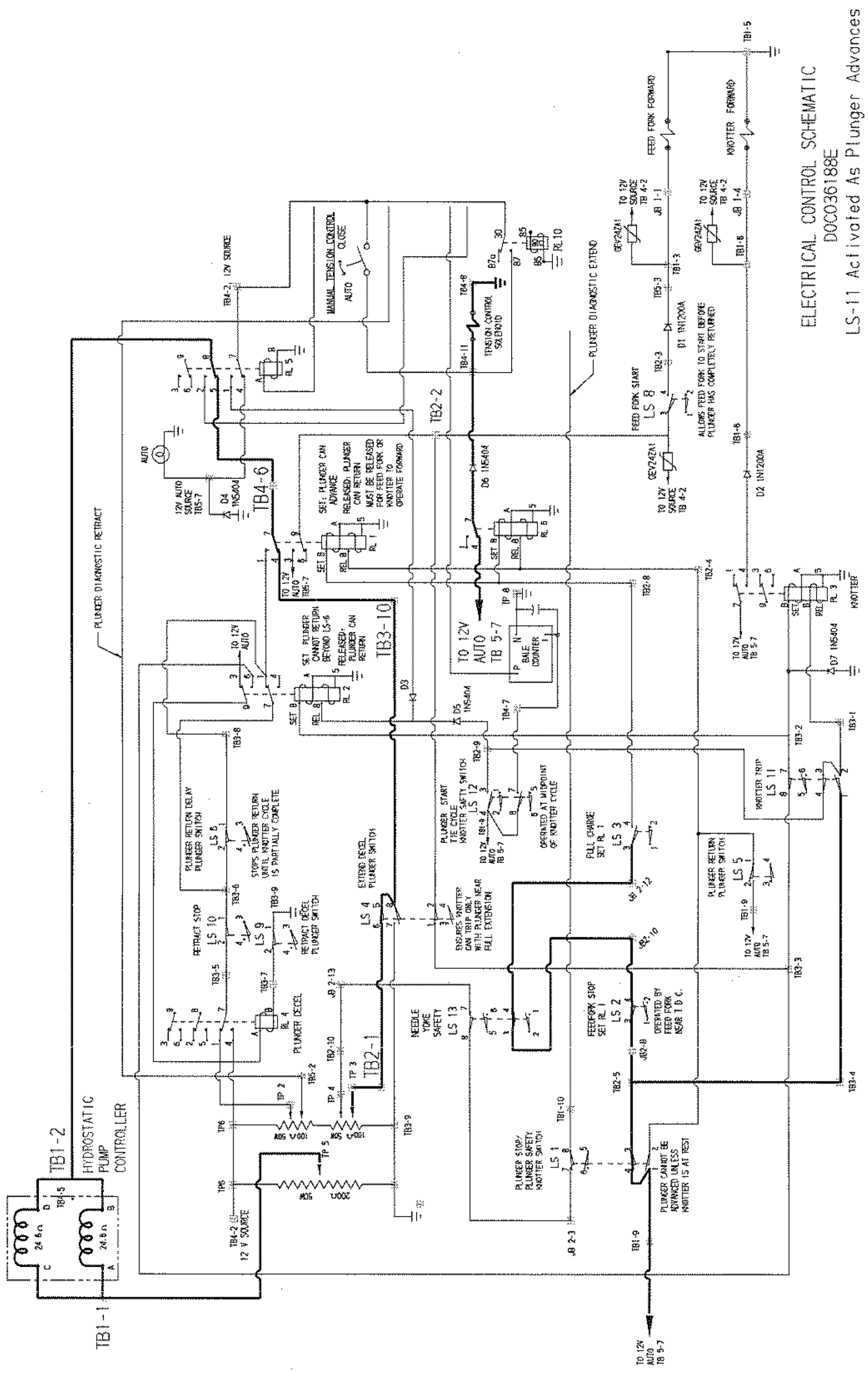
The plunger continues to retract at decel speed until it activates LS-10. When LS-10 is activated this opens the path to the hydrostatic pump controller and the coils in the controller de-energize. The pilot valve shifts to neutral, the hydraulic pressure on the servo cylinders equalizes and the swash plate comes to vertical, straight up and down.

Once LS-10 is activated the plunger has completed one plunger stroke. If you turn back to page 30 the baler is in this condition again. The feedfork is running delivering crop to the bale chamber.

Depending on crop and conditions the average 8 foot alfalfa bale probably requires approximately 20 - 24 plunger strokes. When the bale has grown to this predetermined length the meter bar will activate LS-11, signaling it is time to start a knotter cycle.

The knotter cycle is discussed in the next section. Hopefully what we have discussed so far is becoming clearer. We need to remember what it takes for the plunger to extend and retract. In the next section we will start out just as the plunger has released LS-4 on the extend stroke, and the meter bar raised and activated LS-11.

# PLUNGER EXTENDS AND LS-11 KNOTTER TRIP SWITCH ACTIVATES



## PLUNGER EXTENDS AND LS-11 KNOTTER TRIP SWITCH ACTIVATES

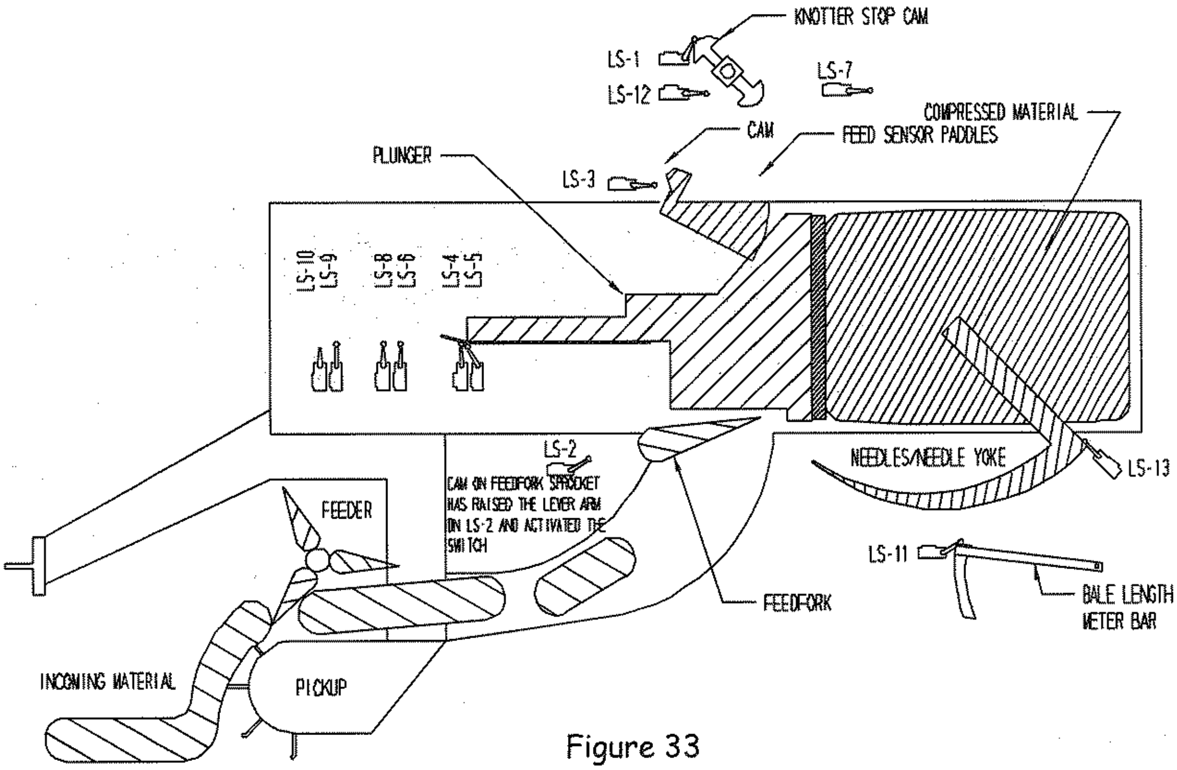



Figure 33

In figure 33 above, the bale length meter bar has raised and activated LS-11 - Knotter Trip Switch. The meter bar raises slightly each time the plunger advances and pushes crop to the rear of the baler. The advancing crop rotates the meter wheel (located in the bottom of the bale chamber), which raises the meter bar.

Looking at the schematic on page 46 you can see that LS-11 (coordinate D6) is now shown activated. Contacts 8 & 7 are closed, but we have no voltage available to set relay 3. Relay 3 needs to be set for the knotter to cycle.

If you follow the current path from contact 8 to TB3-3 and then up to LS-4 you can see that LS-4 is shown released, which closes contacts 1 & 2. If you continue on this current path you run into TB2-2, which connects to contact 9 of relay 1.

The plunger is still advancing so relay 1 is set, and there is no voltage available at contact 6 to set relay 3.

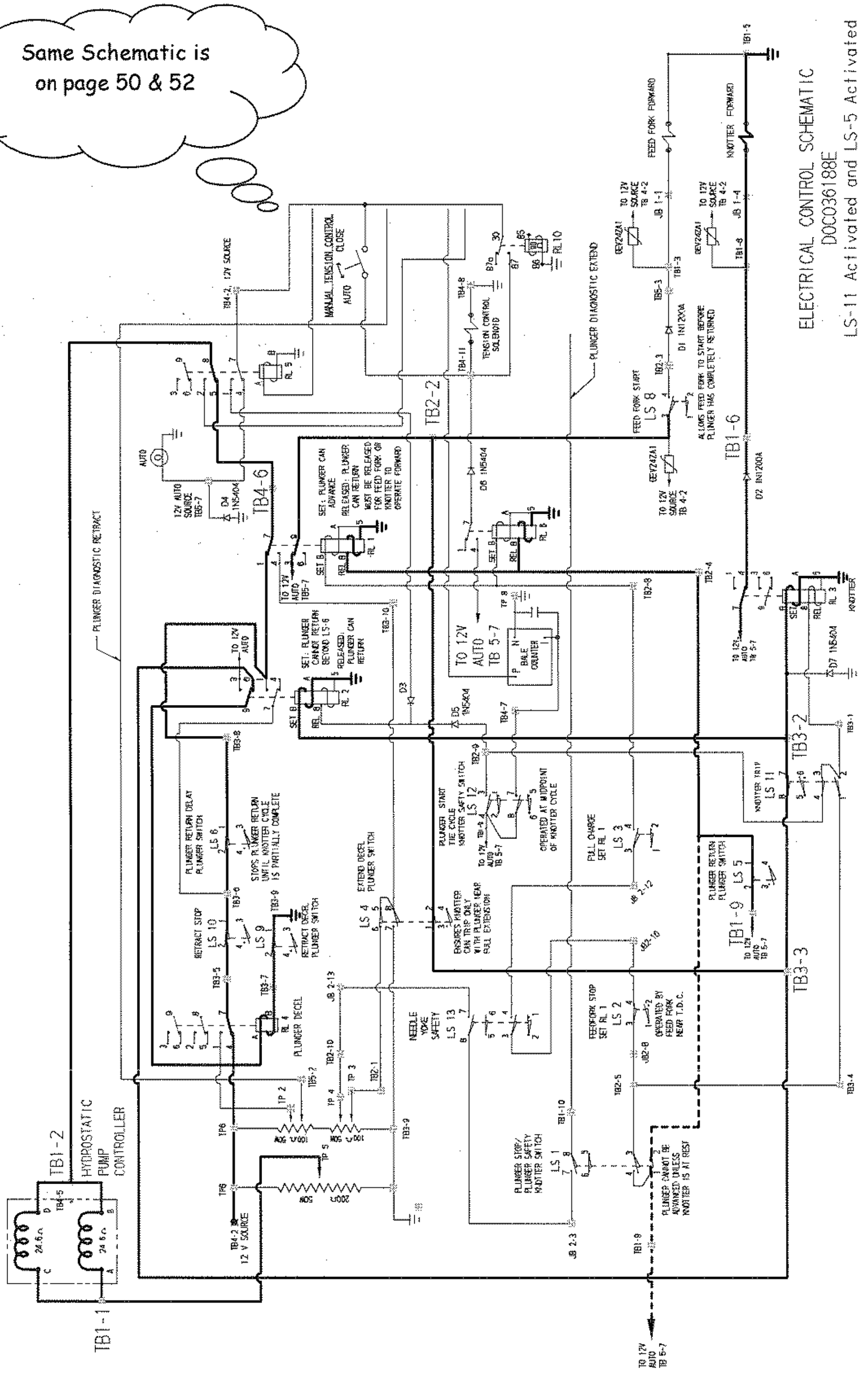
Keep in mind; in order for the knotter to cycle the following conditions must be met;

1. LS-11 must be activated, and at the same time
2. LS-4 must be released.
3. Relay 1 must be released.
4. Relay 3 must be set.

We will now look at the schematic when LS-11 is activated and the plunger has extended all the way to release LS-5, which releases relay 1 and the plunger changes direction and starts its retract cycle.

# LS-11 KNOTTER TRIP SWITCH & LS-5 PLUNGER RETURN SWITCH ACTIVATED

Same Schematic is on page 50 & 52



# LS-11 KNOTTER TRIP SWITCH & LS-5 PLUNGER RETURN SWITCH ACTIVATED

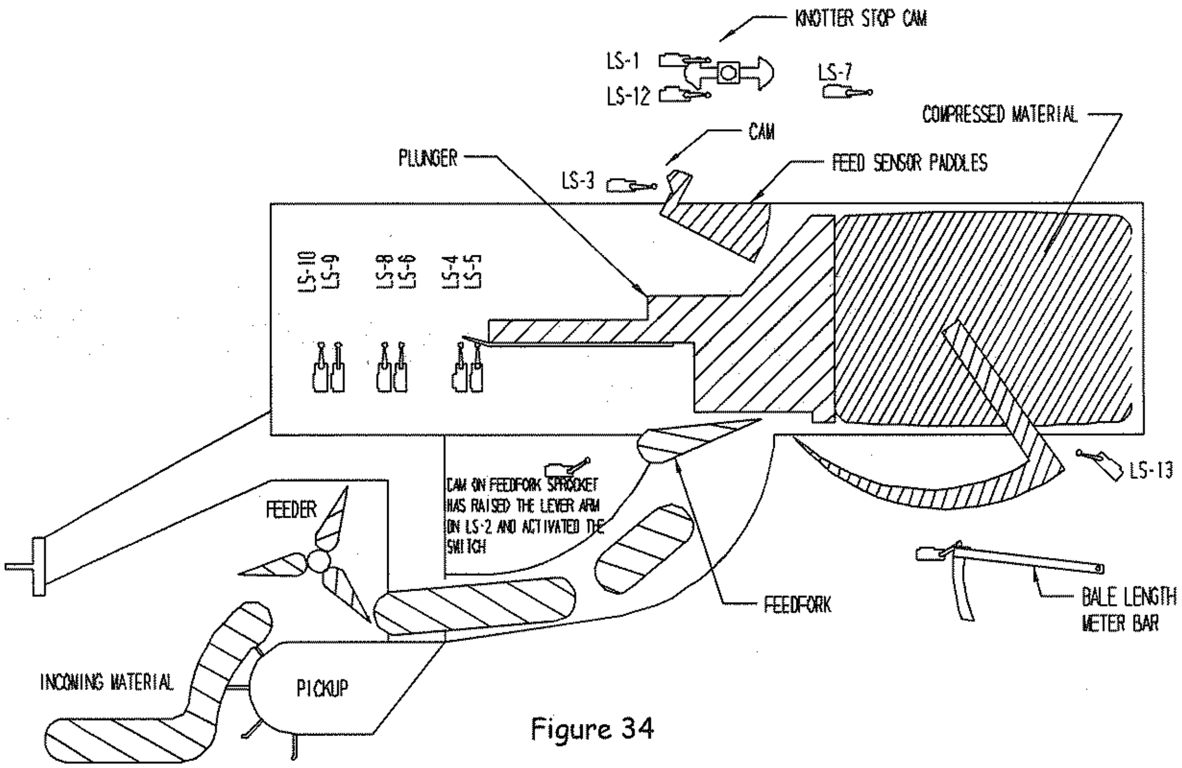



Figure 34

In figure 34 above and the schematic on page 48 you can see that the plunger has now advanced to the end of it's extend stroke and released LS-5, plunger return switch. Relay 1 has released. The knotter has moved from its home position far enough to release LS-1 and LS-13, but has not rotated far enough to allow the meter bar to drop and release LS-11.

In the schematic view on page 48 things look a little busy, but we will break it down step by step and follow each circuit path individually.

The first thing that happens when the plunger reaches the end of its 30" extend stroke, is LS-5 (coordinate D5) is released which closes contacts 1 & 2. This allows current to flow from 12 volts automatic source to TB2-4 and up to the release coils of relay 6 (coordinate F4) and relay 1 (coordinate F3).

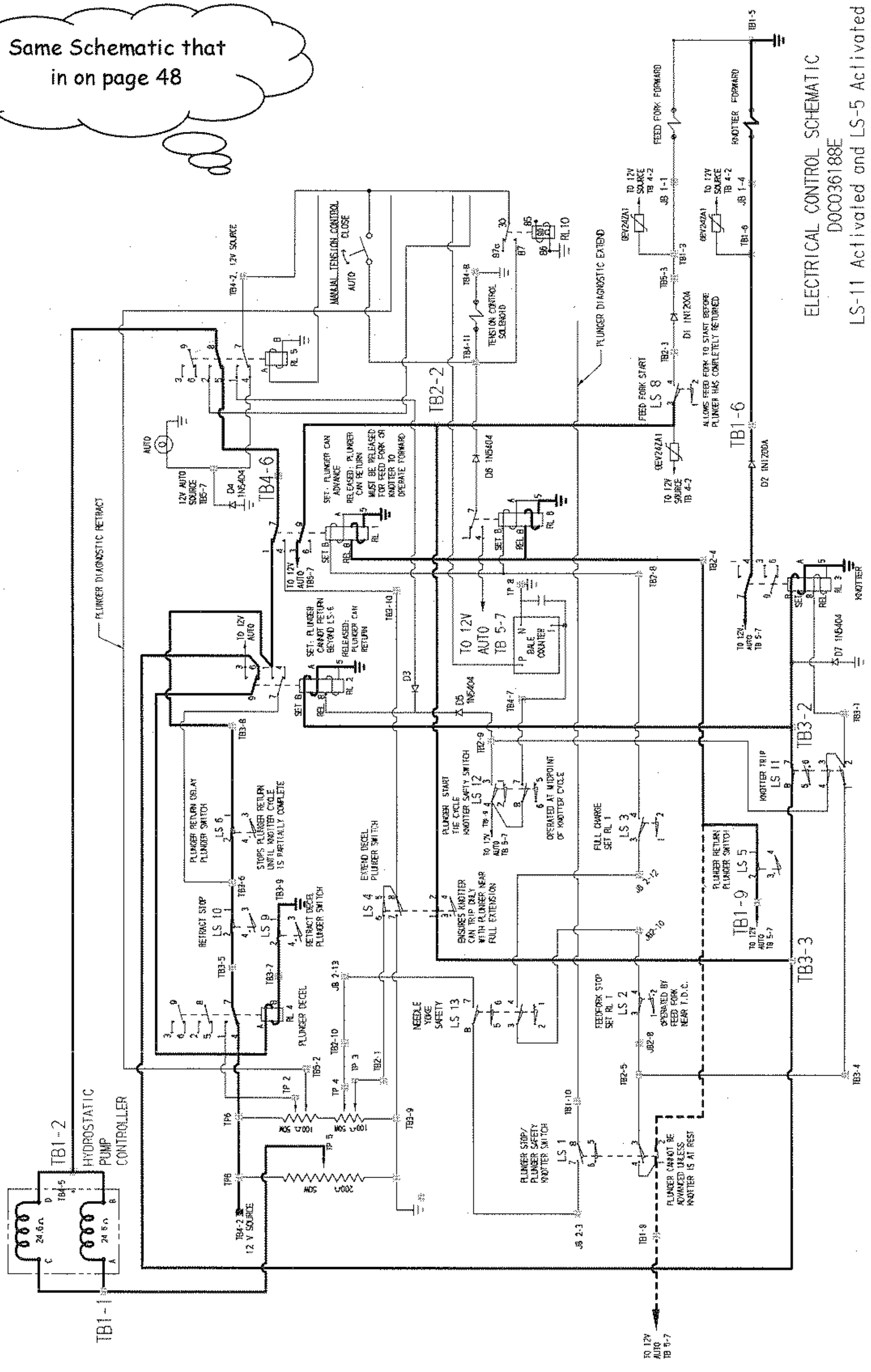
When relay 6 is released voltage is removed from the tension system solenoid valve. The valve is de-energized and it opens. Hydraulic oil pressure is maintained in the tension cylinders, but with the valve open, no additional pressure is added (see hydraulic section for more information). This is the same as was discussed earlier on a regular plunger stroke.

When relay 1 (coordinate F3) is released a couple of things happen. When contact 7 connects to contact 1 the plunger reverses direction and starts to retract at full speed. When contact 3 connects to contact 9, 12 volts is connected to TB2-2. This is also the same as a regular plunger stroke.

Current flows from TB2-2 down to LS-8 but it stops there because the plunger has not retracted yet, (for the purposes of this manual it is momentarily stopped). The plunger cam will not contact and activate LS-8 until the knotter is almost done cycling. LS-8 needs to be activated before the feedfork starts up again.

# LS-11 KNOTTER TRIP SWITCH & LS-5 PLUNGER RETURN SWITCH ACTIVATED

Same Schematic that in on page 48



## LS-11 KNOTTER TRIP SWITCH & LS-5 PLUNGER RETURN SWITCH ACTIVATED

From TB2-2 current also flows (left) to LS-4 (coordinate C3). LS-4 is released so contacts 1 & 2 are closed which allow the current to flow down to TB3-3. From TB3-3 the current goes two directions.

To the right of TB3-3 (coordinate C6) is LS-11 Knotter Trip Switch (coordinate D6) which is activated, closing contacts 8 & 7. Current flows through LS-11 to TB3-2 where the current also goes in two directions.

To the right of TB3-2 (coordinate D6) it goes to the set coil of relay 3, which sets relay 3. On relay 3; as soon as contact 7 connects to contact 4, current is available to the knotter forward solenoid valve from 12 volts automatic and the knotter starts its cycle.

You can see in figure 35 below that as soon as the plunger releases LS-5 it will automatically retract and travel approximately 2-1/4" before LS-4 is again activated. In this view the plunger has not yet changed direction to activate LS-5 so LS-5 and LS-4 are released. LS-4 must be released for the current to flow to LS-11 and on to relay 3. This only happens when the plunger is at full extension (LS-5 released) and relay 1 is released.

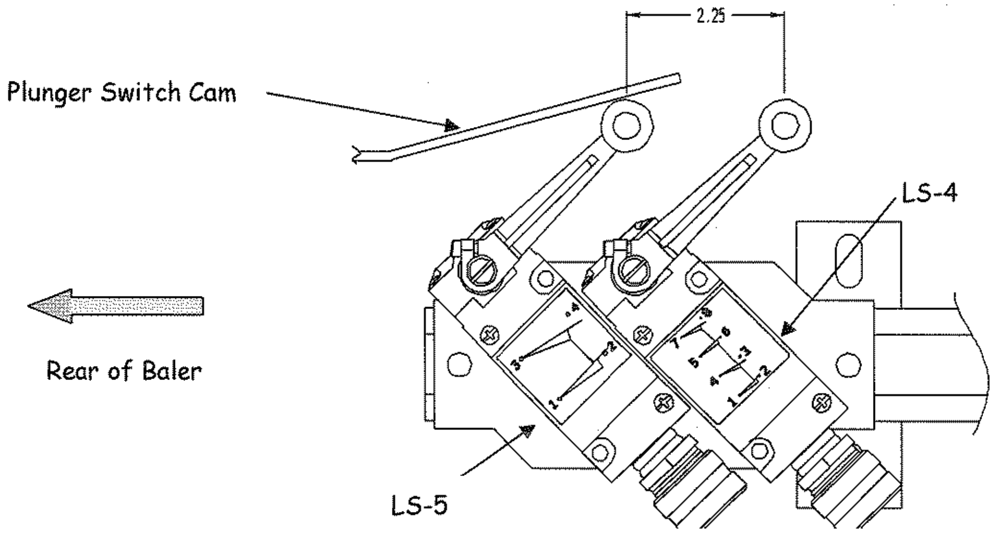



Figure 35

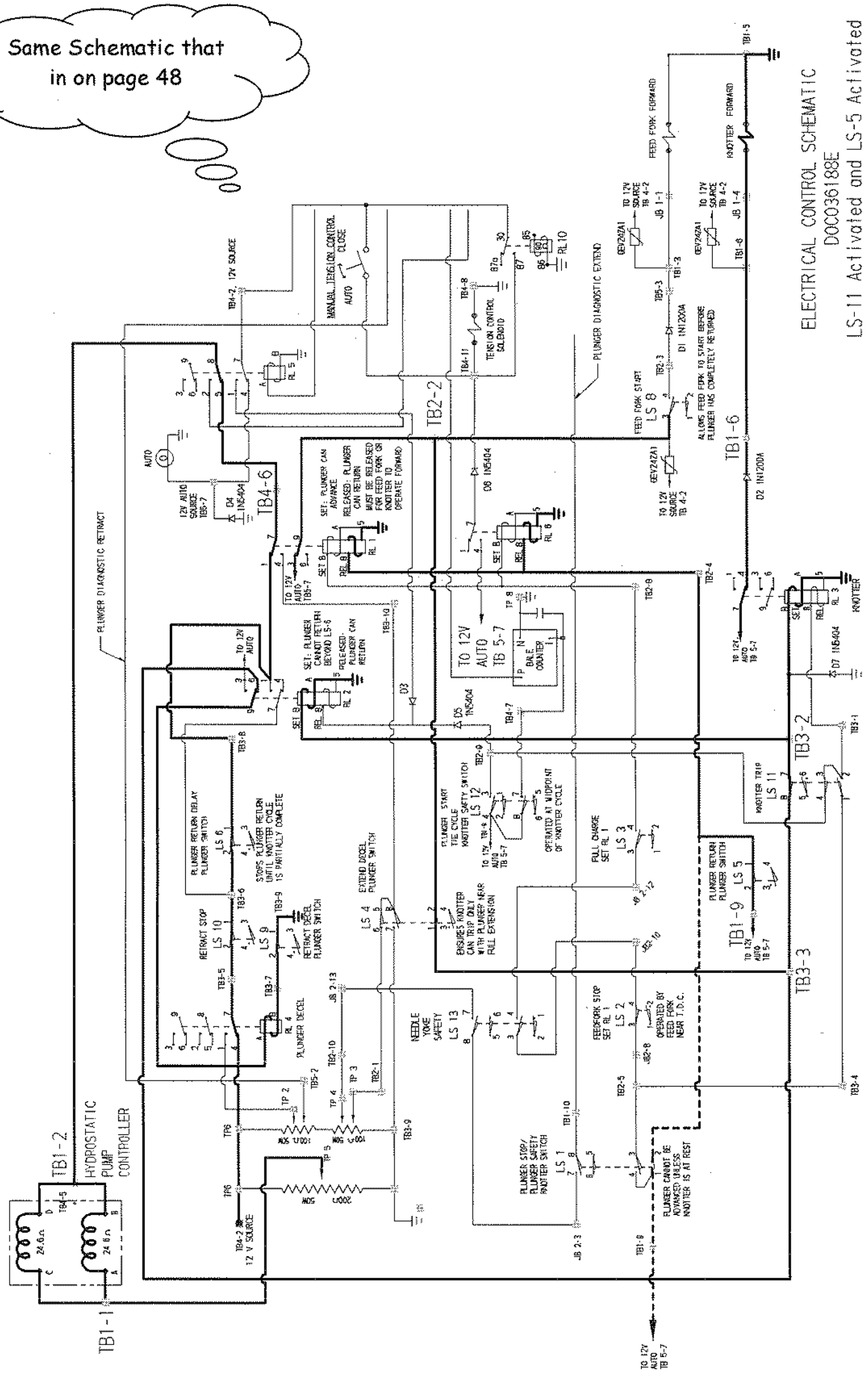
Viewed from inside the baler, under the plunger looking at the plunger switches

If you suspected a problem with LS-11 the troubleshooting sequence is as follows.

1. Shut off tension control system (see Tension System in the hydraulic section of manual).
2. Using the diagnostic controller (see page 24) manually extend the plunger until the cylinder bottoms out and hold for a second to stall. This will slightly open the tension rails and the plunger should stay in this position. The plunger has to stay fully extended to ensure LS-4 is released.
3. Disengage tractor PTO and shut the tractor off.
4. On the baler control box set the local/remote switch to local.
5. On the baler control box set the automatic/test switch to automatic. See page 23.
6. Raise the meter bar and ensure LS-11 is activated.
7. At this time you should have 12 volts at TB3-2 (coordinate D6). Relay 3 should set and the voltage at TB1-6 (coordinate F5) will also be 12 volts.

# LS-11 KNOTTER TRIP SWITCH & LS-5 PLUNGER RETURN SWITCH ACTIVATED

Same Schematic that in on page 48



8. If you have 12 volts at TB2-2 (coordinate F3) and not at TB3-3 (coordinate C6), LS-4 is either activated or defective.

If relay 3 is set during the above test procedure it must be released before you engage the tractor PTO and start the baler. If the baler is started with relay 3 set, the knotter will cycle with the plunger retracted, and the needles may be deflected by the crop and break.

To release relay 3:

1. Turn the power switch on in the automatic mode.
2. Ensure the meter bar is down which will release LS-11.
3. If the needle yoke is in the home position LS-1 is activated there should be 12 volts at TB3-4 which should release relay 3.
4. At this time you should have no voltage at TB1-6 (coordinate F5).

Looking again at the schematic view at TB3-2 (coordinate D6) we will now follow the current up to the set coil of relay 2 (coordinate E3). Relay 2 is set at the same time relay 3 is set. (Remember, relay 2, & relay 3 are only used on a tie cycle).

The function of relay 2 & LS-6 on the tie cycle is to prevent the plunger from retracting too far until the knotter has completed at least 1/2 of the cycle. Once the knotter has completed 1/2 the cycle, the twine discs are closed which holds the compacted crop in a completed bale.

If we go back to schematic view on page 44 and look at LS-6 (coordinate D2) you will see that LS-6 has no effect on a normal plunger stroke, here it does however. Looking at relay 2 (coordinate E3) when contact 7 sets to contact 4 the current that is controlling the plunger retract is forced to travel through LS-6, when the plunger retracts far enough to activate LS-6 the current path opens and the plunger will stop.

When LS-12 (coordinate D4) is activated relay 2 will release. It is activated by the knotter halfway through the cycle when the twine disc close, as mentioned earlier. We will follow and discuss this in the upcoming pages.

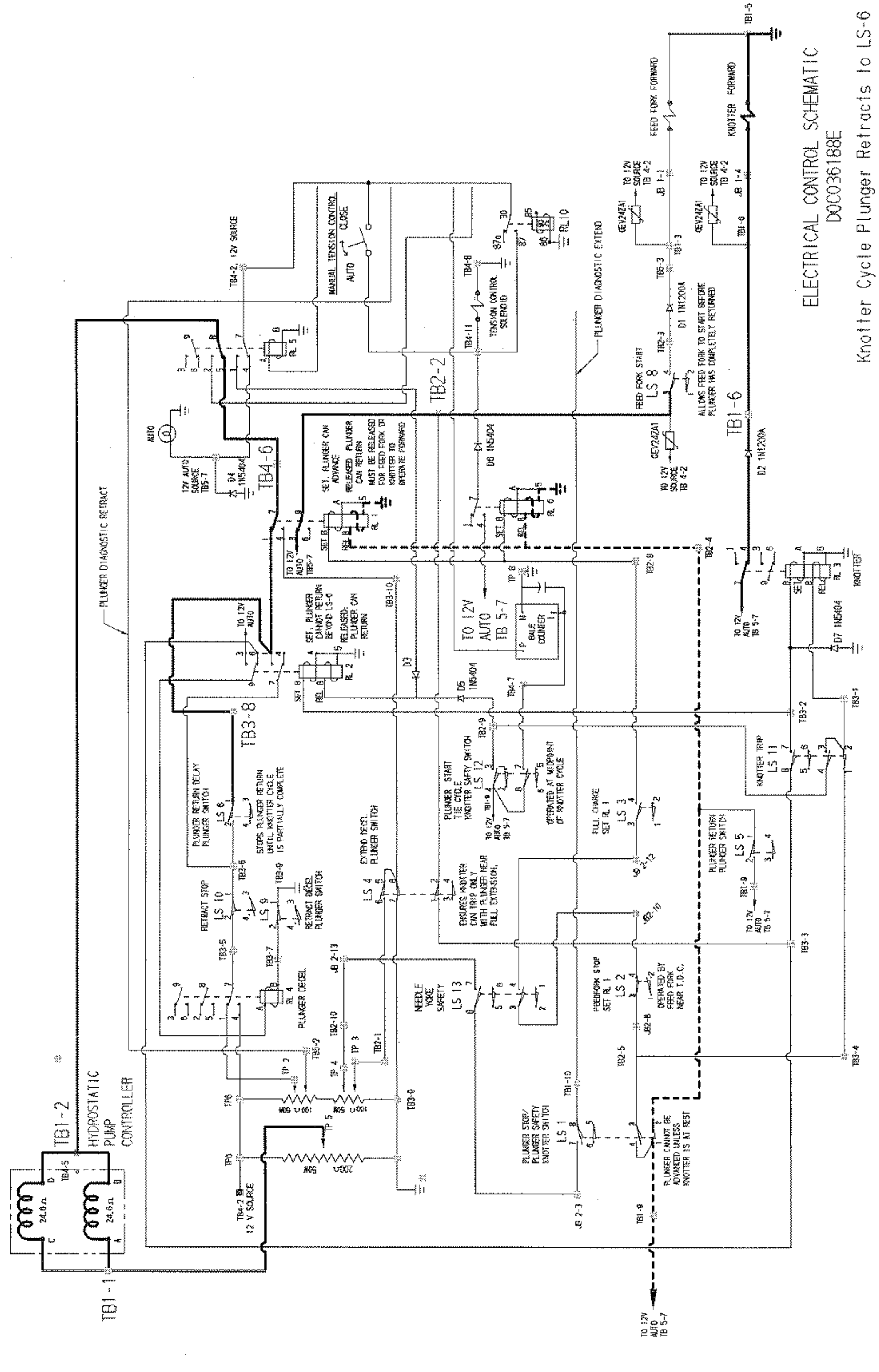
During normal baling operations if watching closely, you might notice the plunger making a slight hesitation when retracting to the LS-6 position. The plunger generally does not stop, as the knotter half cycle is very close in relation to the LS-6 position. If for some reason the knotter does not complete half of the cycle the plunger will stop at the LS-6 position. When this happens the feedfork does not start the feeder and pickup will plug.

If you look at the schematic view at TB3-3 (coordinate C6), recall that the current travels two directions from TB3-3. We have followed to the right, and now we will follow the current to the left, up and over to contact 6 of relay 2 (coordinate E3). When relay 2 was set contact 9 connects to contact 6 and we lost the 12 volts coming from contact 3. This current path from TB3-3 to contact 6 of relay 2 keeps relay 4 set to allow the plunger to retract away from the bale at full speed. This current is only available for 2-1/4" of travel. Just as we have discussed, LS-4 controls all current to TB3-3. When LS-4 is activated relay 4 will release.

As soon as the plunger has retracted and activated LS-4 it slows to decel speed until relay 2 is released by LS-12 or it will stop at the LS-6 position. Later in the hydraulic section the necessity of this fast retract will become clearer as we will talk about the crops tendency to rebound and actually become a driving force on the plunger.

The dotted current path coming from LS-1 (coordinate B4) is discussed in the next section.

# KNOTTER CYCLES AND PLUNGER RETRACTS TO LS-6



## KNOTTER CYCLES AND PLUNGER RETRACTS TO LS-6

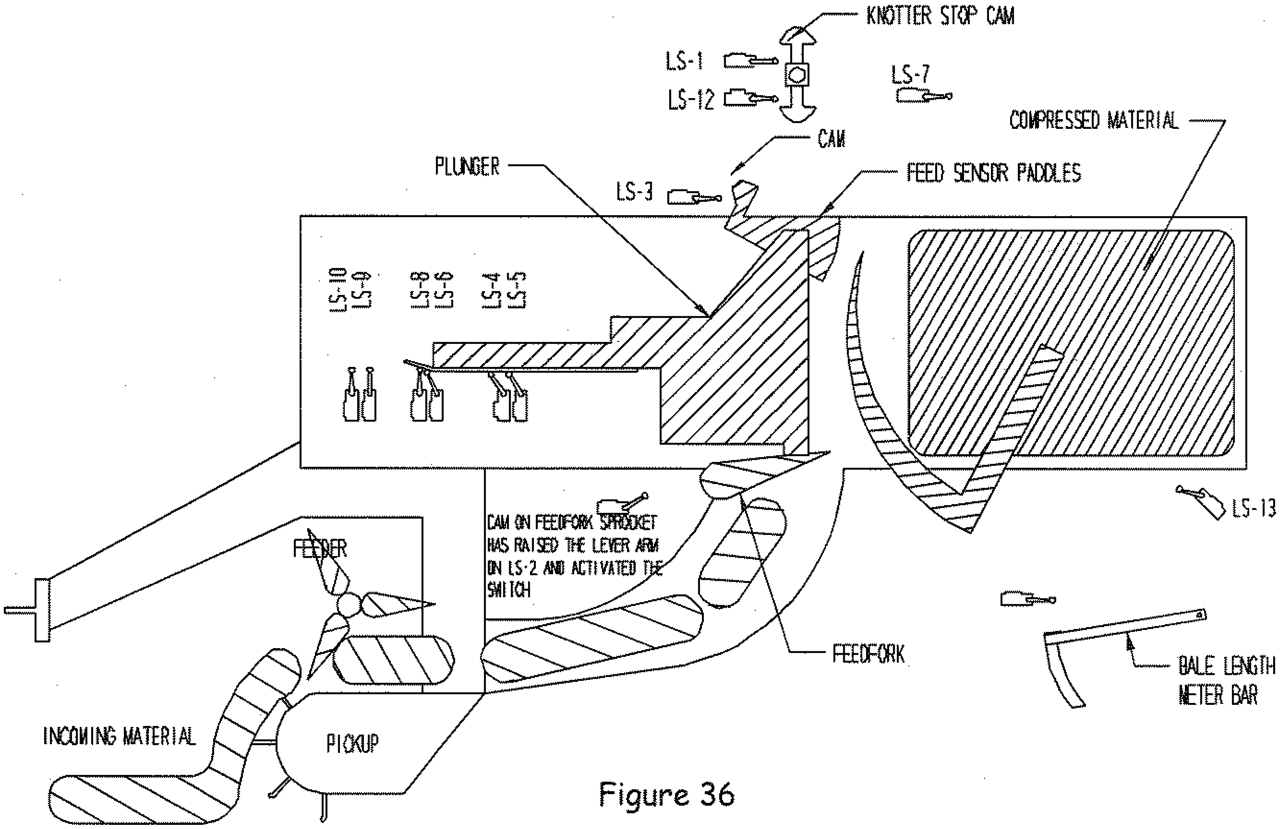



Figure 36

In figure 36 above and the schematic on page 54 the knotter is continuing to cycle. The meter bar has dropped releasing LS-11. The knotter has not yet completed 1/2 of the cycle, but the plunger has retracted to LS-6 and has stopped. It will sit here until LS-12 is activated by the cam on the knotter drive shaft.

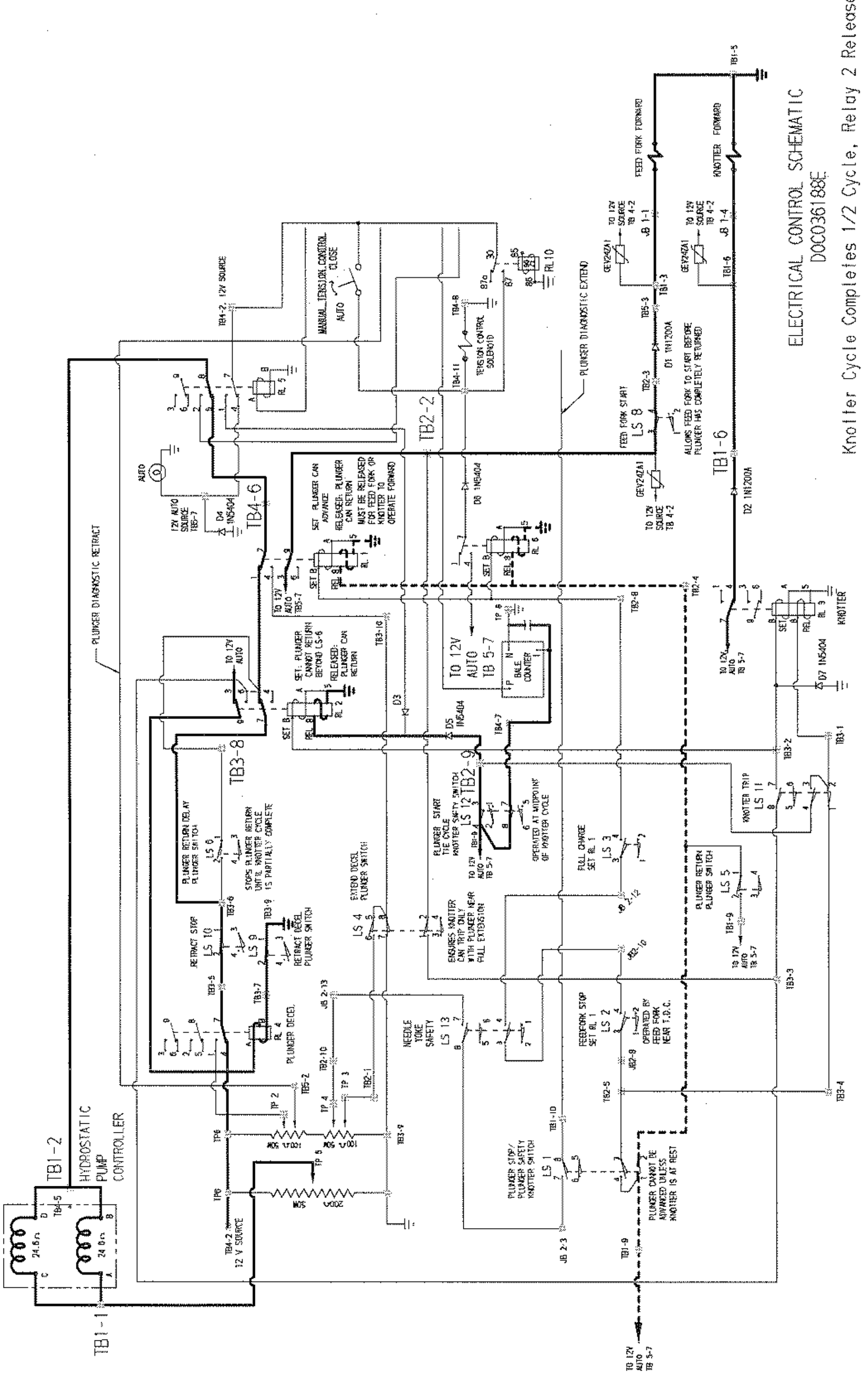
Looking at the dotted current path from LS-1 (coordinate B4), this is a safety circuit that will always apply 12 volts to the release coil of relay 1 anytime the knotter is away from the home position, and the automatic function switch is in automatic. If for any reason the knotter is away from the home position, relay 1 will not set, remember, a magnetic latching relay will not set if 12 volts is being held on the release coil, or vise versa.

When the plunger retracted far enough to activate LS-4 the current going to the set coils of relay 2 & relay 3 was disconnected, but the relays stay set keeping the knotter cycling and stopping the plunger at LS-6 (coordinate D2), as they are magnetic latching relays.

The current going through LS-4 to contact 6 (coordinate E2) of relay 2 was also disconnected which released relay 4 (standard relay) and the plunger retracted from LS-4 to LS-6 at the decelerated speed. Relay 4 is a standard relay so as soon as current is removed from the coil, the relay will release.

As the knotter continues to cycle it will activate LS-12 at top dead center and relay 2 will release, and the plunger will retract at full speed.

# KNOTTER COMPLETES HALF CYCLE, RELAY 2 RELEASES



## KNOTTER COMPLETES HALF CYCLE, RELAY 2 RELEASES

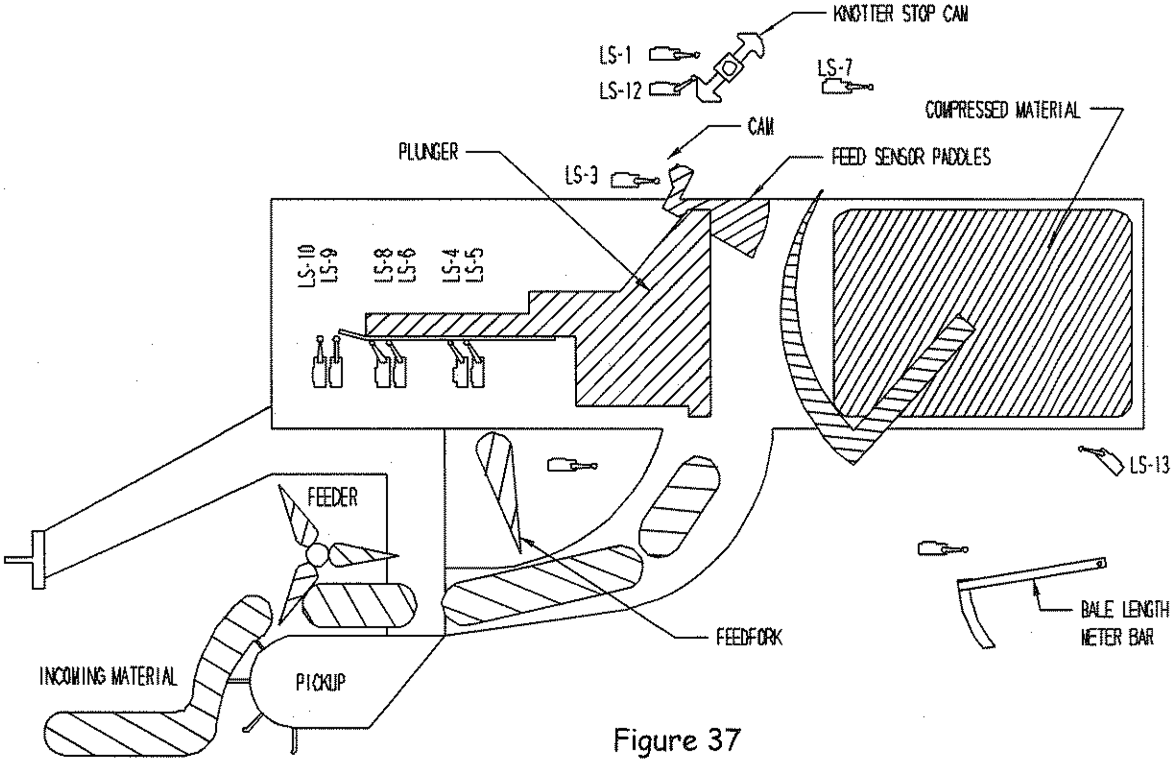



Figure 37

In figure 37 above and the schematic view on page 56 the knotter has continued to cycle and has activated LS-12 and is on the way back down to the home position. Relay 2 has released and the plunger has started its full speed retract cycle. The plunger has retracted and activated LS-8 and the feedfork has started again.

Looking at the schematic view when the knotter cam activated LS-12 (coordinate D4). Contacts 3 & 4 close and the current flows to TB2-9 and up to the release coil of relay 2. When relay 2 releases, contact 9 is connected to contact 3 which sets relay 4 to full speed retract. When contact 7 connects to contact 1 the current path is complete again, bypassing LS-6 and the plunger starts up again at full speed retract.

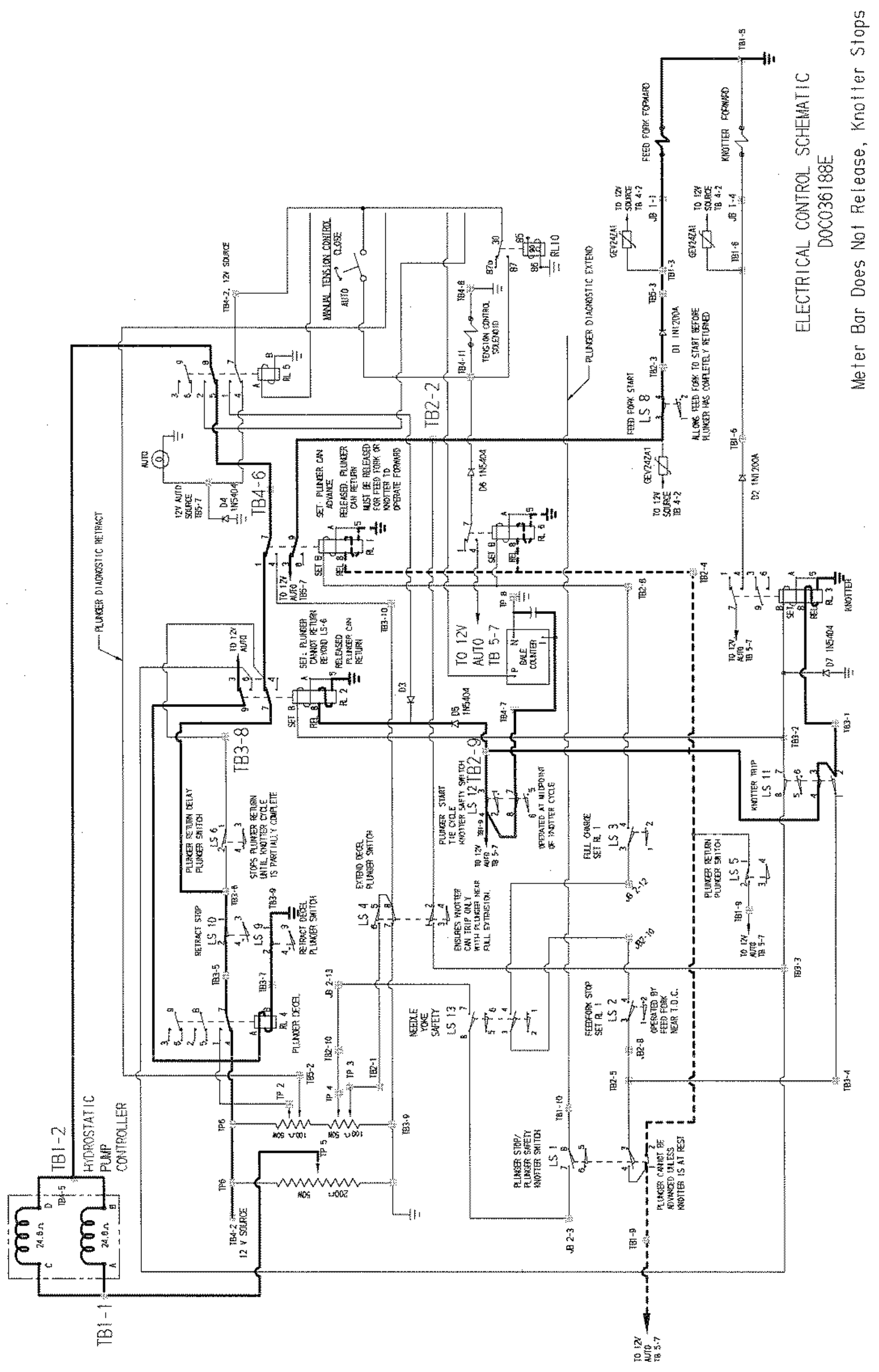
Another function of LS-12 is it is the signal to the bale counter located in the baler control box. When 12 volts is applied to the "I" terminal of the bale counter it advances the counter one digit.

The plunger has retracted far enough now to activate LS-8 (coordinate F5) and current passes through TB2-3 to the feedfork forward solenoid valve and the feedfork will start.

The plunger will now complete it's retract stoke exactly as it does on a regular plunger stroke (see page 45). It will continue to retract to LS-9 slow down to decel speed and will complete its cycle when it activates LS-10.

The knotter completes its cycle and the process starts again for the next bale. When the knotter comes back home the baler is ready for another charge of material exactly as it is shown on page 31 of this manual.

# METER BAR DOES NOT RELEASE, KNOTTER STOPS AT LS-12



## METER BAR DOES NOT RELEASE, KNOTTER STOPS AT LS-12

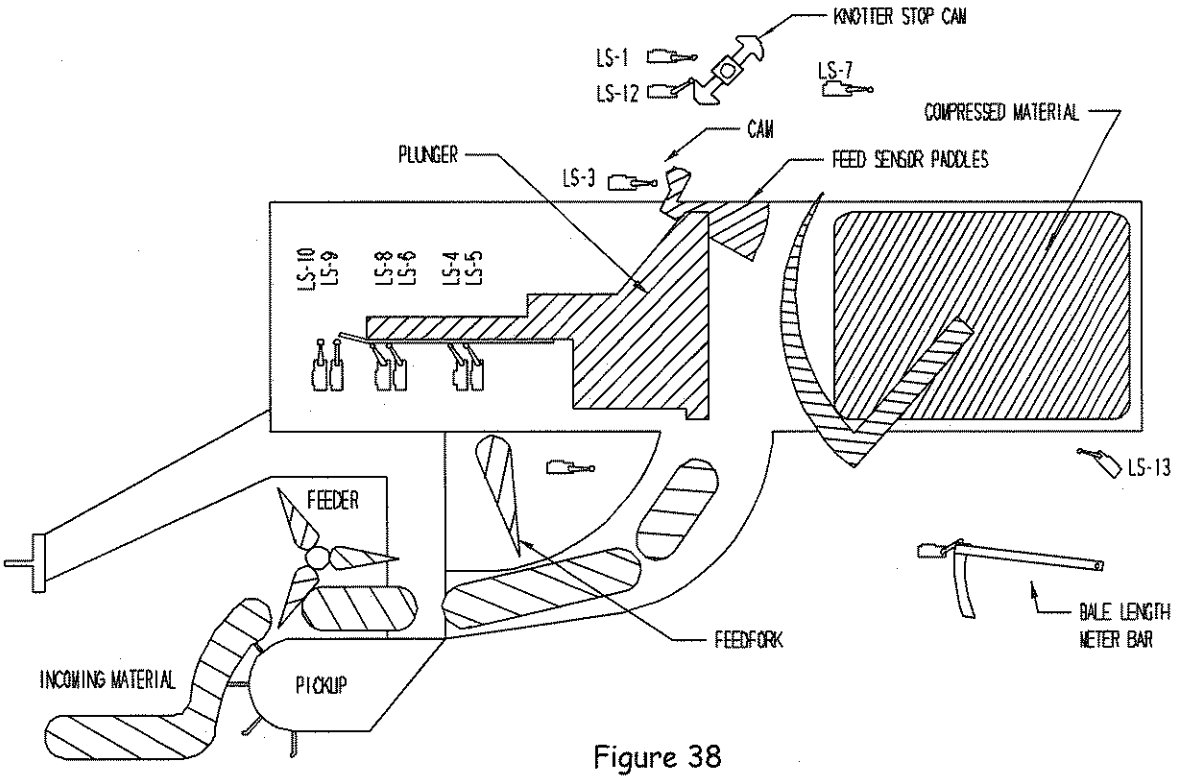



Figure 38

The last thing we will look at is another safety that prevents the knotter from continuously cycling if the meter bar does not drop back down on a knotter cycle. This situation will only happen if the meter bar has a mechanical mishap, such as the pivot mechanism binding and not allowing free operation of the meter bar.

Looking at figure 38 above and the schematic view on page 58 the knotter started its cycle and has stopped halfway through the cycle, as the meter bar did not drop and release LS-11. The knotter cycled and did activate LS-12, so relay 2 was released and the plunger will continue it's retract stroke and continue on home. The knotter will stay at top dead center and the feedfork will stall. The knotter will need to be manually returned to its home position and the plunger will need to be extended using the diagnostic controller.

When using the diagnostic controller in this situation, run the tractor PTO as slow as possible and rotate the knotter forward to complete the tie cycle. This will generally tie the bale as normal, and once the meter bar failure has been corrected you can continue baling and not have to re-bale.

Looking at the schematic view we can see that when LS-11 (coordinate D6) was not released contact 4 & 3 stay closed. There is a jumper wire in the switch body connecting contact 3 to contact 2. Approximately half way through the cycle LS-12 was activated and current is able to pass through LS-11 to TB3-1 and to the release coil of relay 3 causing the knotter to stop.

Next we will look at the hydraulic circuitry that the electrical system controls. We will look at symbols and some hydraulic theory and then study the hydraulic circuits.

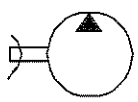
Hydraulic energy has several excellent characteristics that provide us with a system that works well with very little maintenance. Keeping the oil clean with regular filter changes, and keeping hydraulic oil leaks to a minimum are probably the most important functions that will keep a hydraulic system working trouble free.

The 1592 Baler uses three hydraulic filters. One filter on the hydrostatic pump filters all the oil that enters the hydrostatic pump and the plunger cylinder circuit. On top of the hydraulic reservoir is a return filter canister that filters all oil returning to the reservoir. There is also a small suction filter on the tension system pump.

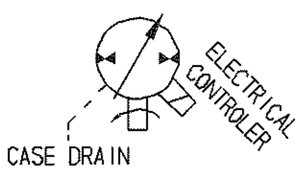
We will start out with the hydraulic symbols and build a simple hydraulic circuit, explaining functions of the components and symbols as we go. The very simplest hydraulic circuit requires a minimum of seven components, eight if we want to have a gauge to monitor hydraulic pressure applied to our actuator.

1. Hydraulic reservoir to store the hydraulic oil.
2. Hydraulic pump to move the oil.
3. Actuator, cylinder, motor or other device to perform the work.
4. Relief Valve to protect the hydraulic circuit from excessive pressure.
5. Control valve to direct the oil and control the working device.
6. Filter to maintain the stability of the oil.
7. Motor or other means to drive the hydraulic pump. A hydraulic schematic will not show the device that is being used to rotate the pump.

Schematic symbol for the hydraulic reservoir (tank). Generally a machine has one reservoir. On the schematic you may see this symbol several times. This is just another short cut so the schematic does not become cluttered with excessive hydraulic paths returning to the reservoir.



Schematic symbol for a hydraulic pump. The one arrow pointing out indicates unidirectional flow (allows oil to flow in one direction only). The shaft with curved arrow indicates it has a rotating shaft that is driven. The baler uses 5 hydraulic pumps; all but the main hydrostatic pump will use this symbol.




Schematic symbol for the main hydrostatic pump. The arrows on either side of the circle indicate that this pump has bidirectional flow (allows oil to flow in two opposite directions). The arrow running through the center indicates that this is a variable displacement pump. This also has a rotating shaft being driven, in this case by the PTO shaft connected to the tractor. The dotted line is the case drain, (oil being returned to tank to cool). The hydrostatic pump controller that we looked at on page 10 of this manual is indicated by the rectangular box on the right-hand side. We have discussed this pump on page 35.

As we start our simple circuit we now have the reservoir and a pump. Which schematically will look like figure 39, we have the pump receiving (suction) hydraulic oil from the reservoir.

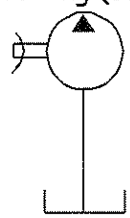


Figure 39

We have discussed the hydrostatic pump which is a piston pump. The pumps that control the pickup, feeder, feedfork and the tension system pump are all Gear Pumps.

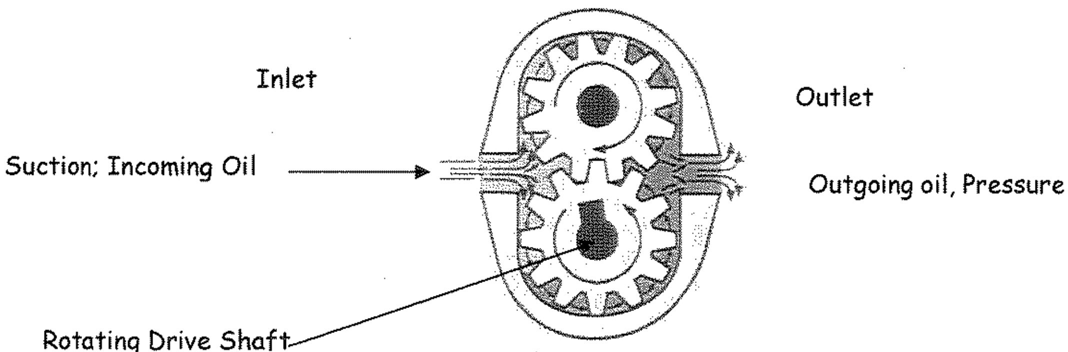



Figure 40

Figure 40 shows a simple cutaway of a gear pump. Oil enters from the suction side, which is the larger of the two ports on the pump; the pressure port is the small port. The drive shaft rotates counter clockwise which rotates the top gear in a clockwise rotation. This configuration pumps hydraulic oil by creating an increasing to decreasing volume. The gears unmesh on the suction side of the pump creating an increasing volume. The oil fills the spaces between the gear teeth and is carried around the gears as they rotate. When the gears start to mesh, this creates a decreasing volume and the oil is forced into the circuit. The pump will pump oil to the circuit, but the pump does not determine how much pressure is applied to the circuit. With little or no down stream resistance, the pump will develop very little pressure. If the downstream resistance is high the pump will apply an equally high pressure, up to the limits of the pump design. All pumps have a maximum pressure that they are able to apply. If this pressure is exceeded severe damage to the pump will occur.

We will now connect a hydraulic cylinder in our circuit and start the pump rotating.

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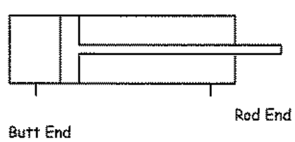



Schematic symbol for a double acting cylinder. It is a double acting cylinder as it has two ports. When oil enters the butt end, the cylinder will extend, and when it enters the rod end the cylinder will retract.

In figure 41 a cylinder is added to our simple circuit. As we rotate the pump oil enters the cylinder, the cylinder extends to its maximum travel and bottoms out. Notice the rod end of cylinder is connected to the reservoir. The pump will continue to apply pressure. If the motor or drive rotating the pump has enough horsepower the pump will continue to apply pressure until either the cylinder blows apart or the pump fails. It will fail either by also blowing apart, or the gears in the pump will start to separate and they will grind away the casing of the pump, which then allows the oil to escape back to the suction side of the pump.

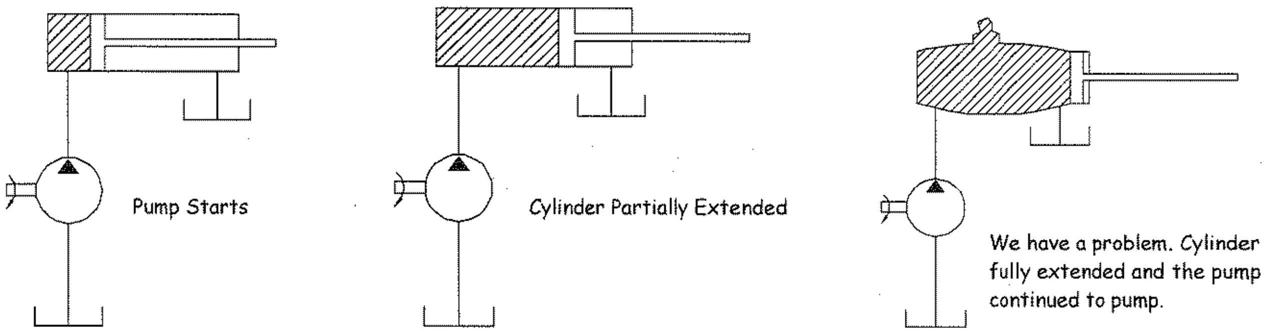



Figure 41

We need to add a relief valve to the circuit to protect not only the cylinder but also the pump and any other components in the circuit. This pressure setting is at a setting that allows the relief valve to open at a pressure that is below the pressure rating of the components in the circuit.

Figure 42 shows a simple cut away of a relief valve. Suppose the maximum desired pressure for our simple circuit is 2000 PSI. For the relief valve below the maximum pressure rating is 2500 PSI, and the minimum is 1000 PSI. If you rotate the adjusting screw all the way counter clockwise the relief valve piston would open when 1000 PSI pressure is applied to the relief valve piston. The only way to accurately adjust a relief valve is by connecting a gauge to the circuit and monitoring the pressure.

If you rotate the adjusting screw all the way clockwise, you completely compress the spring and the relief valve piston can not move upward to relieve the pressure. In figure 42 it looks like the relief valve is at the minimum setting as the adjusting screw looks to be completely backed off (rotated counter clockwise).

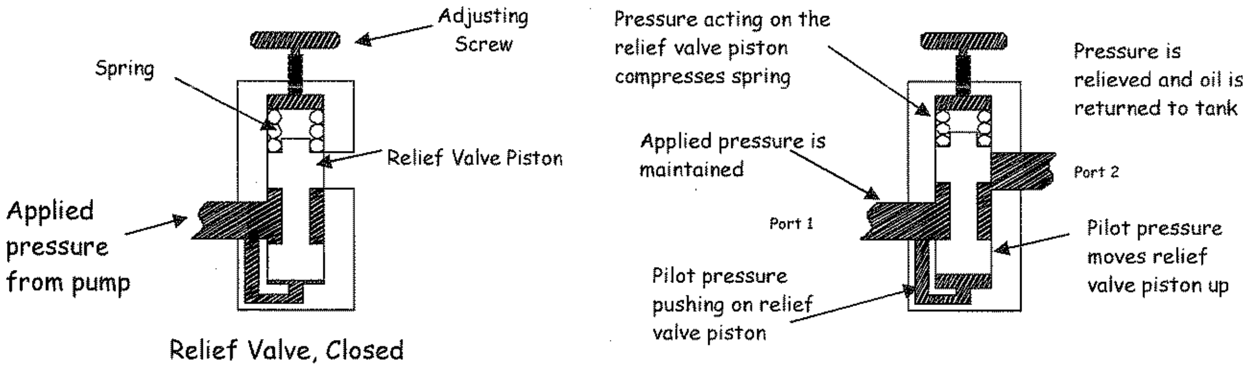



Figure 42

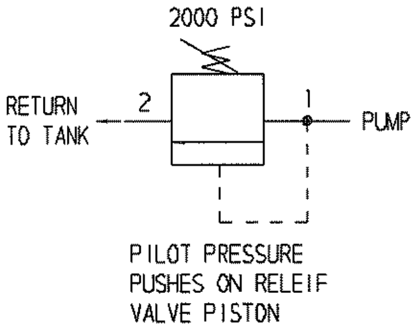



Figure 43

Schematic symbol for a relief valve. The line going to the left (Port 2) is the relieved oil going back to tank. Port 1 is coming from the pump. The dotted line is the pressure that will push on the pilot piston to open it if the pressure in the hydraulic circuit exceeds the setting of the relief valve. The zigzag line on the top represents that the valve setting is controlled by a spring. The arrow running through the spring indicates that this valve is adjustable. The hydraulic schematic will note the pressure setting of the relief valve.

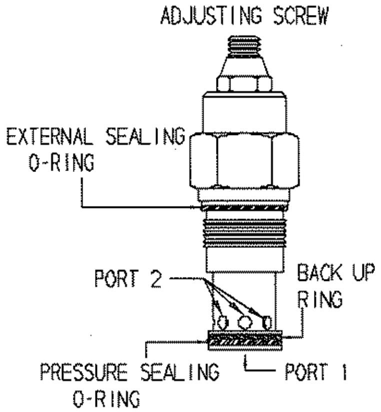



Figure 44

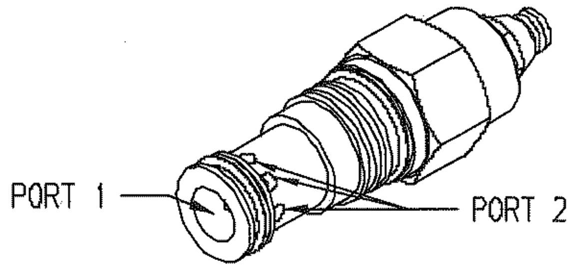



Figure 45

While figure 43 is the schematic symbol for a relief valve, figures 44 & 45 shows what the relief valve looks like in real life. This is a cartridge style valve which means it is screwed into a manifold or block that is specifically machined for this valve. As we have discussed, if the adjusting screw is completely bottomed out (rotated completely clockwise) the relief valve will not open and relieve the pressure. In contrast, if the relief valve piston does not completely close or if the o-ring seals are damaged the system will not be able to build sufficient pressure as there is a path back to tank for the oil to pass.

We have discussed what happens with no relief valve or the relief valve bottomed out; damage results. If the seals are damaged, missing, or if the relief valve piston has a piece of debris in it and can not close; you would see sluggish performance of your cylinder or motor. The hydraulic cylinder may extend until it contacts resistance and requires pressure to push the load. But with the relief valve bypassing pressure the cylinder will stop moving when it encounters resistance.

Usually a hydraulic motor will be connected to a rotating drive. On the baler, hydraulic motors rotate the feeder, feedfork, and knotter. If a relief valve on one of these is stuck open, or adjusted too low the motor will stall when it comes under load and the component will stop rotating. The oil that is required to provide the pressure to rotate it is returning to the tank without performing any work. The relief valve should only open and bypass oil when the cylinder or motor encounter an object or force that is greater then the pressure setting of the relief valve.

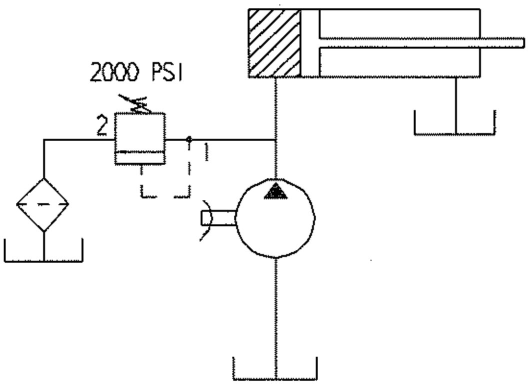


Figure 46

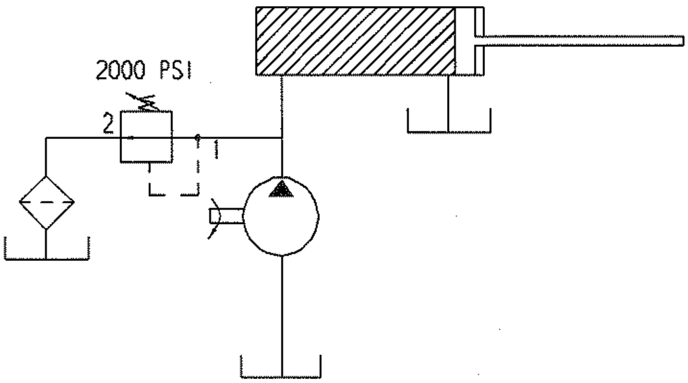
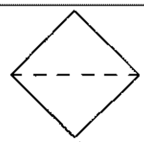
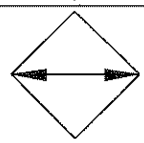


Figure 47

In figure 46 we have added our relief valve and a return filter to the circuit. Now (in figure 47) when the cylinder extends all the way out as soon as 2000 pounds of force is applied by the pump the relief valve opens, port 1 connects to port 2 and the oil that the pump continues to pump, is simply returned to tank.



Schematic symbol for a hydraulic filter.

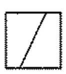


Schematic symbol for hydraulic oil cooler.

You might wonder what pressure the oil being returned to tank is under. The pressure on the oil being returned to tank is only what pressure it takes to move the oil through the return hoses and then through the filter. The return filter in the tank has a 25 pound bypass valve on it. If it takes more than 25 PSI to push the oil through the filters (the filters have plugged), this bypass will open and the oil then will enter the tank through the bypass valve versus the filter. On the gauge panel on the front of the baler we have an indicator that monitors this. See the 1592 Operators Manual page 63.

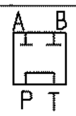
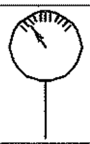
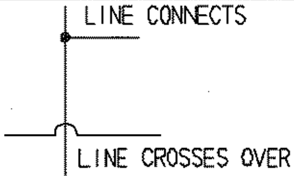
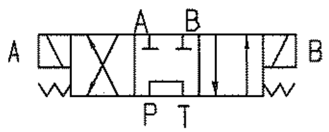
When oil is bypassed through a relief valve, the energy that is being dissipated turns to heat. Excessive bypassing (stalling of a component) causes heat build up that the hydraulic oil cooler might not be able to dissipate.

In figure 47 you can see that our simple circuit schematic is almost complete. We need to add a control valve so we are able to extend and retract the cylinder.



Schematic symbol for an electrical solenoid coil on a directional control valve. In figure 48 on page 65, solenoid coil A is on the left and coil B is on the right. There are more valve controls that we will look at later in the manual.

Schematic symbol for a spring.

| | |
|---|---|
|   | Schematic symbol for a tandem center spool. When the spool is in the centered position oil is able to flow from the pump, down stream to another component or to tank. We will look at different center sections later in the manual. |
|  | Schematic symbol for a hydraulic gauge. |
|   | Schematic symbol for a line connecting is just a dot. If the line crosses over it will have the bridge. |
|   Figure 48 | Schematic symbol for a; 3 position - 4 way - tandem center - solenoid operated directional control valve. The schematic will generally show the solenoid valve where there is no voltage applied to the coils of the valve. The springs indicate that when no voltage is applied to the solenoid coils the spool in the valve is spring centered. |

In figure 48 is the valve we will install into our hydraulic circuit. If we would hook an electrical circuit to the coils we could control the direction of oil flow by energizing coil A or B. If we energized coil A the spool would shift to the right and connect the A port to the T port, and the B port would connect to the P port. Likewise, if solenoid B was energized the A port would connect to the P port and the B port connects to T port. Generally in a hydraulic schematic the P port is connected to pressure and the T port connects to components down stream or to tank.

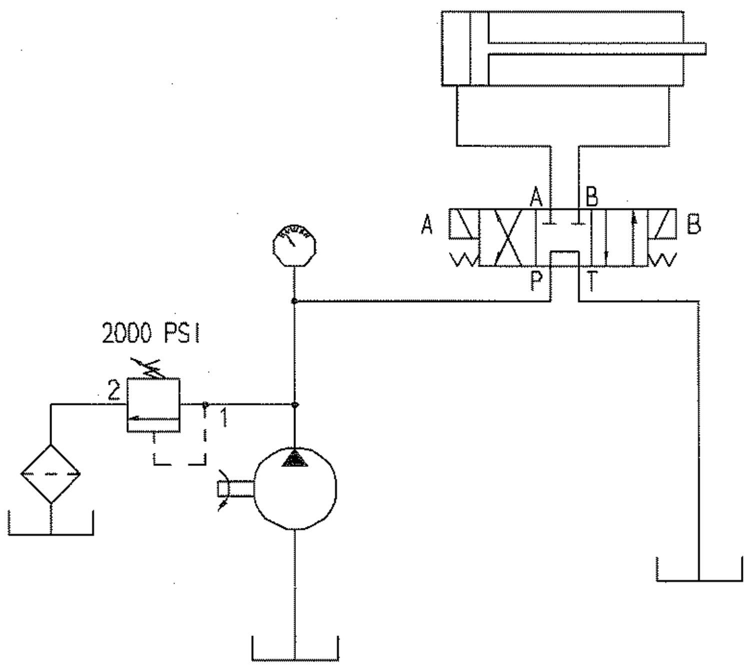



Figure 49

We have now completed our hydraulic circuit. Now with the directional control valve we are able to extend and retract the cylinder, depending on which solenoid coil we energize. Or when the valve is in neutral the oil simply flows through the valve and returns to tank. The last thing we need to do is adjust the relief valve so that we can ensure the cylinder will lift or push the load as it is designed.

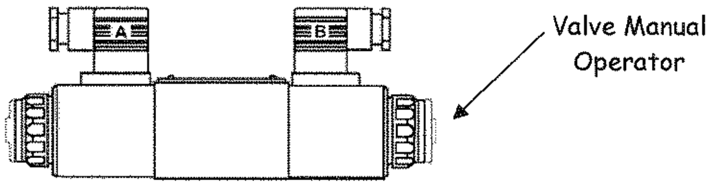



Figure 50

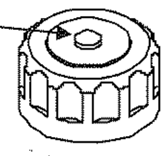


Figure 51

On page 12 of this manual we discussed the solenoid operated directional control valve. On this page there are a few different versions of a solenoid operated directional control valve. Most directional control valves have a manual operator that allows the operator to manually operate the valve during a relief valve setting, or another troubleshooting situation. To manually shift the directional control valve; using a screwdriver push on the manual operator on the end of the valve. Sometimes you might have to push quite hard, as sometimes you may have to over come some residual hydraulic pressure locked in the circuit.

When you replace or install a new relief valve always back the adjusting screw completely counter clockwise, so the relief valve is at its minimum setting. Or if you have adjusted a relief valve and there was no adjustment response (debris in relief valve piston, or blown seals) always turn the relief valve back out several turns. As far as this author is aware, all relief valves adjust as we have discussed, clockwise increases pressure and counter clockwise decrease pressure. This is not the condition of other valves. For example, some counter balance valves adjust opposite of this. Screwing them clockwise decreases the braking/counter balance pressure. If you are ever in doubt check with the manufacture or authorized distributor. When adjusting any valve do not stall the component for more than a few seconds while checking the pressure. Most relief valves are more accurately adjusted if you momentarily stall the component, get a pressure reading, make a small adjustment to the adjusting screw, and then stall again, and repeat as necessary until the desired pressure is achieved.

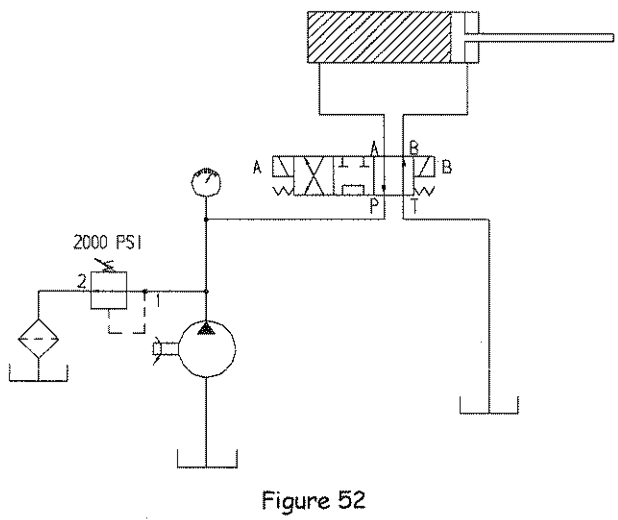



Figure 52

Here us a typical procedure for adjusting a relief valve. Before adjusting the relief valve make sure the relief valve is at the minimum setting. If we stall the system with the relief valve adjusted over 2000 PSI damage could occur to any or all components. Next, using a screwdriver manually shift the directional control valve by pushing on the manual operator on the B solenoid coil end of valve. The cylinder will extend and when it reaches the end of the extend stroke it will stop moving and the relief valve will start to bypass. Because we set the relief valve to its minimum setting we would expect to see approximately 1000 PSI on the hydraulic gauge. Next we release the manual operator and adjust the adjusting screw clockwise to increase this pressure. We rotate it one complete revolution. We stall cylinder again by pushing on the manual operator. This time we notice that the pressure reached 1500 PSI. Release the manual operator and because one revolution gave us approximately 500 PSI we don't want to rotate the adjusting screw one complete turn, instead we turn it only one half turn. When the cylinder is stalled again we see that the pressure has risen to 1800. By repeating this cycle, taking our time and always being aware of what we are doing we will successfully adjust the relief valve to it recommended setting of 2000 PSI. It may take a little longer this way, but we don't run the risk of damaging the components, or inflicting injury to ourselves. A bottomed out relief valve can cause a hand held test gauge to explode.

Extreme caution must be taken when checking hydraulic pressure or looking for leaks. Any fluid under pressure can penetrate the skin and cause personal injury, blindness, or death. Fluid leaks under pressure are not always visible. If a leak is suspected use a piece of cardboard held at a distance to verify leak. If any fluid is injected into the skin, it must be surgically removed by a qualified surgeon within a few hours of injury.

The baler uses several different styles of cartridge style hydraulic valves. There are counter balance valves, logic valves, flow control valves, check valves, and relief valves. One of the things that all these valves have in common is O-ring and backup ring seals. These seals will fail over a period of time. From expanding and contacting due to heat and pressure seals will become brittle and decompose into very small particles. In order for them to escape from the confines of the cartridge cavity and the lands on the valve, the particles are so small they cause no problem. Sometimes when you remove the cartridge portions of the rings will be on the valve, and portions are missing. The portions missing are no doubt captured in the filter and will cause no problems.

The pressure and the oil temperature that the baler is operated at determine the life of these o-ring seals. The higher baling pressure creates more heat shortens the life of the o-ring seals. Customers who bale in the area of 6000 PSI report these seals should be inspected yearly. Customers who bale at pressures around 4000 PSI, generally can go 3 to four years between seal changes. Seal kits are relatively inexpensive and are easily changed. The most important thing when removing a cartridge valve is to ensure that there is no debris around the valve area or in the air that might possibly enter the hydraulic system when the cartridge is removed for inspection.

Flow Control

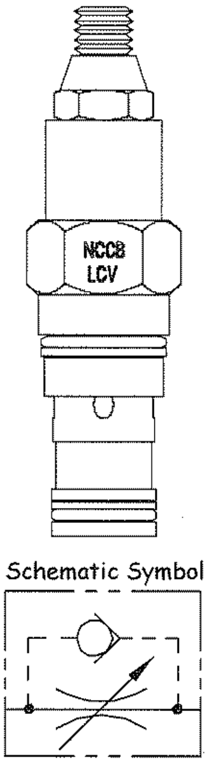



Figure 53

Logic Valve

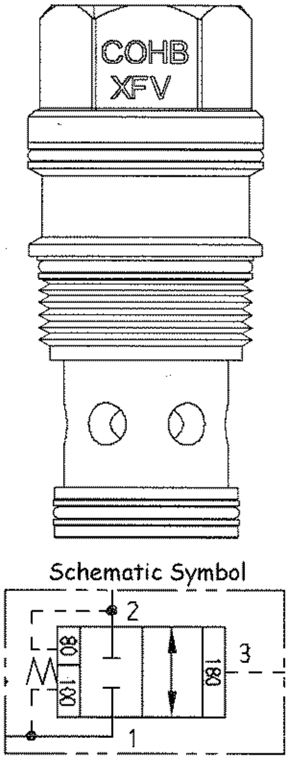



Figure 54

Relief Valve

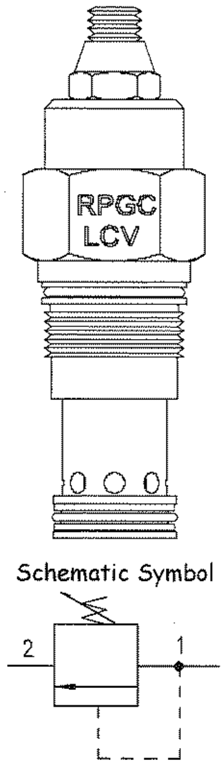



Figure 55

Figure 53 shows an adjustable flow control valve with reverse free flow check valve. On a hydraulic schematic this valve will be contained by dotted lines indicating this a one cartridge valve, as you can have a flow control valve that does not have a check valve and check valves are used frequently all by themselves. Figure 54 is a logic valve and is contained by a dotted line indicating this is one valve. This valve is a three port valve. We will talk about these two valves later. Figure 55 is the same relief valve we discussed previously.

These three valves all perform different functions; the logic valve looks quite different from the flow control valve & the check valve. But the check valve looks very similar to the flow control valve. Sometimes the only way to tell what is what is by the identifying code inscribed on each valve. This is extremely important when replacing seals on the valves. The placing of the backup ring to the o-ring varies from valve to valve, and incorrect placing of the backup ring can lead to premature o-ring failure.

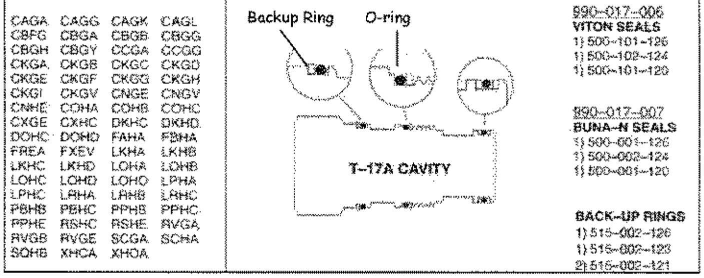
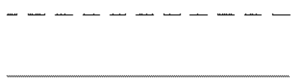


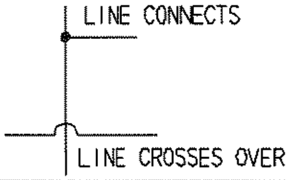

Figure 56

Figure 56 on page 68 is an instruction sheet that you should receive with every seal kit that you order. These sheets list the valves that the seal kit fits on, and also shows how to install the o-rings in relation to the backup rings. Some seal kits may have more seals in them then what you will need. Always apply clean grease to the seals before installing the valves into the cavity.

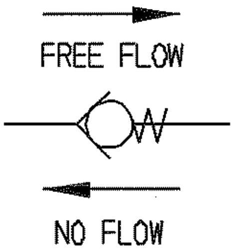
We will now look at the rest of the schematic symbols with a brief description for each.



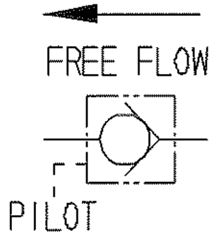
A dashed line represents pilot pressure or a drain line. Sometimes the drain line is a little smaller dashed.
The solid line is the working line, either suction or pressure.



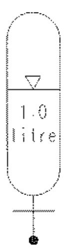

Schematic symbol for a line connecting is just a dot. If the line crosses over it will have the bridge.



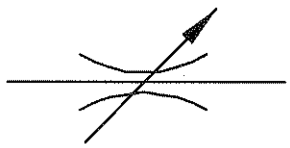

Schematic symbol for a Check Valve. The check valve allows oil to flow (in this orientation) from left to right. The bias spring that holds this valve closed is generally 5 PSI. So it takes a minimum pressure of 5 PSI on the ball to open and oil to flow through. Oil can not flow from right to left.



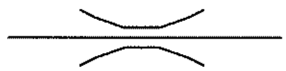

Schematic symbol for a Piloted Closed Check Valve. In this check valve pilot pressure from some external source is holding the valve closed. In order for the valve to open, it must over come the pilot pressure holding the valve closed, or the pilot pressure is opened to a lower pressure source.



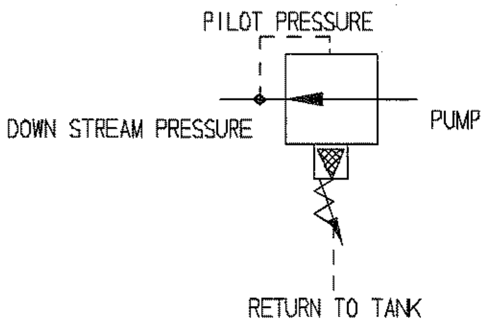

Schematic Symbol for an Accumulator. A container which stores hydraulic oil under pressure as a source of hydraulic power, or a pressurized reservoir that will quickly fill any voids in a system. The inverted triangle in the upper half indicates that the accumulator is pre-charged with a gas. The accumulator on the 1592 is pre-charged to 150 PSI with nitrogen. The pre-charge pressure on the accumulator is a service item that needs to be checked annually.



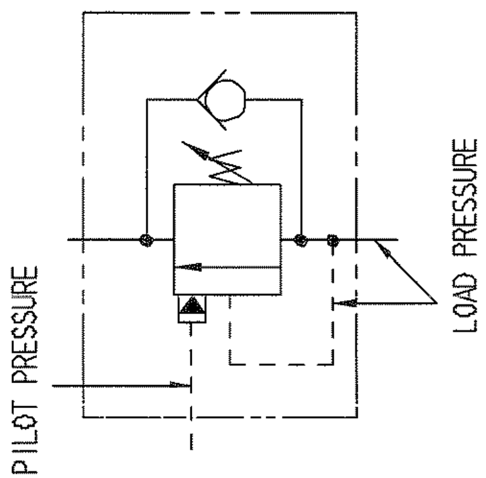
Schematic symbol for an Adjustable Flow Control Valve. This valve limits, controls the flow of oil passing through. The arrow indicates that this flow control is adjustable.



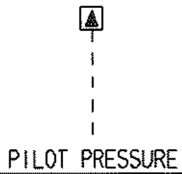
Schematic symbol for an Orifice. This is a non adjustable flow control valve. The oil flow has been predetermined and the size of the orifice is generally noted on the schematic.




Schematic symbol for a Pressure Reducing Valve. This valve acts like a relief valve, only it is reliving downstream pressure. This valve would be set lower than the relief valve in the circuit. It senses the pressure between the relief valve and the downstream component and reduces (closes, shown open) pressure when the predetermined pressure is reached.
The arrow pointing away from the valve indicates that this valve is releasing pressure and returning it to tank.




Schematic symbol for a Counter Balance Valve. Some will also refer to this valve as a braking valve. This valve converts negative overrunning pressure into positive pressure so the components and pumps will always have a positive pressure applied. The counter balance valve has two sources to open the valve. The load pressure coming from the object that is being controlled acts just like a relief valve to open the counter balance valve. Pilot pressure coming from the external source will act on a larger area of the relief valve piston, and will open the valve with pressure that is lower than the pressure from the load source. Counter balance valves are generally rated by pilot ratios. If this counter balance valve had a 3:1 ratio and it was adjusted to open with 1000 PSI on the pilot source; it would still open at 3000 PSI if the was no pilot source pressure applied. NOTE: Most counter balance valves adjust opposite of what is considered normal. Clockwise rotation will reduce the counter balance valve setting.




This arrow pointing into a valve indicates that the valve is actuated by applying pilot pressure.

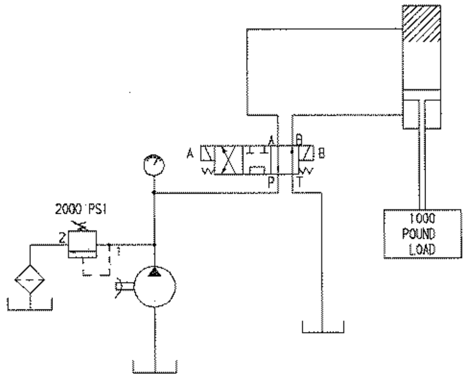



Figure 57

Figure 57 shows the simple hydraulic circuit we created earlier. The cylinder has been rotated vertically and has a 1000 pound load hanging from the rod of the cylinder. Without a counter balance valve in the circuit the cylinder rod and piston could create a negative pressure on the control pressure as the rod extends faster than the supply oil can push against the rod piston.

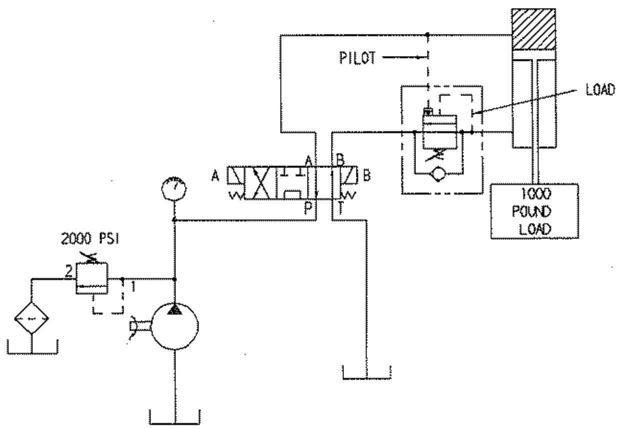
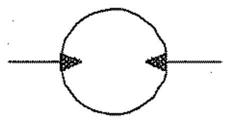
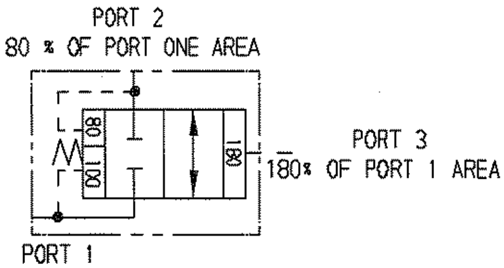



Figure 58

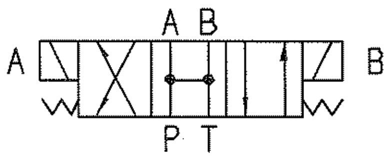
In figure 58 a counter balance valve has been added to the rod end of the cylinder. The cylinder is able to retract normally through the check valve, but now in order for the cylinder to extend the pilot pressures acting on the valve piston have to overcome the spring setting of the valve, so the pump and directional control valve always see positive pressure. If the valve is adjusted to open at 1000 PSI on the pilot source, (rod end) the cylinder will not extend until the pilot pressure acting on the butt end of the cylinder reaches 1000 PSI; or if this is a 3:1 ratio, the valve would open when 3000 PSI is applied to the rod end (load) of the cylinder. We leave the ratio and pressure setting adjustments to the discretion of the design engineer; to properly size the components so the circuits operate properly.



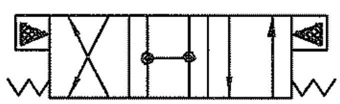
Schematic symbol for a Hydraulic Motor. Notice these arrows point inwards, versus a pump that points outward. Most hydraulic motors are bidirectional indicated by two arrows. If the symbol has one arrow, this indicates that the motor is designed to operate in one direction only.



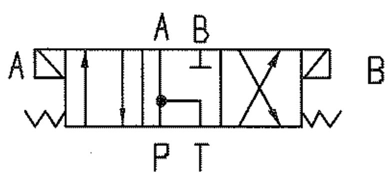

Schematic symbol for a Normally Closed Logic Valve. The logic valve is a two position pilot operated directional control valve that has three different sized areas for the pilot pressure to act on to close or open the valve. Port 2 which is the smallest area is generally always connected to tank. Pressure at port 3 which has the largest pilot area opens the valve with a lower pilot pressure then what is needed at port 1 that keeps the valve closed. If 1000 PSI was applied at port 3, port 1 pressure needs to be below 1800 PSI for the valve to open.



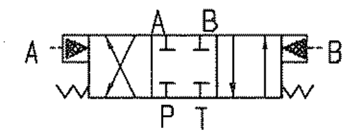

Schematic symbol for an Open Center Solenoid Operated Directional Control Valve. This is a three position, spring centered 4 way valve. In the neutral (shown) position all four ports are connected. This valve will shift when voltage is applied to either the A or B solenoid coil.



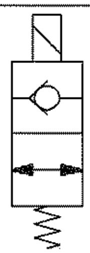
Schematic symbol for an Open Center Pilot Operated Directional Control Valve. This is an identical valve as the one above, except it does not have the solenoid coils to shift the main spool. This valve shifts when pilot pressure is applied to the pilot pistons, which then shift the main spool.



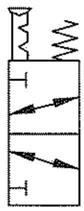

Schematic symbol for a Float Center Solenoid Operated Directional Control Valve. This is a three position, spring centered 4 way valve. In the neutral position shown) ports A, P & T are connected. This valve will shift when voltage is applied to either the A or B solenoid coil.



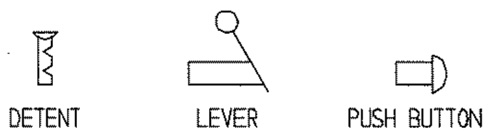

Schematic symbol for a 3 way 4 position Closed Center Pilot Operated Directional Control Valve. This valve shifts when pilot pressure is applied to the pilot pistons, which then shift the main spool. In the neutral position (shown) no ports are connected.



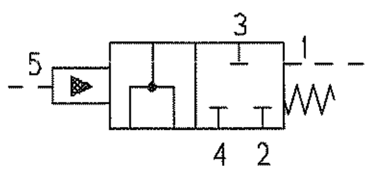
Schematic symbol for a two position two way normally closed Solenoid Operated Directional Control Valve. When the solenoid coil is energized the valve shifts (down) and stops the flow of oil through the valve. This valve is used on the tension system.



Schematic symbol for a two position, 3 way, Manually Controlled directional control valve. This valve is used to open the tension rails on the baler. It is manually operated by the operator. Pulling up on the operator opens the tension rails, and when released the springs returns it to the position shown.




These are schematic symbols for valves that have a manual operator. The valves that these operators are connected to do not have the solenoid coil or pilot symbol. The tension solenoid valve above has a manual operator that is lifted and rotated (detent) to hold it in the shifted position.




Schematic symbol for the tension system unloader valve. This is a Pilot Operated 3 Way, 2 Position Normally Closed Directional Control Valve. Port number 1 is a pilot source that assists the bias spring to keep the valve closed (as shown). When this valve is in operation pilot pressure is increased on port 5 which is trying to open the valve. When the predetermined pressure is achieved, we remove the pilot pressure from port 1 and the valve opens allowing port 4 & 2 to connect to port 3 and the tension system will unload.

Now that we have a fair idea of what it takes to create a hydraulic circuit, and know what some of the hydraulic schematic symbols identify. We will take a look at a few of the hydraulic components that make up the hydraulic system on the baler, and then we will look at the actual hydraulic circuit schematics.

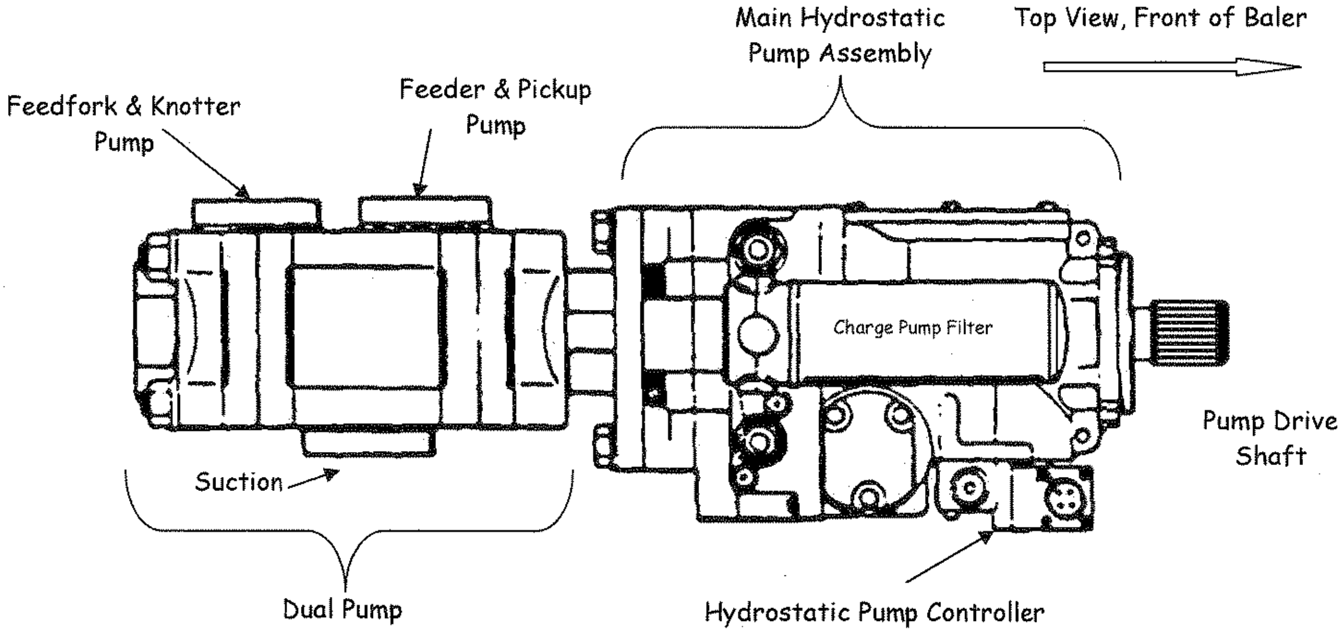



Figure 59

Figure 59 shows the hydrostatic pump and coupled to a dual pump that contains two separate pumps. The dual pump is connected to the rear of the main hydrostatic pump and is driven by the hydrostatic pump.

The main hydrostatic pump assembly contains five main components.

1. Charge pump filter that filters all oil entering the hydrostatic pump.
2. Hydrostatic pump.
3. Charge pump (internal not shown).
4. Charge pump relief valve (not shown in this view).
5. Hydrostatic pump controller.

The controller mounts on the front right-hand corner of the hydrostatic pump, and the filter mounts on the top of the hydrostatic pump. The suction supply for the charge pump is on the lower left-hand side. If the plunger is extending the pressure side is the right-hand side and the suction side is the left-hand side. The charge pump is inside the pump and the relief valve is adjustable from the right-hand side. We will look at this relief valve and location later in the manual. On page 35 of this manual is a brief description on how the hydrostatic pump functions.

The two pumps in the dual pump assembly share a common suction supply have the same displacement and are both driven by the same drive shaft. Other than that they are completely independent of each other. Oil under pressure from one pump can not communicate to the other pump, and one pump can fail and the other one will work fine.

The feeder motor is controlled by a solenoid operated control valve that is connected to the front pump of the dual pump assembly. When one of the solenoid coils on the solenoid valve is energized both the feeder and pickup (which is driven off the feeder) rotate forward. When the other side of the solenoid valve is energized the feeder reverses direction. The pickup does not rotate backwards when the feeder is reversed. The relief valve that protects the feeder/pickup circuit is combined into the solenoid valve assembly. This valve assembly is mounted inside the baler frame on the forward left-hand side ahead of the feeder leg.

The feedfork and knotter are independently controlled by separate directional control valves that are mounted onto a manifold (see figure 60). The manifold also contains the relief valves, and counter balance valves that are used to control each separate component.

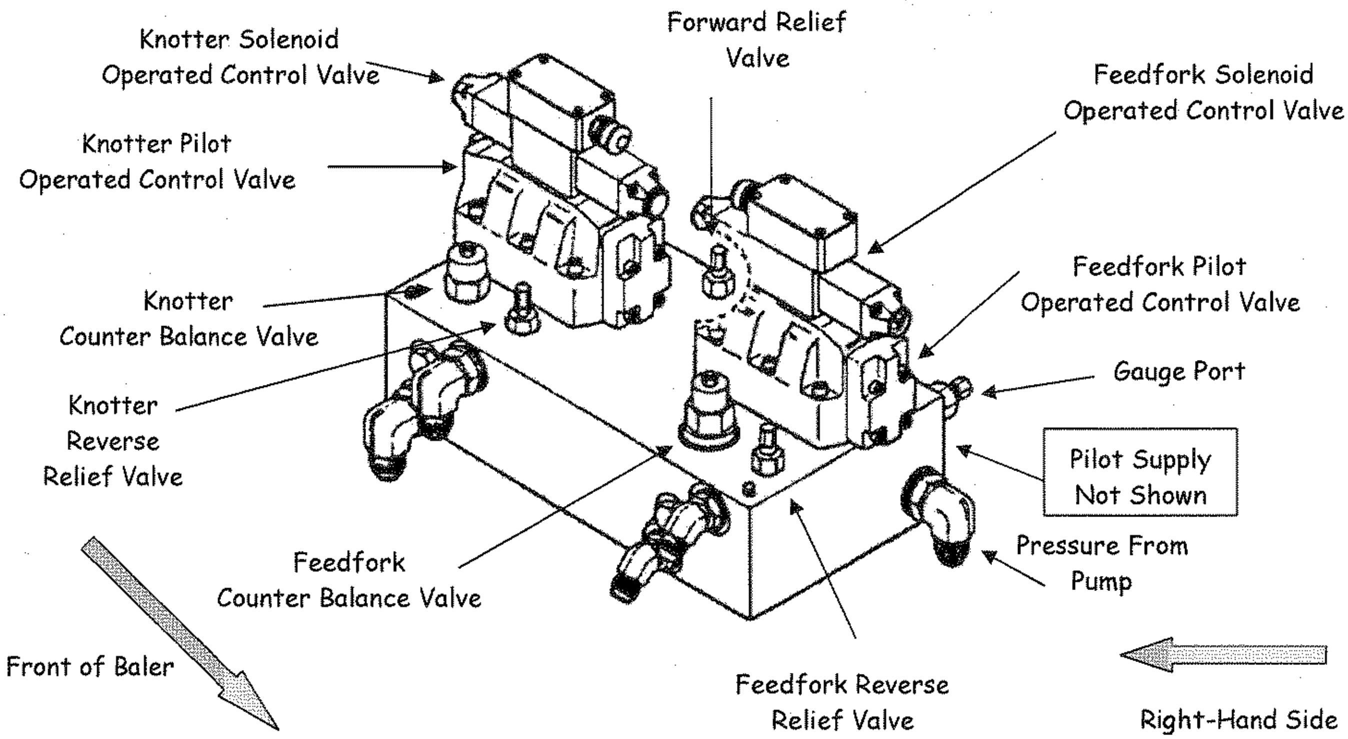
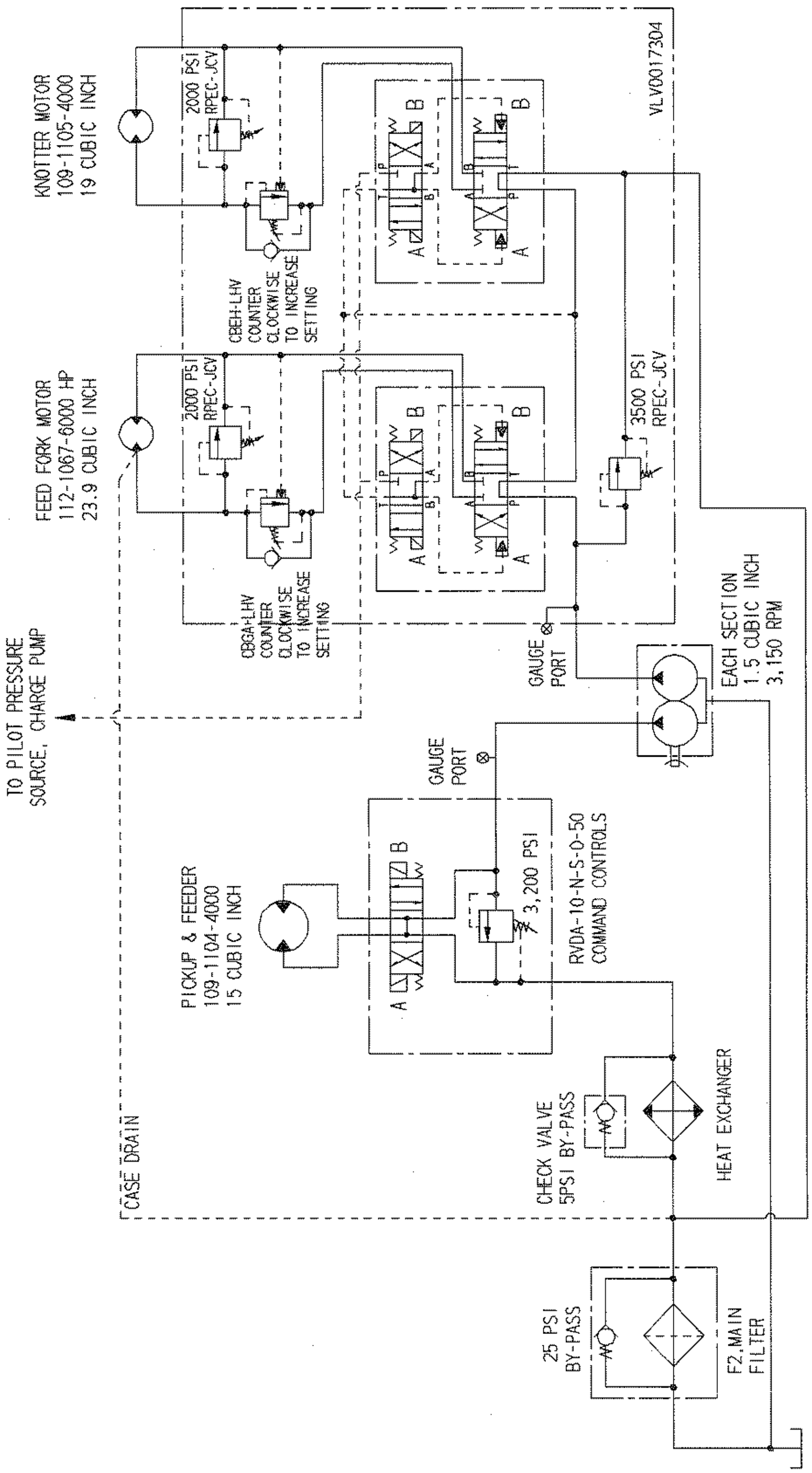



Figure 60

The feedfork knotter manifold sits on the top right-hand frame angle, just behind the hydraulic reservoir. There is one relief valve centered on the inside of the manifold that protects both the feedfork and knotter circuits in the forward direction. There is a separate counter balance valve and reverse direction relief valve for both, and each is controlled by a directional control valve assembly.

The directional control valves for the feedfork and knotter are each actually two valves. The solenoid operated control valve sits on top of the pilot operated directional valve. When the solenoid operated control valve is energized pilot pressure (pilot pressure supply is located on the left-hand side of manifold and is not shown in this view) from the charge pump is directed to the bottom section of the valve assembly (pilot operated control valve). The pilot pressure shifts a large spool in the bottom section and oil from the dual pump is directed to the feedfork motor.

# FEEDER, FEEDFORK & KNOTTER HYDRAULIC SCHEMATIC



The schematic on page 76 combines the feeder, feedfork, and knotter circuits. These are fairly simple circuits and we will start with the feeder circuit.

Each pump of the dual pump assembly is 1.5 cubic inch. Which means on every revolution each pump pushes 1.5 cubic inches of hydraulic oil into their respective circuits. The pumps rotate at approximately 3,150 RPM and there are 231 cubic inches in a gallon of oil. If we take the RPM x cubic inch displaced on each revolution and divide this by 231 (cubic inch per gallon), each pump delivers approximately 20 Gallons per Minute (GPM). GPM is the common measurement when we speak of hydraulic circuits.

The feeder motor is a 15 cubic inch displacement motor, which means it has to be given 15 cubic inches of oil to complete one revolution. We have approximately 4,725 cubic inches of oil per minute coming from the pump so the feeder motor rotates at approximately 315 RPM. Taking into account the ratio of the drive and driven sprockets, the feeder crank shaft will rotate at approximately 162 RPM at full PTO speed. The actual RPM of each component is noted on the schematic.

Oil leaves the front pump of the dual pump, and is delivered to the feeder solenoid operated directional control valve, which has an open centered spool. In neutral as shown, oil passes through the control valve, the heat exchanger (oil cooler), the return filters and returns to the hydraulic reservoir (tank). The open center spool in the control valve allows the feeder to coast to a stop when no material is entering, and when in neutral oil pressure is equal on both the forward and reverse ports on the motor, so the feeder will stay motionless.

If the feeder becomes plugged for any reason (over feeding, feedfork plugged, or foreign object) the relief valve will open when the pump has applied 3200 PSI to the motor that can not rotate due to the obstruction.

The feedfork and knotter operate just about the same way. The feedfork knotter circuit is a series circuit so they share a relief valve for the forward rotation. This is why the feedfork and knotter can not be under pressure at the same time. The knotter and feedfork can run at the same time, as long as the knotter does not require more than what pressure is available.

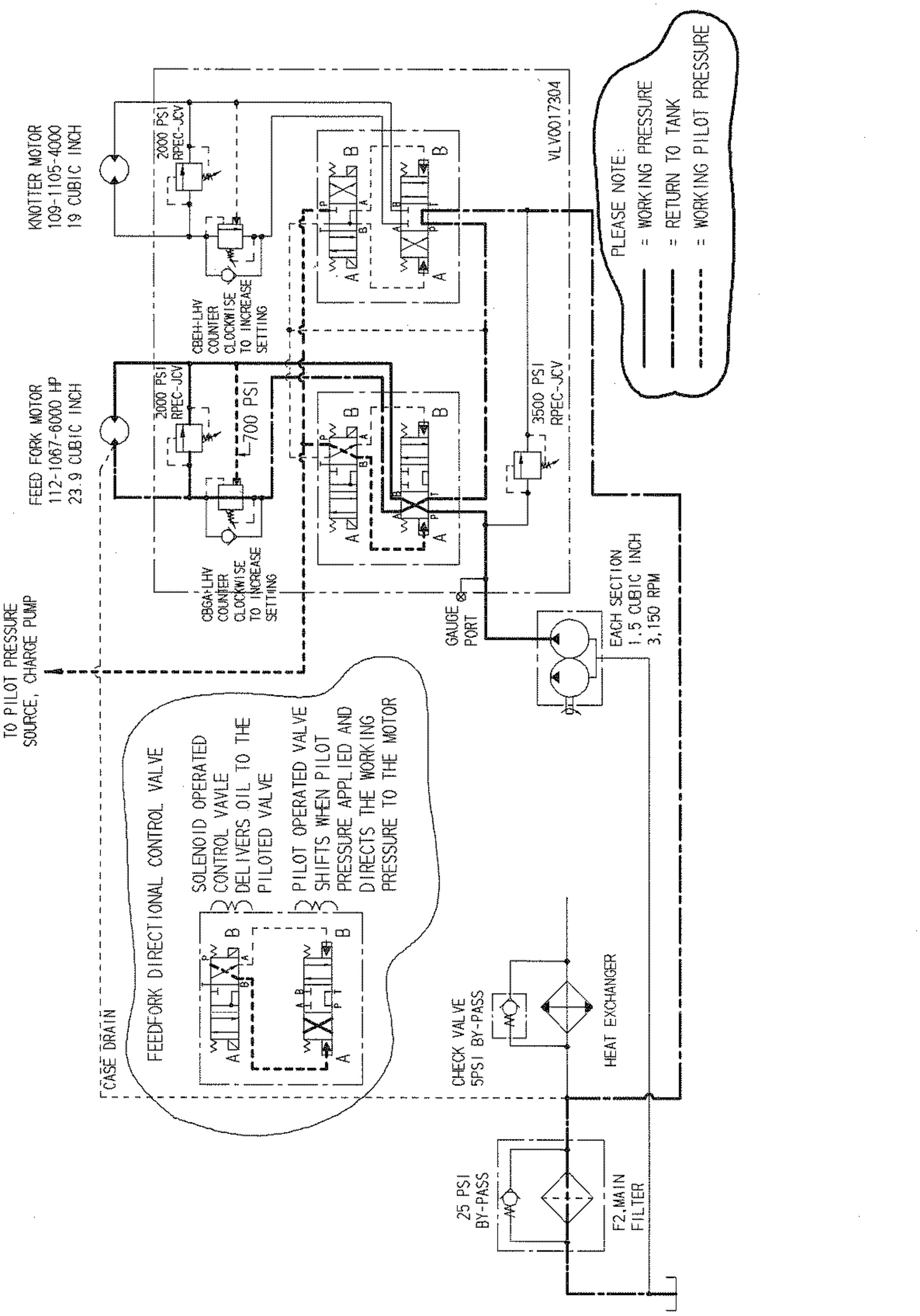
On the schematic there are larger dashed lines surrounding the two directional control valve assemblies, the reverse relief valves, the counter balance valves and the forward, 3500 PSI relief valve. These lines indicate the manifold (block) that these components are located in.

In the center of the schematic you will see a dotted line with an arrow which points to the pilot pressure source which is the charge pump (will see this source in an up coming schematic). If you follow this line to the right it tees off and goes to the "P" ports of the solenoid operated valve on each valve assembly. If the flywheel on the baler is rotating at approximately 400 PTO RPM (approximately 1,200 on the flywheel), there will be approximately 400 PSI of pilot pressure available.

Notice that the solenoid operated control valve has a float centered spool. When the solenoid valve (top) is in neutral, both the "A & B" ports are connected to tank. If you follow these lines down to the pilot operated control valve you will see that both sides of the pilot operators will also be connected to tank. This allows the springs to center the spool which blocks the "A" & the "B" ports.

When the pilot operated valves are in neutral neither the feedfork nor the knotter can rotate, as there is no place for the oil from the motor to escape to.

# FEEDER, FEEDFORK & KNOTTER HYDRAULIC SCHEMATIC FEEDFORK RUNNING



On page 78 the circuit paths have been highlighted as indicated in the note (the feeder circuit has been omitted to make room for notes on the directional control valve). Oil leaves the rear pump of the dual pump (working pressure) and is delivered to the knotter/feedfork manifold (VLV0017304).

This is a series circuit and the feedfork and knotter share a common relief valve for the forward direction. The relief valve is the first item in the circuit as it protects the entire manifold. This relief valve is set at approximately 3500 PSI and is closed as we are not baling any hay.

When we turn the power to the baler on in automatic mode, 12 volts is applied to the forward (B) coil of the feedfork solenoid operated control valve. This shifts the spool and connects the P port to the B port sending pilot pressure to the pilot operated valve. Pilot pressure shifts the pilot operated directional control valve spool and connects the P port to the B port and oil from the dual pump is delivered to the feedfork drive motor.

In this schematic we show that we have approximately 700 PSI. We need 700 PSI as a working pressure so we can open the counter balance valve to allow oil to flow through the motor. The oil can not pass through the check valve, and so momentarily the motor can not rotate until we build 700 PSI and open the counter balance valve.

The adjustment for this counter balance valve should be as low as possible, without the feedfork running away from the motor, and not exceed 700 PSI. If the counter balance valve is set too low you will notice a zinging over running action as the feedfork passes over top dead center and starts back down.

If the counter balance valve is set two high the following can happen: (1) Excessive heat can build. (2) The higher the counter balance valve setting the lower our effective working pressure is to deliver hay into the chamber. (3) You may notice a jerking, slam bam, motion as the feedfork starts up. This is caused as we have to build such a high pressure to open the counter balance valve to get the motor to turn and as soon as the motor starts to turn it requires less pressure. The working pressure drops off and the counter balance valve slams shut again.

Once we get the feedfork motor turning the oil flows through the manifold and returns to tank. If the feedfork (or knotter) becomes plugged for any reason (over feeding plug, or foreign object) the relief valve opens. The pump applies 3500 PSI to the motor that can not rotate due to the obstruction and the oil is returned to tank through the relief valve.

You will notice that there is no counter balance valve action if the feedfork (or knotter) is operated in reverse. They very seldom operate in reverse and this action is not needed. If the feedfork plugs by over feeding the easiest way to clear the plug is to manually extend the plunger using the diagnostic controller and return the operation mode to automatic. The plunger will automatically retract and the feedfork should start as normal and clear the plug. Depending on the amount of material, you may have to extend the plunger more than once.

The knotter operates the same way as the feedfork, although it remains motionless for the most part and only operates when a bale is being tied. The counter balance valve for the knotter uses the manufactures factory setting and should never need to be adjusted.

The reverse relief valve setting for both the knotter and feedfork is 2000 PSI. You will notice that the reverse relief valve drains into the forward (pressure) side of the motor. If sluggish performance is noticed on the feedfork or knotter and seals on the valves is suspected, do not over look the reverse relief valves. If the seals on the nose of this relief valve are missing the oil will take the path of least resistance and pass though the relief valve cavity and return to tank.

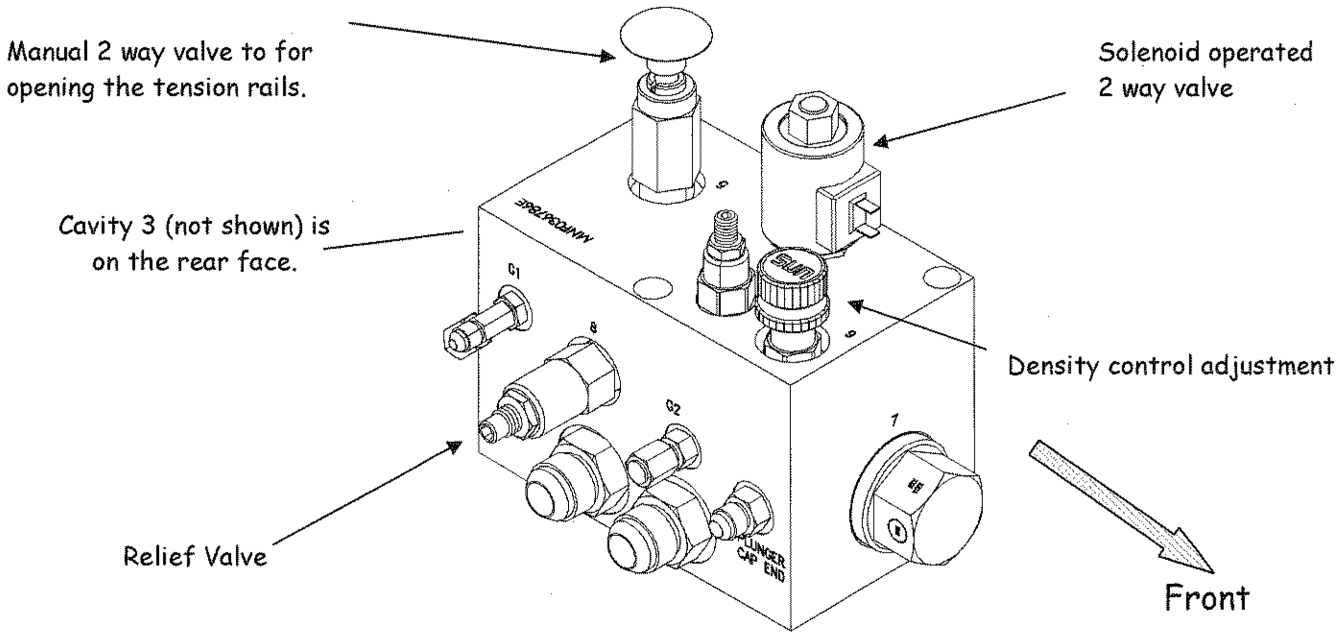


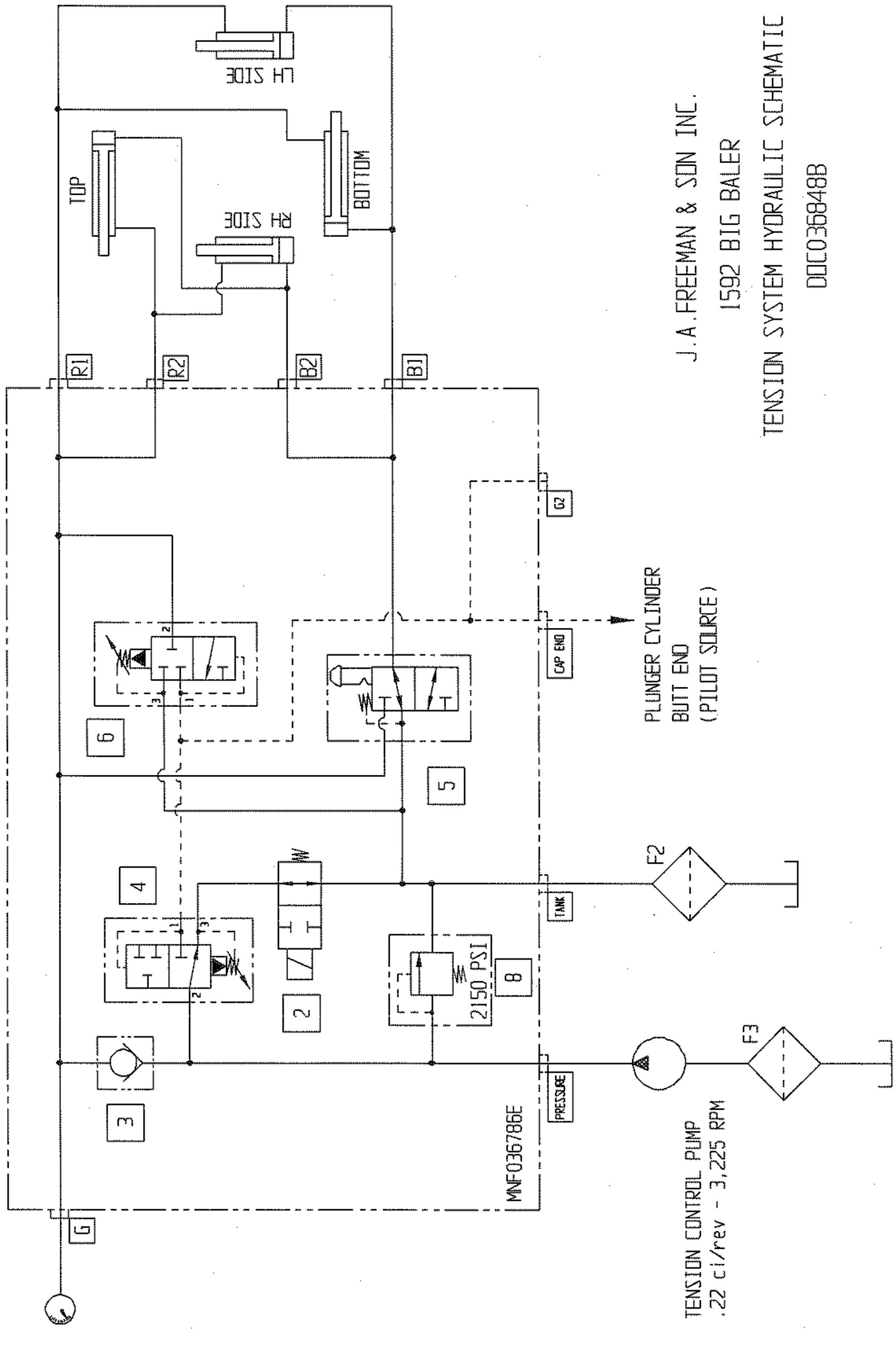

Figure 61

Figure 61 above shows the tension system manifold. This manifold is located on the right-hand rear side of the baler, by the service ladder storage location. The cartridge valves are identified on the manifold with numbers, and cylinder and gauge ports are identified by letters. These numbers and letters correspond to the same numbers and letters on the hydraulic schematic.

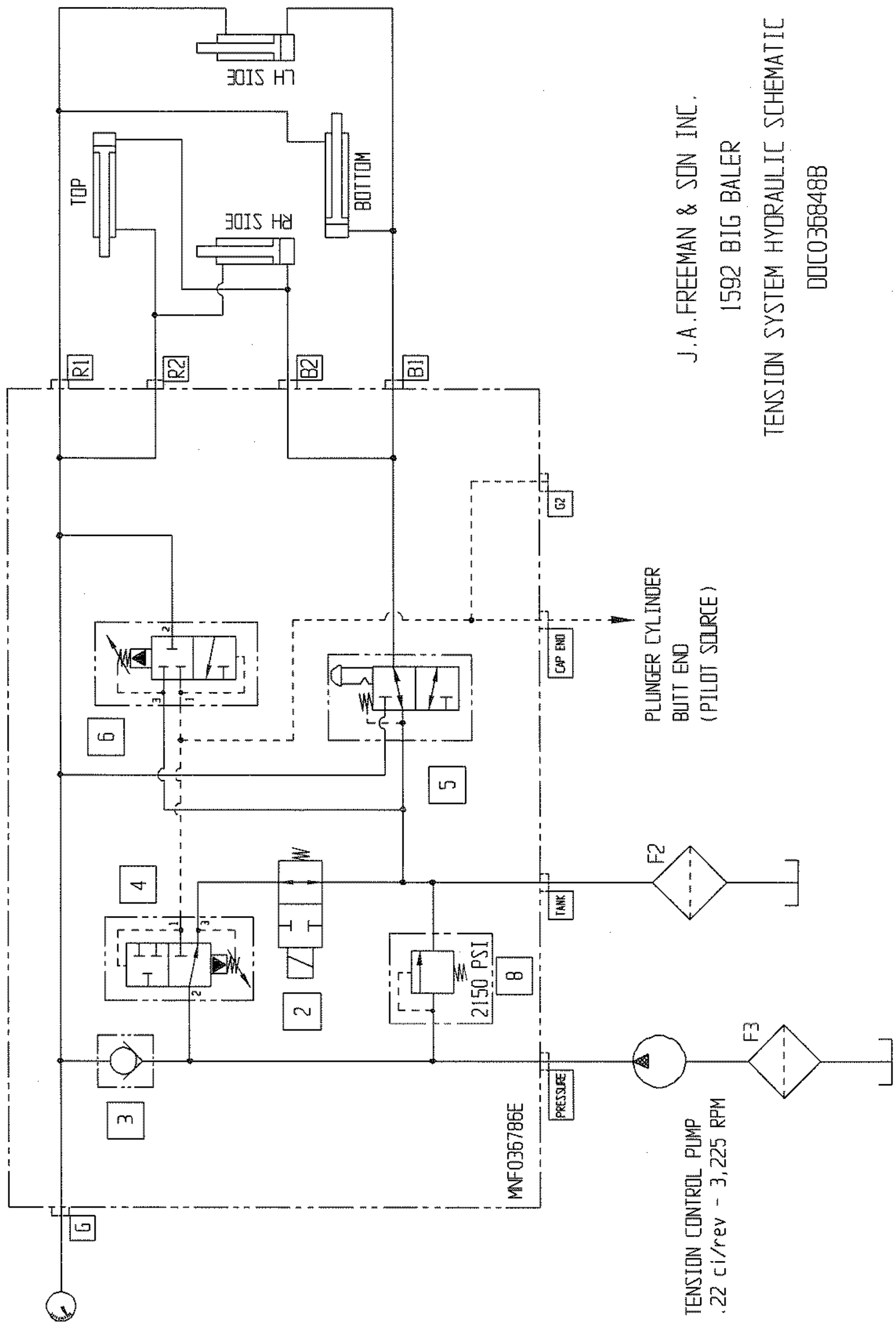
The relief valve is in cavity number 8 and is set to 2150 PSI. Cavity number 6contains the density control valve. Clockwise rotation increases bale density/plunger pressure. Cavity 3 contains a check valve that prevents the system from losing pressure between plunger strokes. Cavity 2 contains the solenoid operated 2 position directional control valve. Cavity number 5 contains the manual 2 position valve to open the tension rails. Pull this valve up and rotate it 90 degrees to hold the valve open. For normal baling operation keep this valve in the closed (down) position. Cavity 7 has no function and contains a plug (you will see no reference to cavity 7 on the schematic).

The ports to the hoses are called out on the schematic. The manifold has two gauge ports. The G port is connected to the tension system gauge that is on the front gauge panel of the baler. This gauge tells you the pressure being applied to the tension cylinders. The G2 port is for troubleshooting purposes. The pressure at this port reads the same as the main gauge on the front of the baler. The tension system for the most part is a stand alone system. The only connection to the baling process is at the Cap End port. The Cap End port is connected to the butt end of the plunger cylinder. If you read 4500 PSI on your plunger pressure gauge, 4500 PSI is also being applied to the unloading system. The Cap End pressure, the main cylinder pressure and the G2 port pressure reading is one and the same

# TENSION SYSTEM HYDRAULIC SCHEMATIC



# TENSION SYSTEM HYDRAULIC SCHEMATIC



## TENSION SYSTEM HYDRAULIC SCHEMATIC

The tension system hydraulic pump delivers .22 cubic inches of oil each revolution. The pump rotates at approximately 3,225 RPM when the baler is operating at 1000 PTO RPM (pump delivers approximately 3 GPM at full speed). The plunger extends in just less than one second, during the plungers extend stroke the tension system pump will deliver approximately 6 ounces of oil.

In the schematic view, the tension system solenoid valve (cavity 2) is shown not energized, which means the valve is open and oil is allowed to flow through it directly to the reservoir. When the solenoid is energized, the valve shifts closed. With the direct path to tank blocked, the oil must travel through number 3 check valve and close the tension rails by filling the rod ends with oil. If you remember, the tension system solenoid valve is energized when relay 6 sets (page 33). Since relay 6 sets at the same time as relay 1, you should keep in mind that the tension system should be energized every time the plunger begins it's extend stroke.

If the tension system was empty it would take several plunger strokes (closing the solenoid valve) to fully pump the tension cylinders full. For this reason the operator may chose to pump the system up to pressure manually before starting to bale. To manually pump the system to 2,150 PSI, switch the automatic/manual switch in the remote control box (item 2, figure 23, page 22) to manual, or the tension control switch on the rear of the main baler control box (item 19, figure 24, page 22). By switching either of these to the manual position, 12 volts is applied to energize the solenoid valve, which closes the valve.

Once the tension cylinders are full the tension pressure will hold at 2150 PSI unless the pressure is relieved through valve #6. Looking at this valve in the schematic, we can see that this is a normally open two position, two way, pilot operated directional control valve. This valve has 3 ports. Port 1 is connected to the cap end (butt) of the plunger. Port 2 is connected to the tension system pressure that is being applied to the tension cylinders and port 3 is connected to the tank. As the plunger extends and compresses the material, the pressure in the plunger cylinder will increase. Pilot pressure from the cap end of the plunger cylinder is applied to port 1 and works against the spring in the valve. Once the pilot pressure overcomes the spring adjustment (six turns = 4500 PSI), the spool in the valve shifts and port 2 is now connected to port 3, which connects the tension system pressure to tank and unloads the tension system. "To tank" means the path is opened to the reservoir which allows oil to leave the hydraulic system, which results in a reduced pressure being applied to the tension cylinders. The pressure applied to the tension cylinders should drop just enough to allow the hay to slide in the chamber using a steady 4500 PSI in the plunger cylinder.

To help understand this process, consider the following example. Let's say we have our system pumped full and are ready to bale. For sake of discussion, we will assign some random values to help describe our imaginary baling session. None of these numbers are intended to be actual recommended settings for any specific crop condition. The hay we will start baling with is on the dry side, about 11% moisture. Suppose we turn the density control valve (cavity/valve number 6), six turns clockwise.

This tightens the spring in the valve such that it is going to take 4500 PSI of pressure to open. Note: If the tension pressure is at zero when you start baling, it may take two to three plunger stokes to stabilize the tension system. You will notice that on these first couple of strokes the plunger does not achieve the full 4500 PSI.

We have our system pumped up but as we have been talking it has lost a couple hundred PSI. This is not uncommon as in the chamber the bale under pressure can compress somewhat which reduces the force on the cylinders. However as soon as the plunger leaves its home position (relay 1 & 6 set) the solenoid valve (valve 2) closes and the system pumps back up to 2,150 PSI.

As the main cylinder extends the tension cylinders clamp down tight on the bale and restrict its movement. The plunger continues to extend and it starts to build pressure, when the working pressure in the main cylinder reaches 4500 PSI valve number 6 opens. When valve number 6 opens (port 2 & 3 connected) it connects the rod (pressure end) of the cylinders to tank (and also their butt ends). This allows the extra pressure in the tension system to be relieved (unloaded).

If we were watching the tension system gauge on the front of the baler, it would have pumped up to 2150 PSI, held there for a split second and then dropped down say to 1800 PSI. This 1800 PSI would be the pressure that was required to restrict the bale, allowing the bale to advance without requiring more than 4500 PSI plunger pressure.

This hay as we said earlier was at approximately 11% moisture. If the hay was at 19% moisture the pressure required to restrict it would be less, as wetter material has more friction and therefore requires more plunger force to slide through the chamber. So baling a wetter material we would expect our tension system pressure to unload more oil to tank, dropping tension pressure down to maybe 1200 PSI. Our plunger pressure stays the same however, at 4500 PSI as we have not adjusted the number 6 valve (remember at our setting it takes 4500 PSI from the plunger cylinder to unload the tension system). The only thing that has changed is the moisture content of the material we are baling.

Let's say that with this wetter material we find that it needs less compacting for the bale density stays the same. This will require an adjustment to the number 6 valve. We screw it out one turn counter-clockwise to decrease the unloading pressure. It may take a stroke or two for the system to adjust and settle in, but shortly we will see that the plunger pressure decreased to 4000 PSI, and our tension system unloading pressure also decreased, to around 1000 PSI.

When we are baling at 4500 PSI plunger pressure and 1800 PSI of tension pressure we would expect the tension system to pump back up to the 2150 PSI on every plunger stroke and then unload down to 1800 when the plunger approaches 4500 PSI. This is possible because not much oil must be added to the cylinders to reach a tension pressure of 2150 PSI.

This is not the case if we were baling with the 19% hay, which only required 1000 PSI of tension system pressure. In this situation the tension pump may only supply enough oil to build tension pressure back up to 1500 or 1600 PSI. Remember that the tension system only supplies oil to the cylinders when the plunger is extending. In this brief amount of time the pump can supply only about 6 ounces of oil.

The point of this exercise is to demonstrate that 2150 PSI is the maximum tension pressure that can be attained; it does not necessarily need to be reached on every plunger stroke. The purpose of the tension system is to provide just enough restriction on the material that a consistent, predetermined plunger force is needed to compress it. This system is operating properly as long as the plunger system reaches the unloading pressure and the tension system is unloading on every plunger stoke. This provides firm bales with uniform density in virtually any material regardless of desired bale weight.

Valve number 4 in the manifold is the same style valve as number 6. This valve is an added backup for the number 2 solenoid valve. If the number 2 solenoid fails you are still able to bale, as the number 4 valve will close and perform the same function as the number 2 valve, when the pilot pressure from the main cylinder reaches approximately 2000 PSI.

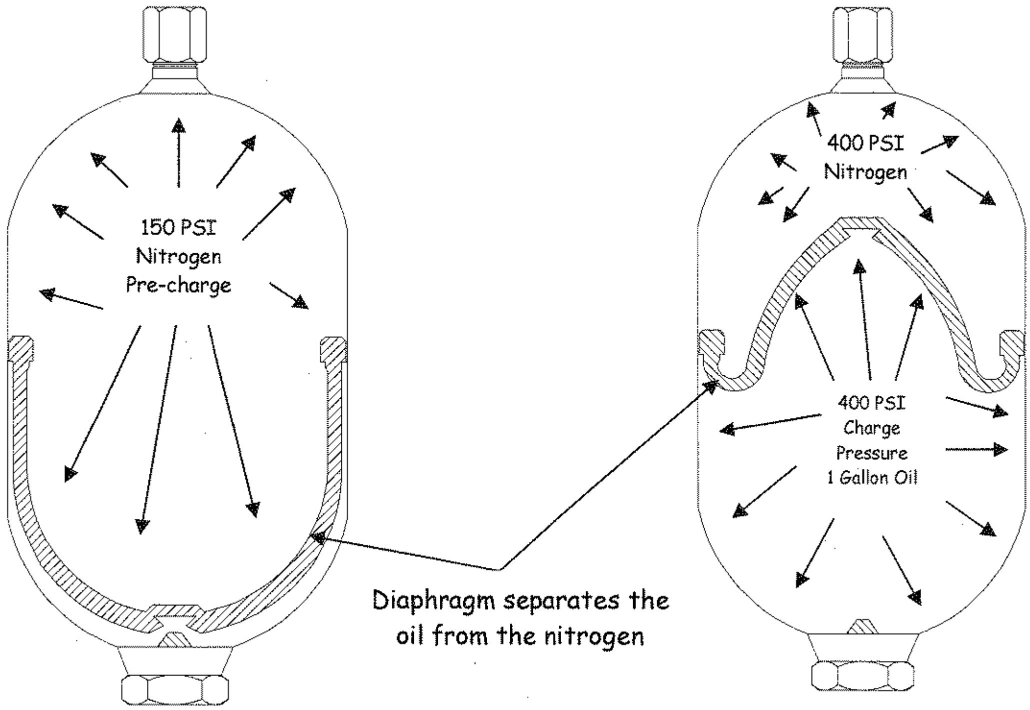



Figure 62

Figure 63

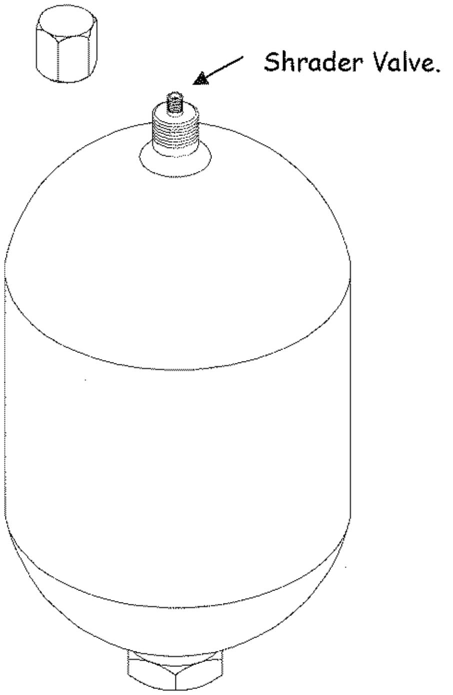



Figure 64

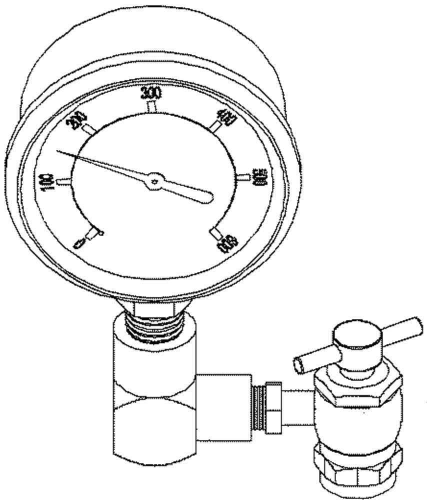


Figure 65

We have the last system on the baler to look at, the plunger drive hydraulic system. Before we study this system we want to take a quick look at the plunger drive accumulator, how it works, and its function.

Figure 62 on page 86 shows an accumulator that is empty, except for the 150 PSI nitrogen pre-charge. The pre-charge is factory installed and is always there, in the accumulator. When the baler PTO is engaged the charge pump fills the accumulator with approximately 1 gallon of oil.

The charge pump is the only pump on the baler that performs a function automatically. There is no electrical control or valves to this pump, if the baler PTO is turning, the charge pump is pumping. So, the charge pump is always applying pressure to the accumulator keeping it full and applying 400 PSI.

If we look back to the definition of an accumulator (page 69) it is described as "a container which stores hydraulic oil under pressure as a source of hydraulic power, or a pressurized reservoir that will quickly fill any voids in a system". As the charge pump fills the accumulator oil displaces the diaphragm in the accumulator compressing the nitrogen gas, as shown in figure 63. This gallon of oil is held in reserve, with the capability of being discharged if the hydraulic pressure decreases.

The plunger drive system is a "Closed Loop" system. Looking back at figure 28 on page 36 and again below in figure 66 we see that the Sundstrand main pump has two ports directing oil flow. One port is connected to the rod end and the other is connected to the cap (butt end) of the plunger main cylinder. When the plunger is extending the rod end of the cylinder is the suction side of the loop and the cap (butt end) of the cylinder is the pressure side. When the cylinder is retracting they are reversed, the rod end becomes the pressure end, and so the cap (butt end) end becomes the suction. In a closed loop system, once the system has been filled by the charge pump the system is full and basically closed. There is per say no suction oil added from the reservoir, the same amount of oil that leaves (pressure) the Sundstrand pump must be returned (suction) to the Sundstrand pump. We do exchange some oil out on every plunger stroke using the charge pump which will be explained during the schematic study.

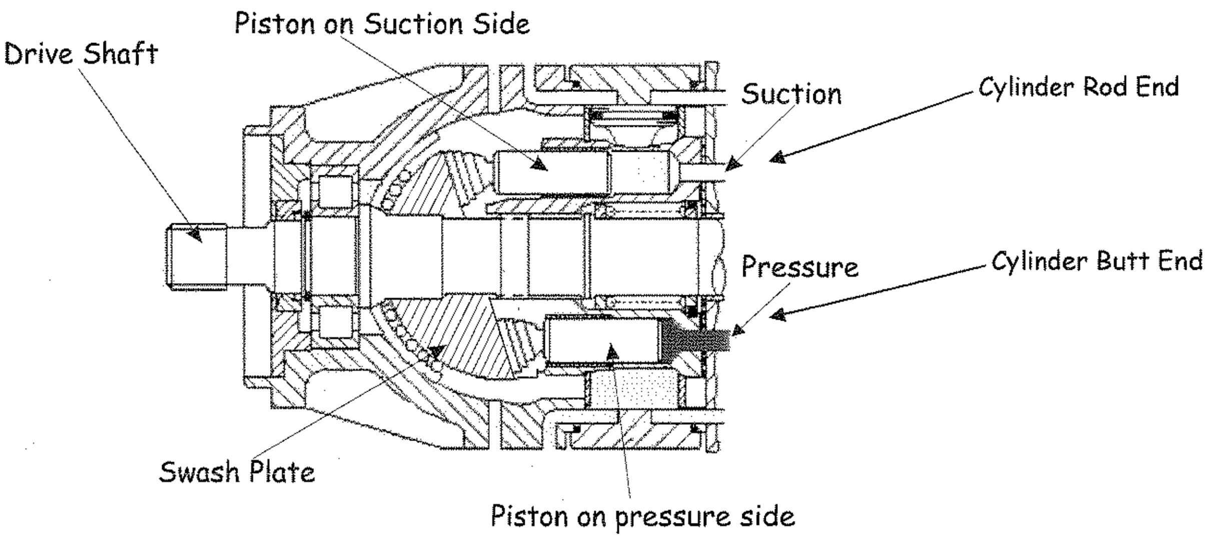



Figure 66

When we look at the plunger drive schematic (page 89), we will see that besides the main cylinder there are two auxiliary cylinders (make up cylinders). These two cylinders combined make up the amount of oil that is displaced by the rod in the main cylinder. When the main cylinder extends there is approximately half of the oil available to return to the Sundstrand pump as the rod takes up the other half. Typically we put 80 GPM into the cap (butt end) of the cylinder as it extends, the rod end of the cylinders supplies approximately 40 GPM and the make up cylinders supply the other 40, so we maintain the same amount of oil being retuned to the Sundstrand as is leaving.

Because a closed loop system does not draw from the reservoir we split the system into two halves. The high side is the pressure side and the low side is the suction side. The accumulator shown on page 86 is branched off the charge pump and is also connected to the makeup cylinders. The makeup cylinders and accumulator are always connected to the low side through a series of cartridge valves housed in the manifold valve assembly that we will look at next. The accumulator is discharged a varying amount on each plunger retract stroke keeping the Sundstrand pump full.

As the plunger activates LS-5 and starts it's retract stroke it rebounds away from the hay (more so from straw) faster than the pump is driving it. The force from the hay becomes the driving force and the Sundstrand pump is more or less turned into a motor. It is at this time that the accumulator is needed. If the plunger rebounds away from the bale faster than the Sundstrand pump is either putting out (or taking in) a vacuum is created in the system because the charge pump can not pump enough oil to fill this void, so the 400 PSI from the charge pump decreases, and the accumulator discharges, filling this void.

If a pump fails, or a hydraulic valve fails or sticks the results are fairly obvious, something quits working or its performance is decreased. This is not the case with the accumulator. If it starts leaking externally there is a good chance it has lost the pre-charge, but it can also loose the pre-charge over a period of time unnoticeably. If the plunger drive system operates for a period of time without the accumulator function, a catastrophic failure of the Sundstrand pump is inevitable.

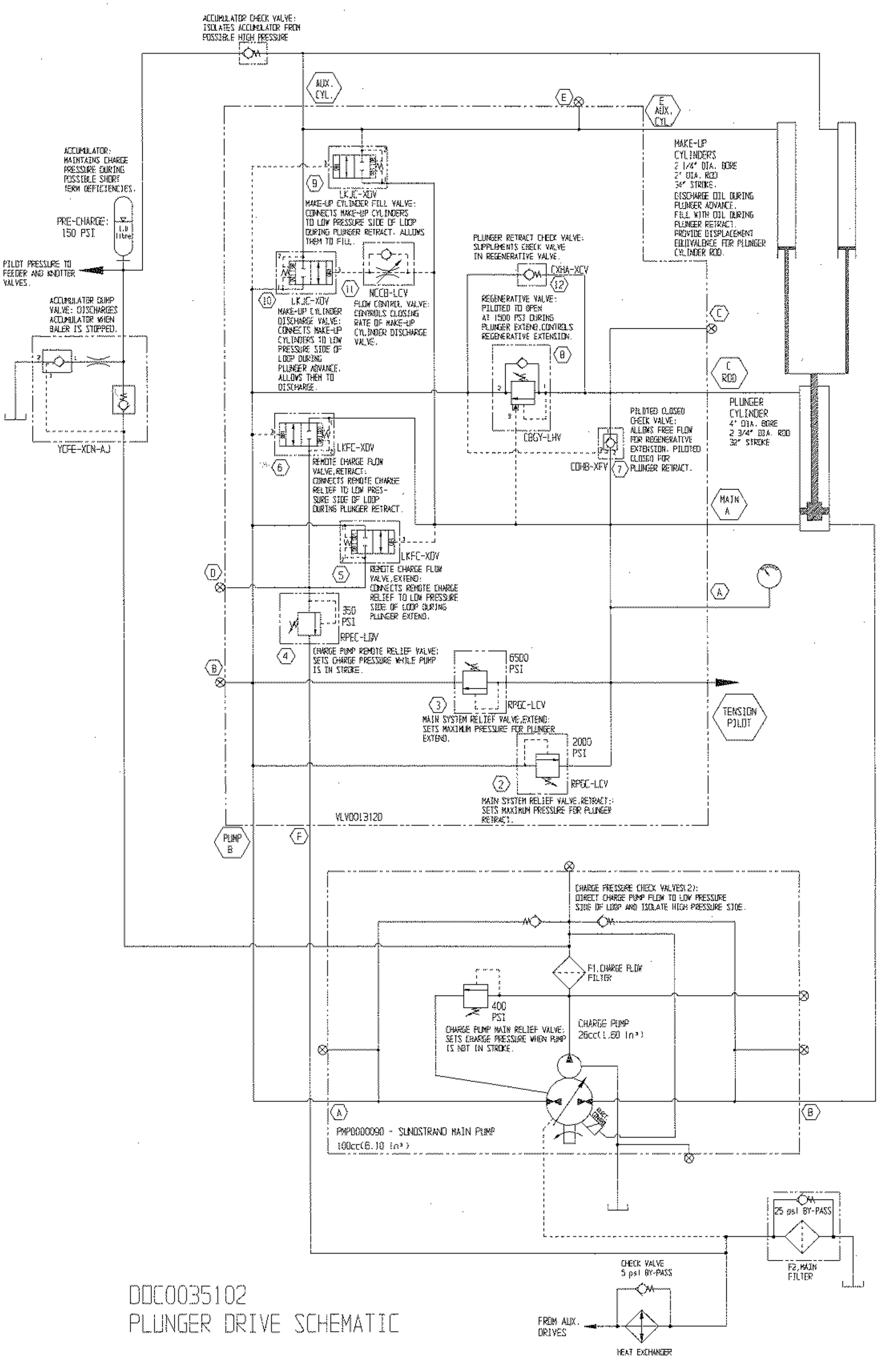
The majority of hydraulic operated equipment on the average farm today has an accumulator of sorts. Nitrogen pre-charging (re-charging) is something most farm equipment dealers can do. The only way to guarantee the accumulator is going to discharge is periodic checking of the pre-charge.

Your dealer should have the necessary gauges and equipment to check and fill the accumulator. Figure 65 on page 86 shows a typical gauge assembly for checking the accumulator pre-charge. Using this gauge assembly reduces the amount of nitrogen that will be expelled during a check. If the pre-charge is at zero or close to it there is a good chance that the diaphragm has ruptured and close checking after recharging is mandatory to insure the pre-charge is maintained. The diaphragm is ruptured if you find oil escaping from the shrader valve when the gauge assembly is removed. Recharging the nitrogen in the accumulator is the only repair that can be made. Complete replacement is necessary for any other failure. Generally, replacement accumulators will come empty and will need to be pre-charged prior to installing.

To expose the fill/check shrader valve remove the 1 1/16" hex cap at the top of the accumulator, see figure 64 on page 86.

It is recommended that you check the pre-charge in the accumulator two times a season, once at the beginning and again midway through your baling season. Some may consider this a bit of an overkill but it is of this authors opinion that it is cheaper to be safe than sorry.

# PLUNGER DRIVE HYDRAULIC SCHEMATIC



# PLUNGER SYSTEM MAIN VALVE ASSEMBLY

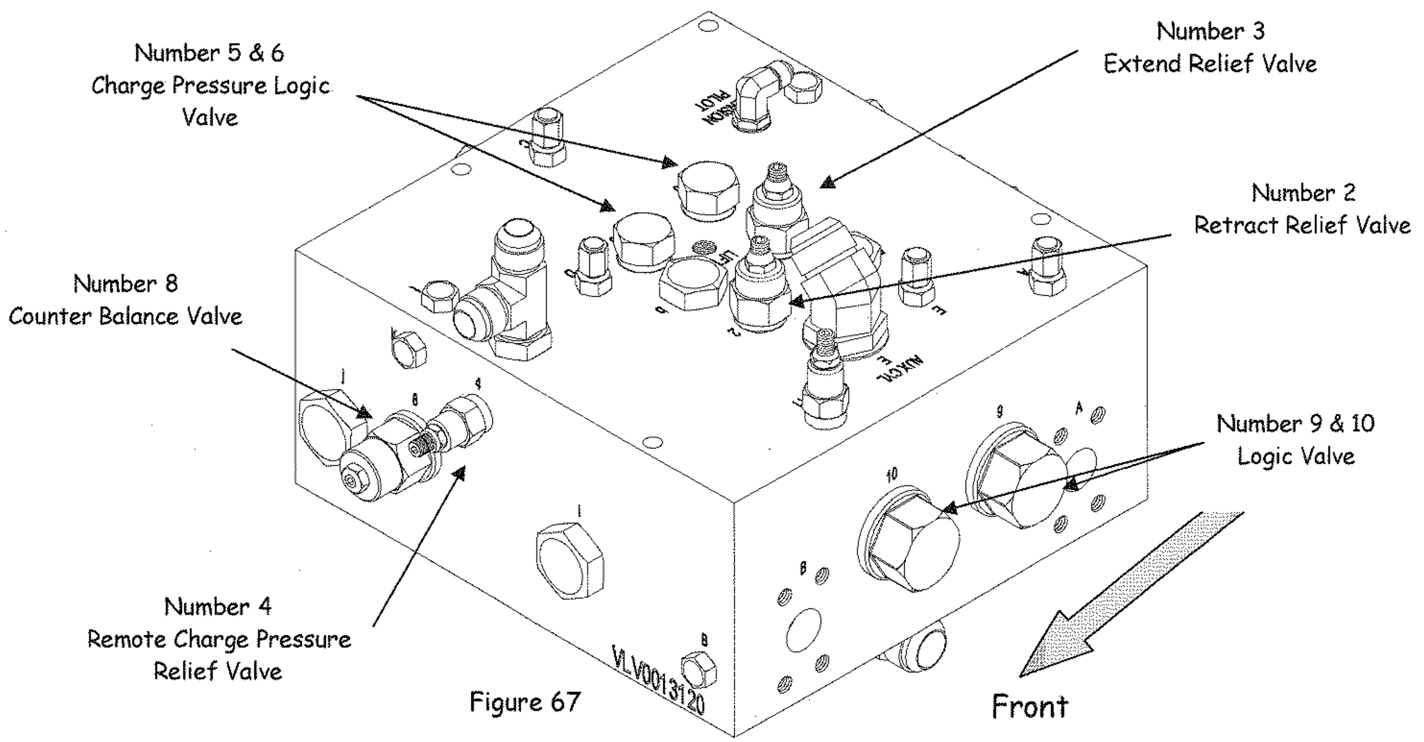



Figure 67

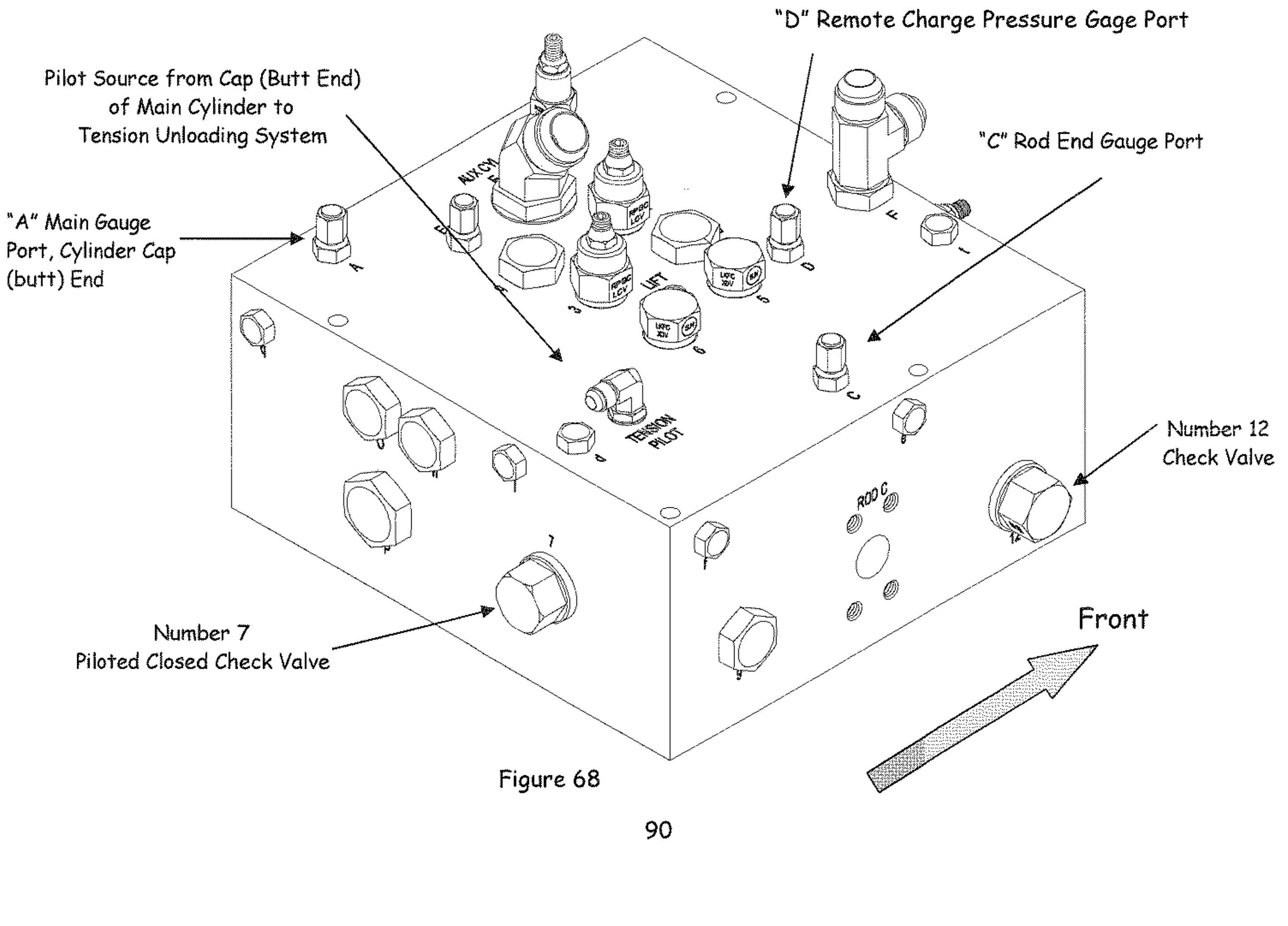
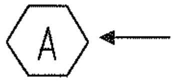



Figure 68

## PLUNGER SYSTEM MAIN VALVE ASSEMBLY

Figures 67 & 68 on page 90 show the plunger drive main valve assembly. This manifold sits below and to the right of the Sundstrand pump. It contains 12 cartridge type valves that control oil flow and hydraulic pressure to and from the Sundstrand pump and the plunger cylinders. We will look at the valves and their function and then the complete circuit. On the schematic view the valve are identified by numbers and the hose and gauge ports are identified by letters. Both are encircled by a hexagon.

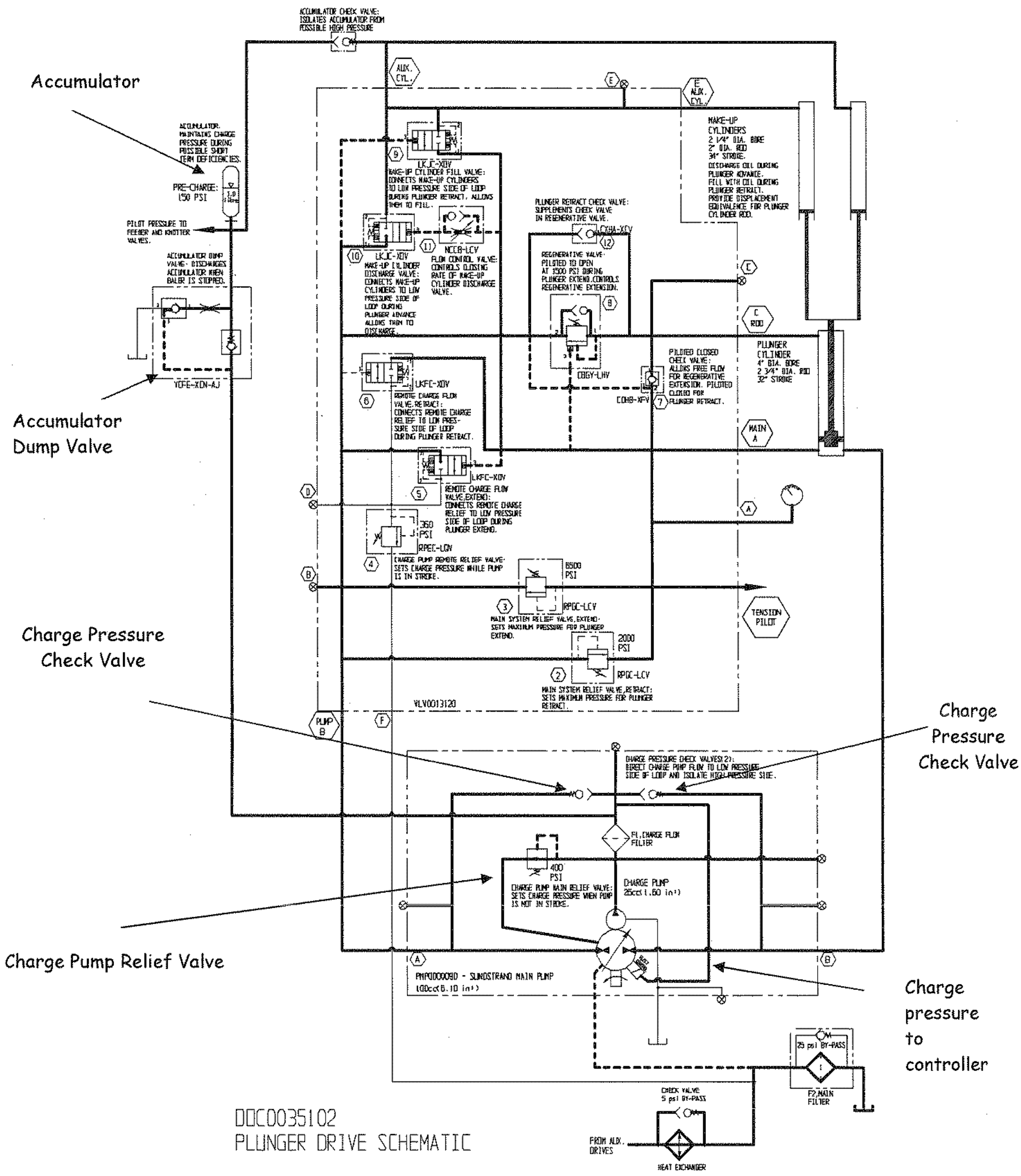


Gauge Port "A" identifier

- Number 2 relief valve, (top of the manifold) 2000 PSI, maximum pressure on the plunger retract stroke.
- Number 3 relief valve, (top of the manifold) 6500 PSI, maximum pressure on the plunger extend stroke.
- Number 4 remote charge pressure relief valve, also called a hot oil exchange valve, (front of manifold) set to 350 PSI. Set 50 PSI below the charge pump to ensure oil is retuned to the reservoir for cooling on every plunger stroke.
- Number 5 logic valve, (top of manifold) directs low side oil through the number 4 remote charge pressure relief valve during the plunger extend stroke.
- Number 6 logic valve, (top of manifold) directs low side oil through the number 4 remote charge pressure relief valve during the plunger retract stroke.
- Number 7 pilot to close check valve, (rear of manifold) allows oil to flow directly from the rod end to the cap (butt end) during the plunger regenerative extension.
  - Regenerative - Increasing a hydraulic cylinders extending speed by taking the discharge flow from the rod end and adding it to the flow entering the cap (butt end).
- Number 8 regenerative valve, (front of manifold) set to approximately 1500 PSI to open and stops the plunger's regenerative extending period.
- Number 9 logic valve, (left-hand side of manifold) connects the make up cylinder oil to the low side of the system during the plunger retract stroke.
- Number 10 logic valve, (left-hand side of manifold) connects the make up cylinder oil to the low side of the system during the plunger extend stroke.
- Number 11 flow control valve, (top of manifold) allows oil to free flow to the number 10 logic valve during the extend stroke, but delays it from closing while the plunger is rebounding away from the hay on the retract stroke.
- Number 12 check valve, (right-hand side of manifold), used in conjunction with the number 8 regenerative valve adding another flow path for the oil when the plunger is retracting.

Gauge ports located on top of the manifold.

- Gauge port "A" - plunger extending pressure, already connected to the gauge on the baler.
- Gauge port "B" - plunger retracting pressure.
- Gauge port "C" - rod end pressure.
- Gauge port "D" - remote charge pressure.
- Gauge port "E" - make up cylinder pressure (very seldom checked).


Accumulator
Accumulator Dump Valve
Charge Pressure Check Valve
Charge Pressure Check Valve
Charge Pump Relief Valve
Charge pressure to controller
PRE-CHARGE: 150 PSI
YCFE-XDN-AJ
LKJC-XDV
LKJC-XDV
NCCB-LCV
LKFC-XDV
LKFC-XDV
CXHA-XFV
CBGY-LHV
CDHB-XFV
RPEC-LCV
RPGC-LCV
RPGC-LCV
350 PSI
6500 PSI
2000 PSI
400 PSI
VLV0013120
MAKE-UP CYLINDERS
PLUNGER CYLINDER
TENSION PILOT
FL, CHARGE FLOW FILTER
CHARGE PUMP
PMP0000090 - SUNDSTRAND MAIN PUMP
F2, MAIN FILTER
HEAT EXCHANGER
FROM AUX. DRIVES
DOC0035102
PLUNGER DRIVE SCHEMATIC

The hydraulic schematic on page 92 is shown with heavier lines indicating the path of oil. It will be easier to follow on the full sized documents provided with the baler, but these heavier lines will hopefully be of assistance in following and understanding this system. This system is hard to illustrate this way as we have two systems operating at the same time. We will have the Sundstrand pump delivering and receiving oil and also the charge pump will be exchanging some oil back to the reservoir.

We will look at the charge pressure system first, and then go onto the main plunger extending and retract, with references back to the charge pressure system.

The system starts from the Sundstrand pump, in the lower half of the page surrounded by a dashed line. The pump contains several items but in a schematic view we only show the relative symbols. The schematic symbol reference for the Sundstrand & charge pump are back on page 60. The charge pump is contained in the pump along with the relief valve, two charge pressure relief valves, and a filter. The filter is actually mounted externally on the Sundstrand but for schematic purposes we show it as being contained in the pump. There are several pressure test ports on the Sundstrand pump & charge pump but we are only concerned with one. The charge pressure test port as shown in figure 69. Pressure test ports are shown on the schematic with an "X" inside a circle.

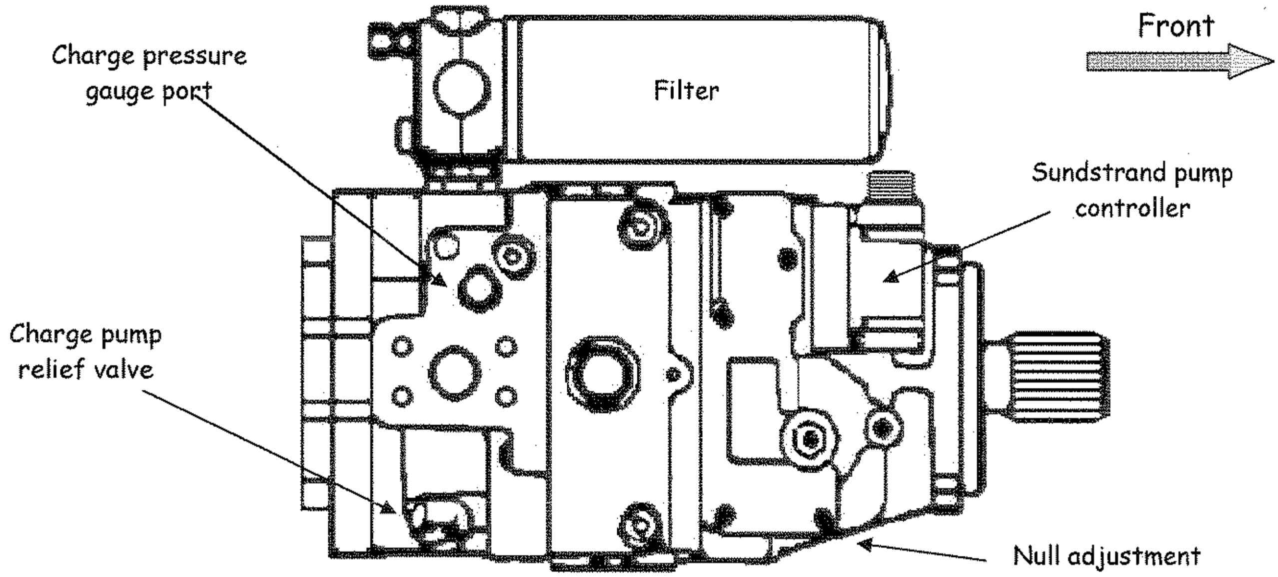



Figure 69
Right-hand side of pump

The charge pump has four functions. It supplies charge pressure to the Sundstrand pump controller, the rotating pistons inside the Sundstrand pump to keep them in contact with the swash plate, it makes up any oil that is lost in the circuit (hot oil exchanged), it supplies pilot press for the feedfork & knotter hydraulic system and it keeps the accumulator full.

## PLUNGER DRIVE HYDRAULIC SCHEMATIC

All oil that enters the closed loop system is drawn from the reservoir through the charge pump, through the filter <u>and then</u> into the system. Looking at the schematic on page 92, just pass the filter, the oil goes back down to the Sundstrand pump controller. In this schematic view the baler PTO is engaged put no power has been turned on. The charge pump is rotating and has filled the system with oil.

On page 35 & 36 the Sundstrand pump and controller were discussed on how voltage applied to the controller allows the charge pressure to be applied to the servo cylinders and the swash plate tilts and the pistons start moving oil. In the neutral position or when no power is applied the swash plate has to remain in a vertical position. The neutral position is referred to as null, or nulling the controller.

Slight tilting (controller out of null) of the swash plate allows the pistons working area to start increasing and decreasing which will cause the plunger to creep slowly away from the retracted position. With the power off the plunger will creep all the way to the extended position. With power on, in automatic the plunger creeps only until it releases LS-10. Once LS-10 is released power is applied to the controller and the plunger retracts until LS-10 is activated. The plunger will continuously extend 2 inches and retract two inches until the controller is nulled. Anytime a new Sundstrand pump controller is installed it must be nulled to ensure the swash plate is in neutral.

On the bottom of the controller is the null adjustment screw. It is locked into position by a lock nut on the adjustment screw; see detail "B" on the attached page. The lock nut is 13 MM (a 1/2" wrench will work) and the null adjustment screw is 4 MM (a 5/32" allen wrench will work). To set the null proceed as follows:

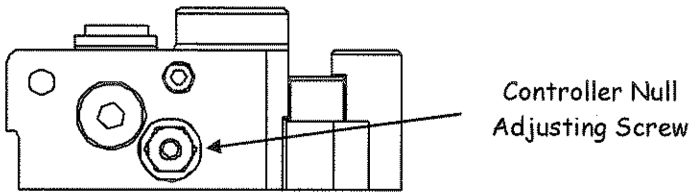



Figure 70
Sundstrand Controller Bottom

NOTE: THE TRACTOR PTO MUST BE ENGAGED FOR THIS PROCEDURE. EXTREME CAUTION MUST BE USED WHENEVER THE TRACTOR PTO/BALER IS OPERATING, AND THE OPERATOR IS MAKING ANY ADJUSTMENTS.

1. The pickup and feeder do nut need to be rotating. Put the feeder in neutral so the feeder and pickup remain motionless.
2. Position the service ladder on the right-hand side of baler so you have a safe, steady working platform.
3. Start the baler and run at 1,000 PTO RPM.
4. Do not turn the power to the baler on. The power to the controller must remain off. Unplug the electrical connection if necessary to ensure no power is going to the controller.
5. Loosen the lock nut on the adjustment screw.
6. Rotate the null adjustment screw clockwise just until the plunger starts to move.
7. Stop the adjustment screw rotation and note the angular position of your allen wrench.
8. Keeping track of the number of turns; rotate the null adjustment screw counter clockwise just until the plunger starts to move in the opposite direction.
9. Rotate the null adjustment screw clockwise half the number of turns between the locations noted in step 6 and 8.
10. Hold the null adjustment screw stationary with the allen wrench; tighten the lock nut on the adjustment screw.
11. The controller should now be in neutral.

    Example: If in step 6 you rotate the adjustment screw clockwise to the approximate 2:00 position. As you rotate counter clockwise as in step 8 you come back out to the 6:00 position. Turn the adjustment screw back in (clockwise) to the 10:00 position and set the lock nut. On some controllers you may have more than one complete turn in step 8.

Looking at the schematic on page 92 again; when the system is full the charge pump relief valve opens and 400 PSI is maintained throughout the system. This is why the plunger pressure gauge on the front of the baler never goes completely to zero. It will always show approximately 400 PSI. The charge pump relief valve drains back into the Sundstrand pump case, and then back to the reservoir.

Just above the filter oil flows out to the left (far left) and up to the accumulator dump valve and the pressure opens the check valve in the dump valve and flows on up to the accumulator, tees off pilot the feedfork knotter system, and is also connected to a check valve that isolates the accumulator and the make up cylinders. Oil will only flow from the accumulator to the low side if the pressure on the make up cylinder side of the check valve drops below the charge pressure setting.

The accumulator dump valve consists of a check valve, a piloted closed check valve and an orifice all contained in a small manifold block that mounts directly beneath the accumulator. This dump valve drains the accumulator when the baler is shut down, (PTO no longer rotating) and the flywheel has quit rotating. Charge pressure is no longer available to hold the piloted closed check valve closed, but the accumulator still holds one gallon of oil with 400 PSI. Once the piloted closed check valve is allowed to open the accumulator drains the one gallon of oil to tank.

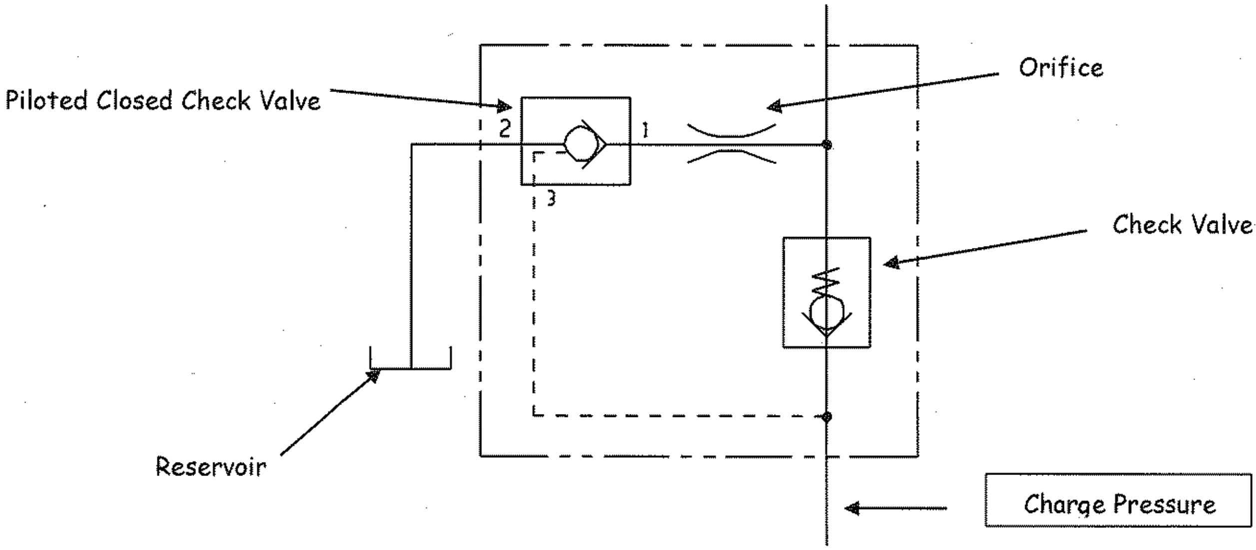



Figure 71

Figure 71 above shows the schematic for the accumulator dump valve. The check valve prevents the accumulator oil from traveling back into the system forcing it to pass out to the reservoir. The orifice creates a pressure drop across the piloted closed check valve so that the pilot pressure holding the valve closed is higher than the pressure being applied to port 1 of the piloted closed check valve. With no charge pressure present there is nothing to hold the piloted closed check valve closed.

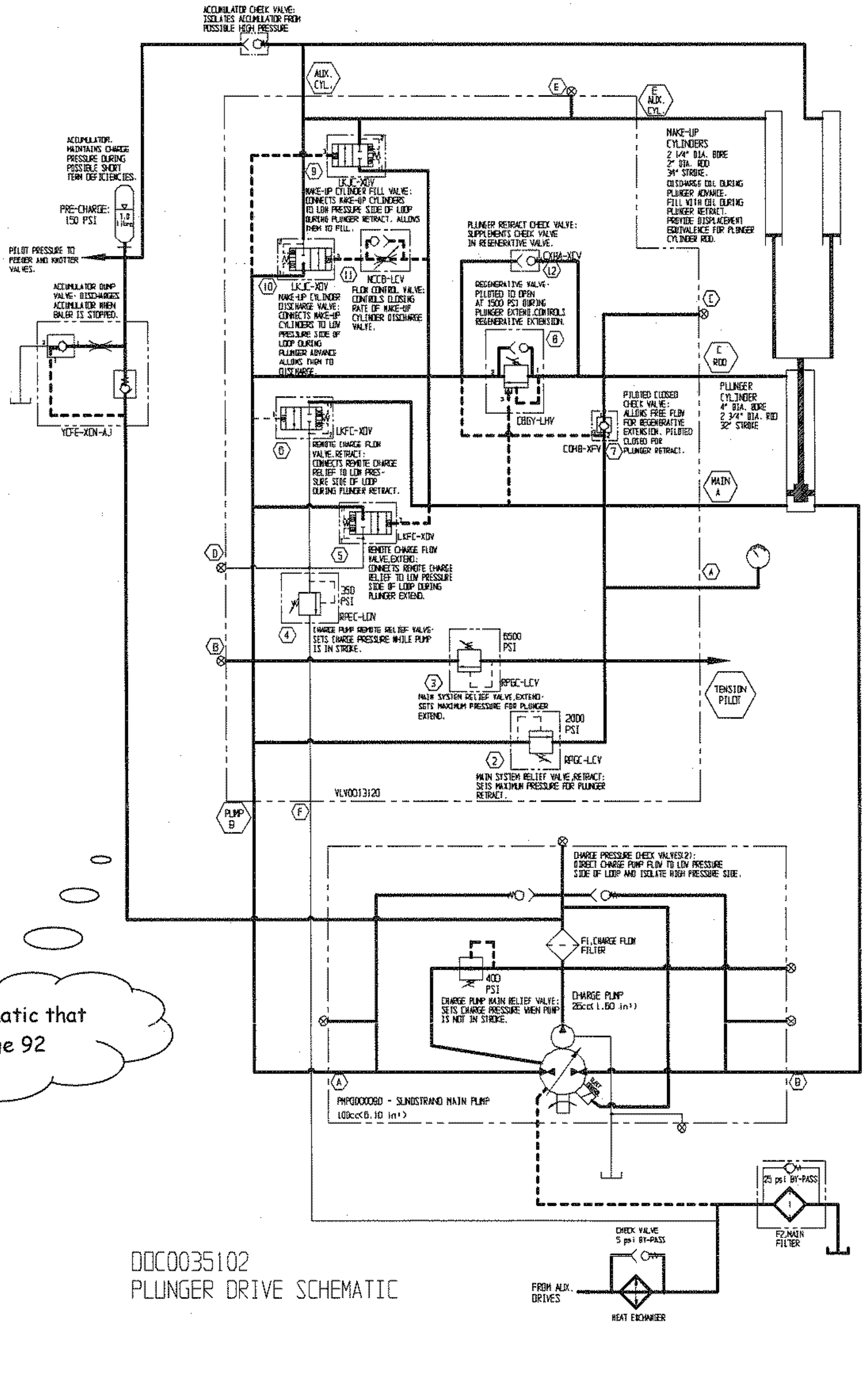
If you look closely at the schematic on page 97 you can see that heavier lines are shown on almost the complete schematic except for the return oil coming from the number 4, remote charge pressure relief valve. With pressure equal on both sides of the loop, neither the number 5 or 6 logic valve can open and connect the charge pressure to the number 4 remote charge pressure relief valve.

Just above the filter are two check valves. These are the Sundstrand pump charge pressure check valves. In this schematic view they are both open as right now with the swash plate in neutral there is no high or low side. The charge pressure is equal on both sides, 400 PSI.

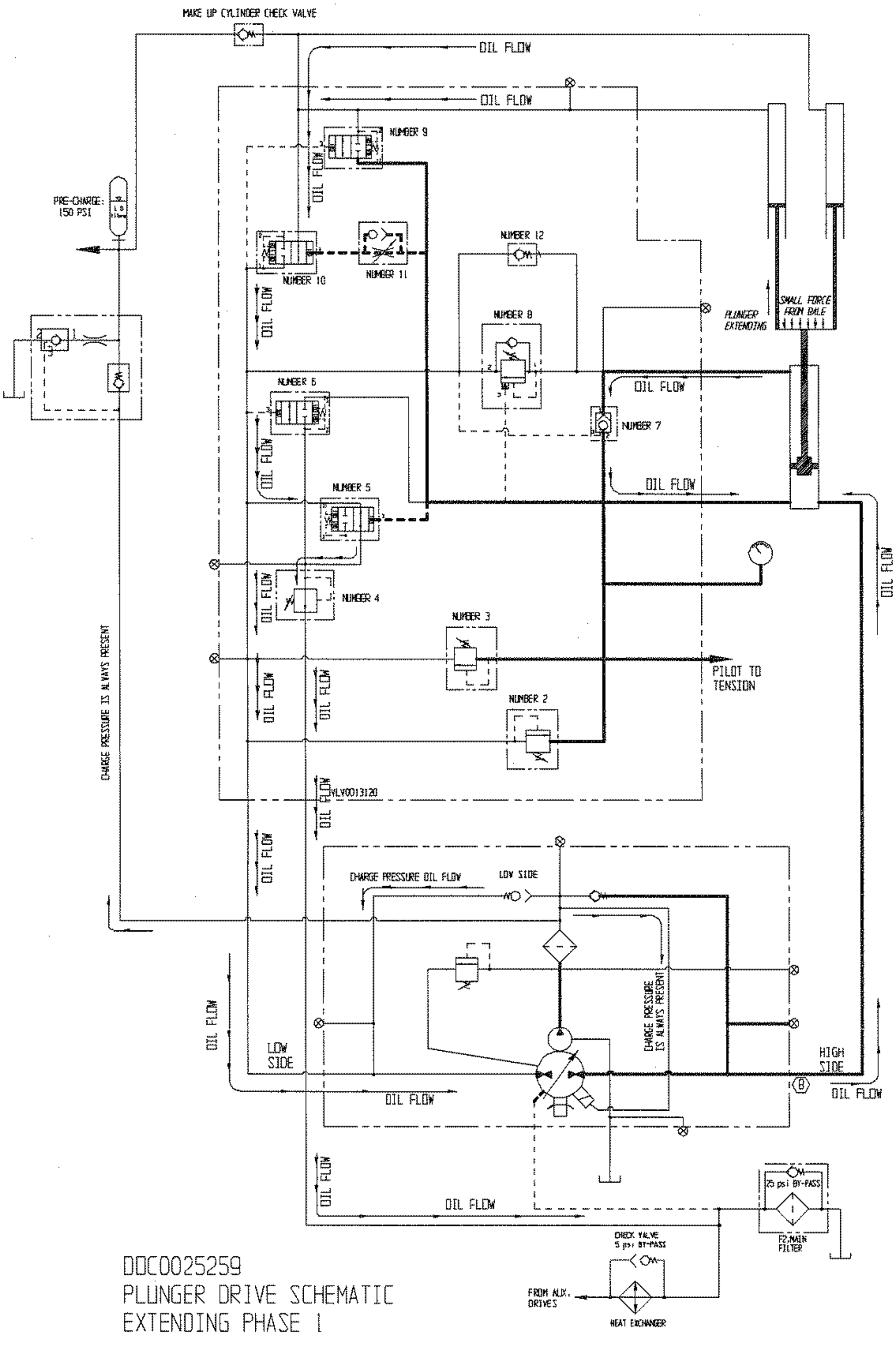
When the power is turned on and a charge of hay activates the feed sensor paddles, the feedfork stops at the highest point in the chamber, relay 1 sets and voltage is applied to the controller which will shift the servo valve in the controller. This will direct charge pressure to the servo cylinders which will tilt the swash plate in the Sundstrand pump and the pistons immediately start pumping 80 GPM.

At this time the system is split into the high and low side, as pressure starts to build the high side charge pressure check valve will close which allows pressure to build to the setting of the system relief valve, while the low side remains at 400 PSI (charge pressure).

# PLUNGER DRIVE HYDRAULIC SCHEMATIC




Same Schematic that in on page 92




DOC0025259
PLUNGER DRIVE SCHEMATIC
EXTENDING PHASE 1

On the schematic view on page 98 relay one has set and the plunger is just starting the regenerative portion of the extend stroke. Only the high side lines have been highlighted to be heavier. Arrows and notes illustrate oil flow for both sides. Remember that as long as the PTO is turning the charge pump is always pumping.

The Sundstrand pump is 6.10 cubic inches per revolution and the pump turns approximately 3125 RPM at 1000 PTO RPM (operating speed). This equates to approximately 82 GPM. The charge pump is 1.60 cubic inches which equates to approximately 21 GPM. For this schematic study we will round these figures to 80 GPM & 20 GPM.

As soon as the Sundstrand pump controller receives the voltage from relay 1 the swash plate tilts to the full flow position in the direction that allows oil to flow out the port that connects to the cap (butt end) of the main cylinder. 80 GPM immediately starts to flow and the plunger leaves its retracted position at full speed.

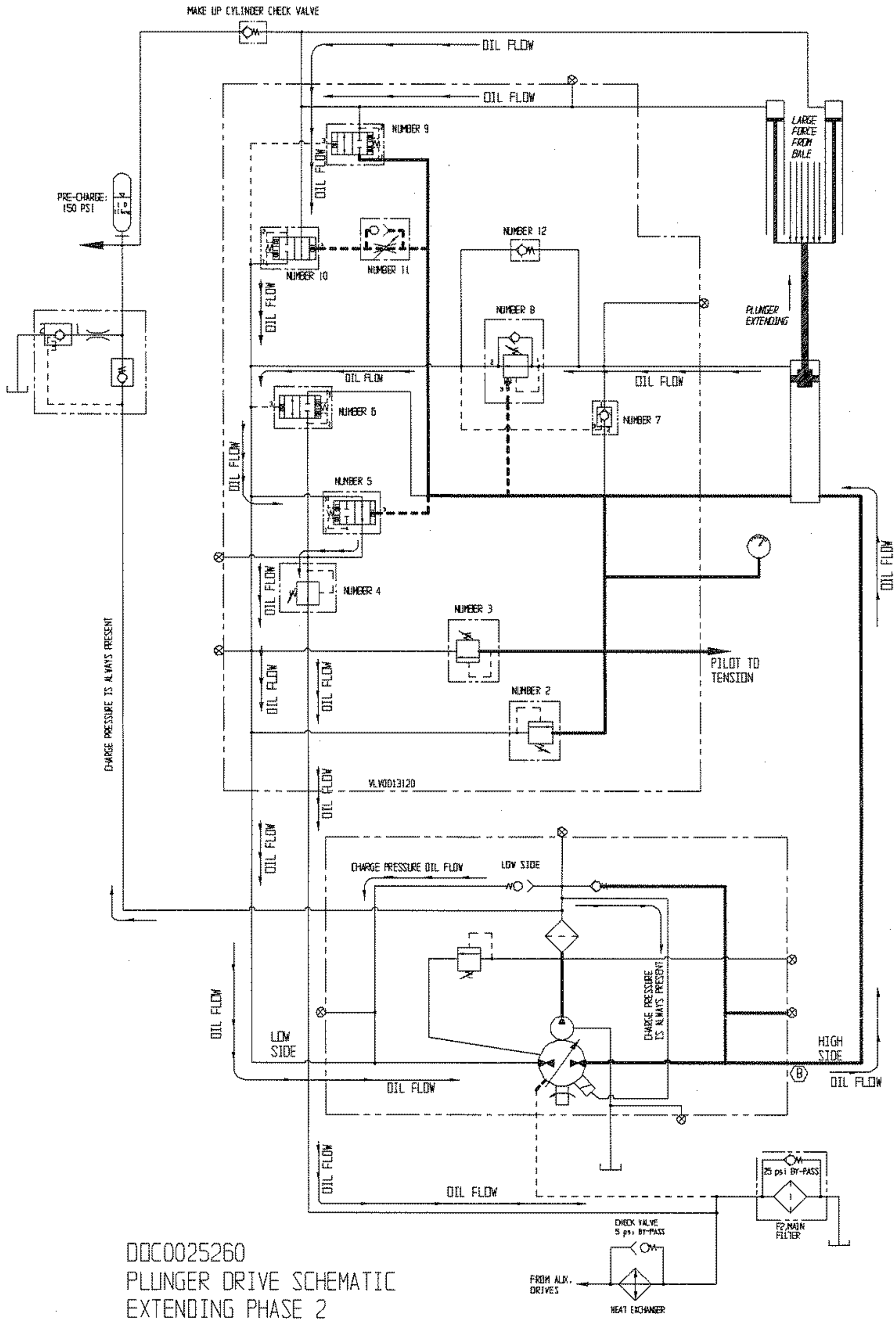
As oil leaves the rod end of the cylinder it runs out and can not pass through the # 8 regenerative valve. (It will take approximately 1500 PSI on the number 3 pilot port to open the number 8 valve). The oil then has no other option but to pass down through the number 7 piloted closed check valve and reenter the butt end. This allows the cylinder to extend twice as fast; this is called regenerative extension. The plunger will continue to extend at full regenerative speed until the hay is compressed to the point that the plunger will start to apply pressure is excess of approximately 1500 PSI.

As soon as the plunger starts to extend it becomes the high side of the system and the pressure required to extend the plunger closes the charge pressure check valve (right-hand side) and the other side remains open as the charge pump is applying pressure to the low side. At the same time the charge pressure check valve closes, (high side) pressure is also applied to logic valve # 10 and logic valve # 5. Pressure applied to # 10 opens the logic valve and connects the make up cylinders to the low side. The low side supplies the suction oil for the Sundstrand pump. The number 11 flow control has not effect now as the oil is able to free flow around the orifice through the check valve.

If you look at the # 5 logic valve there are two paths the oil can take. One straight down and back to the Sundstrand or it can take a right and pass through the # 5 logic valve and then down to the # 4 remote charge pressure relief valve. As long as the low side is full and there is pressure in excess of 350 PSI (# 4 setting) the excess oil is allowed to leave the low side and return to the reservoir for cooling. In the view as shown the low side is full and oil is leaving to be cooled. The flow back to the cooler depends on the amount of oil needed by the low side. The amount of oil returned to the reservoir on each plunger stroke will vary.

Pressure (pilot) is also being applied to the tension system and to the gauge on the front of the baler. In this view the gauge is below 1500 PSI and the pilot pressure going to the tension system has no effect; yet, unless you are baling at less than 1500 PSI plunger pressure.

The plunger continues to extend compressing the hay and the pressure applied to the cap (butt end) of the main cylinder continues to rise. The number 3 relief valve will protect this high side if pressures exceed the relief valve setting of 6500 PSI.




DOC0025260
PLUNGER DRIVE SCHEMATIC
EXTENDING PHASE 2

On the schematic view on page 100 not a whole lot has changed, the low side is still delivering the oil to the Sundstrand. The bale is compressing and our pressure is increasing. For purposes of this schematic we will say our baling pressure is 4000 PSI. On this view our gauge on the front of the baler will be between 1500 and 4000 PSI. The plunger physical position is probably in between LS-6 and LS-4 position, with approximately 4 inches of plunger extension before LS-5 is released.

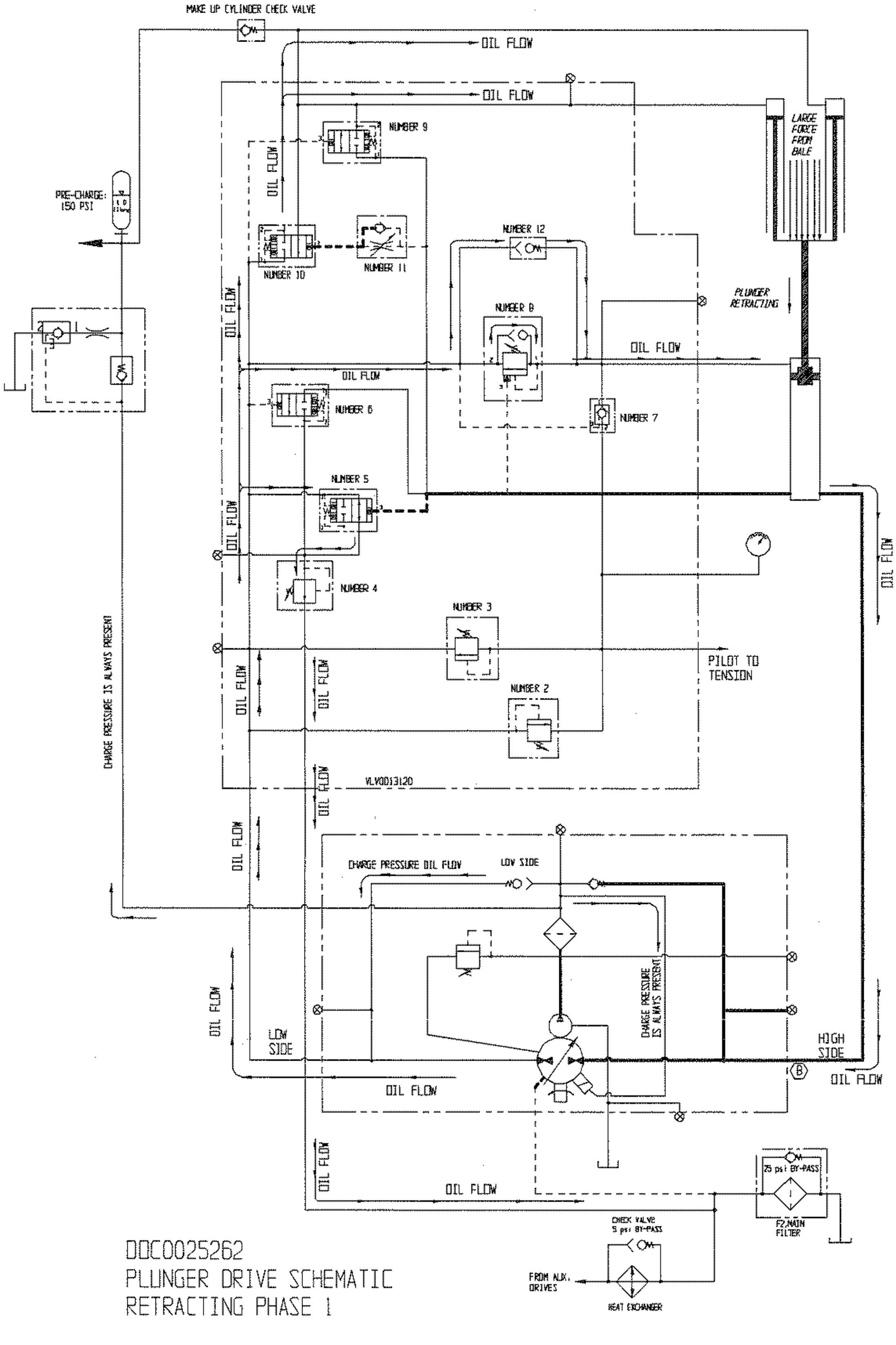
When the pressure in the cap (butt end) of the main cylinder reaches 1500 PSI the pilot pressure being applied to port 3 of the number 8 valve forces the main spool in the valve open and connects ports 1 & 2 of the number 8 regenerative valve. This connects the rod end of the cylinder to the low side and now this oil is being returned to the Sundstrand. When this occurs the number 1 port of the main spool in the # 7 piloted closed check valve will see 350 PSI but port 2 sees 1500 PSI (plus). This closes the piloted closed check valve and this ends our regenerative extension. The plunger continues to advance with full Sundstrand pump flow of 80 GPM, but the plunger slows to approximately half speed.

The plunger will continue at this speed until it releases LS-4. At this time we reduce the voltage to the Sundstrand pump controller, the swash plate starts to return to neutral and the flow from the Sundstrand pump is reduced to approximately 40 GPM, which is the plunger decelerated speed. It will continue at this decelerated until it releases LS-5. At that time relay 1 is released and the plunger will start the retract stroke. Someplace during the period of time between LS-4 and then LS-5 releasing the tension pilot pressure being applied to the tension unloader reaches 4000 PSI, the tension unloading system dumps and the plunger pressure is maintained until the plunger reverses its direction.

On the plunger extend stroke there are three speeds, full speed (regenerative), half speed (pressure on the plunger in excess of 1500 PSI), and the decelerated speed just before the plunger releases LS-5 and starts the retract stroke. The plunger retract stroke has only two, full & decelerated. But because the rod only takes half the oil than the cap (butt end) takes it retracts as fast in retract as it does in regenerative extension.

This is why the switch adjustments of LS-4 & LS-9 are different. LS-4 adjustment is to <u>be as close</u> to LS-5 as possible. LS-9 adjustment is to be <u>adjusted away from</u> LS-10 as necessary so the plunger has a smooth transition to its stopping position without an extended period of decelerated retracting. We are not concerned about the smooth transition between LS-4 & LS-5; when the plunger approaches LS-4 it is at half speed, the same speed the plunger approaches LS-10.

One last thing before the plunger changes direction, if you have been paying attention you will have noticed that there is only 350 PSI of charge pressure when the plunger is extending. This is the function of the # 4 remote charge pressure relief valve. It is set 50 PSI below the main charge pressure setting in the Sundstrand pump. The charge pump relief valve is only opened when the Sundstrand pump is in neutral. When the plunger is in motion and either the # 5 or the 6 logic valves are opened the charge pressure drops to the # 4 remote charge pressure relief valve setting.




DDC0025262
PLUNGER DRIVE SCHEMATIC
RETRACTING PHASE 1

The schematic view on page 102 is just as LS-5 is released and the plunger is starting to retract, or rebounds off the hay as was described on page 88 when we were discussing the accumulator. This is the portion of the retract stoke that the accumulator is most likely used.

Possibly one thought would be when you look at the schematic is that I have forgotten to switch the high side and low side as they have remained the same, even though the oil flow has changed direction. This is a good thought as that is what should have happened, but because the hay is now the driving force it is pushing harder than 400 PSI on the cap (butt end) of the plunger. There is more pressure on the cap (butt end) than what the plunger is requiring to be retracted. The rod end might actually be under a vacuum or negative pressure if the accumulator were not present. The logic valve # 5 is still the hot oil exchange valve.

The pressure being applied to logic valve # 10 is reduced but the pressure could be completely removed, as the # 11 flow control valve is metering the flow from the pilot on the # 10 logic valve. The pressure on port # 3 of the logic valve has to drop below approximately 350 PSI before it will open.

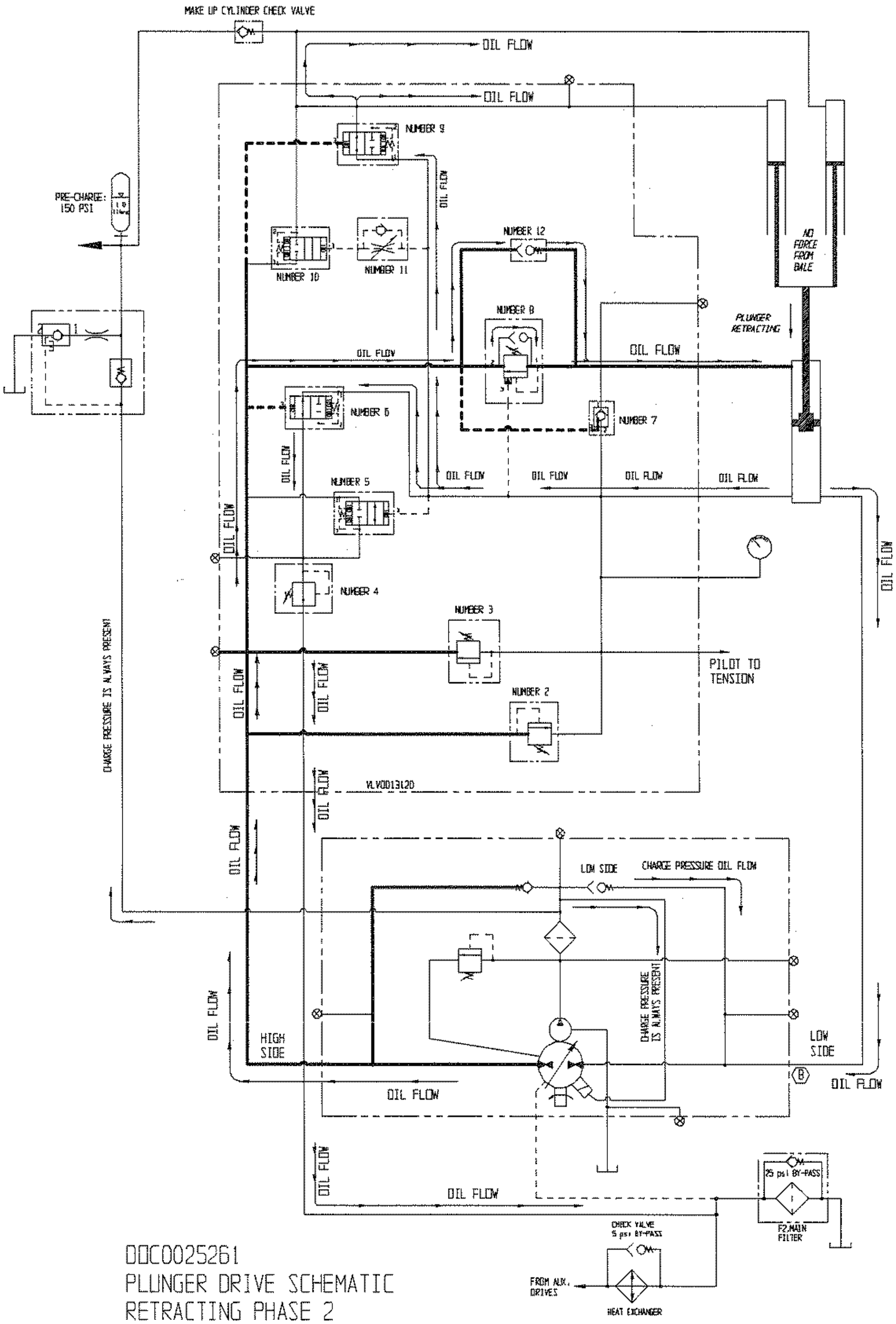
As you can see on the schematic logic valve # 9 is still closed as there is still a fair amount of pressure on port # 1 of this logic valve, and at the most there would be 350 PSI (charge pressure) on the pilot at the number 3 port. It will only take approximately 630 PSI on port 1 to keep this valve closed.

If logic valve 10 closes to rapidly and the number 9 logic valve has not open yet, all the oil being returned to the Sundstrand pump would be put into the rod end. This will start a hydraulic hammering of the plunger that can be felt in the tractor. Instead of splitting the oil between the rod end and the make up cylinders all the oil goes to the rod, which creates a pressure spike on the cap (butt end), which opens the logic valve # 10, which divides the oil again between the make up cylinders and the rod end, but just as fast we loose the pressure spike and logic valve 10 closes again and all the oil goes into the rod end. This cycle keeps repeating until the pressure in the cap (butt end) is reduced sufficiently to allow the number 9 logic valve to open.

This hydraulic hammering is quite violent on the plunger and can be felt in the tractor. The factory setting for the number 11 valve is bottom out the adjustment screw (clockwise) and then rotate it 3/4 turn counter clockwise. This adjustment works well in most crops. Once in a while a customer will bale fine all year in alfalfa, but when he starts baling straw this hammering effect starts. This is because the straw has more rebound and the # 10 logic valve needs more time to close. If this occurs adjust the # 11 flow control valve 1/16 of a turn clockwise (closes the orifice which closes the path for the oil to escape), just until the hammering stops. If # 11 flow control valve is closed to much, there will be a delay for the plunger to come back to full speed retract. If the number 11 flow control valve is closed off completely the plunger will extend, but if the # 10 logic valve can not close, the logic valve # 9 opens and the retracting oil from the Sundstrand pump is simply returned to the low side with out moving the plunger.

Once the logic valve 10 is softly shifted the rebound effect diminishes and the plunger starts its normal full speed retract.

# PLUNGER DRIVE HYDRAULIC SCHEMATIC




DOC0025261
PLUNGER DRIVE SCHEMATIC
RETRACTING PHASE 2

The schematic view on page 104 is now just as you would expect. The rod end of the plunger is the high side and the cap (butt end) is the low side. The plunger is retracting under the flow of oil from the Sundstrand pump. Once the hay quit rebounding and the pressure in the cap (butt end) lowered to approximately 350 PSI the # 9 logic valve opened and now the oil flow retuning from the cap (butt end) is split between the rod end of the main cylinder and the make up cylinders. Also at the same time the # 6 logic valve opens and connects the low side to the # 4 remote charge pressure relief valve and oil is returned to the reservoir for cooling. The # 2 relief valve protects the plunger retract stoke, not to exceed 2000 PSI.

The plunger will continue to retract just as shown until it activates LS-9, which slows only the pump flow to approximately 40 GPM until it activates LS-10 ending the retract stroke.

This completes the cycle and also the study of the plunger hydraulic system study. There are just a few items to mention.

You will note that most of these valves are connected to both the high and low side. The only thing that keeps these two sides from communicating is the o-ring seals on the valves. As these seals deteriorate and fail (they will see page 67) they allow the high pressure oil to escape and therefore not perform any work.

As we have discussed throughout this manual when the plunger leaves its home position we apply full voltage to the Sundstrand pump controller (80 GPM), when the plunger releases LS-4 we cut this voltage in half (decal, 40 GPM). The diagnostic controller applies less voltage than the decal voltage (possibly 30 GPM).

Here is typical situation when the seals in the main valve assembly (VLV0013120) start to fail. The baler bales good until the oil start to get hot. Then it may struggle to complete the stroke, and then it may stall at a pressure below your baling pressure. When you get out and try to advance the plunger manually using the diagnostic controller you can't even get close to the baling pressure. This is because the seals in one, two or three of the valves is allowing the high pressure oil to escape to the low side, and therefore there is excessive leakage and there is only between 40 GPM (decal) and 30 GPM (diagnostic controller) available to advance the plunger. This is a common occurrence and will happen unless the seals are replaced on a regular basis, every two to three years. The higher the baling pressure the lower the seal life.

To help you determine if you have a seal failure the use of the manual override on the Sundstrand pump controller can be a valuable tool. It can also be disastrous to the needles if they are in the chamber when this override is used. The manual override does not require any voltage to put the pump into stroke, and therefore there is no protection for the needles. If the needles are in the chamber and you move the manual override to the advance position; **you will destroy the needles.** And depending on where the needles are at in their stroke, **you may also take out the needle yoke**. So let this be your warning, even if you know the needles are at home, always walk back and verify that they are in fact in the home position. If you do not do this you will at some time bale the needles. It has been known to happen to the most experienced operators, and if you have to air freight replacement parts this little error can run you in the neighborhood of $ 7000.00. So please always be aware.

On the bottom of the controller the bottom end of where the power cable connects there is a rotating type lever see figure 72 below.

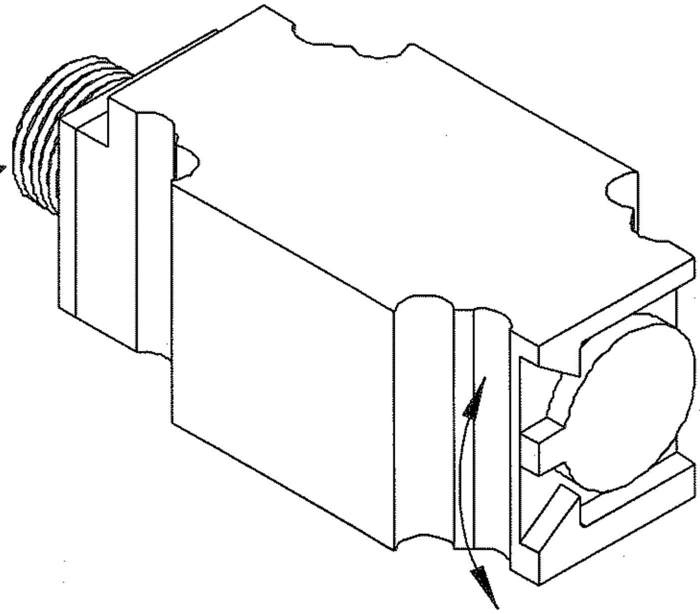



Figure 72

Rotating the manual override to the rear of the baler extends the plunger at full Sundstrand pump output. The baler PTO RPM's determines how much oil, or how fast the plunger will extend. At 1000 PTO RPM the Sundstrand will put out full flow when the manual override is rotated. At half speed it will put out 40 GPM, and at 1/4 speed it will put out 20 GPM. So using this manual override you can determine if a plunger stalling problem is related to the valves and or seals in the main valve. If when you use the diagnostic controller at full PTO RPM, (30 GPM) the plunger stalls at below baling pressure. Follow the below sequence.

NOTE: THE TRACTOR PTO MUST BE ENGAGED FOR THIS PROCEDURE. EXTREME CAUTION MUST BE USED WHENEVER THE TRACTOR PTO/BALER IS OPERATING, AND THE OPERATOR IS MAKING ANY ADJUSTMENTS.

1. Walk back and visually inspect the needles to ensure they are in the home position. If they are not use the diagnostic controller to position the needle yoke in the home position.
2. Turn the power to the baler off. This prevents the pickup from rotating or any electrical functions from operating. Remember the manual override does not require any power, this is why there is no protection for the needles.
3. Run the baler PTO at approximately 1/2 speed.

4. Rotate the manual override towards the rear.
5. The plunger will advance, hit the end of the stroke, and stall.
6. At this time the relief valve opens and the gauge on the front of the baler should read 6500 PSI.
7. If this happens the leak in the system is approximately 10 GPM if you were unable to stall, using the diagnostic controller at full speed.
8. If the plunger does not stall at half speed, increase PTO to approximately 3/4 speed, 60 GPM.
9. If you stall now the leak is somewhere around 10 - 20 GPM.
10. At full PTO speed you stall you have a leak in the neighborhood of 20 - 30 GPM.

If at anytime RPM (is really irrelevant) using the manual override, but can not stall the plunger using the diagnostic controller, there is a good chance the seals in the valves need to be replaced.

If at 1000 PTO RPM you are still unable to stall the plunger at 6500 PSI, the charge pressure relief valve setting needs to be looked at. See figure 69 on page 93 for gauge port and the relief valve position. All test ports on the baler are 1/4" male JIC. Using a 1000 PSI gauge connect it to the gauge port on the right-hand side of the pump.

NOTE: THE TRACTOR PTO MUST BE ENGAGED FOR THIS PROCEDURE. EXTREME CAUTION MUST BE USED WHENEVER THE TRACTOR PTO/BALER IS OPERATING, AND THE OPERATOR IS MAKING ANY ADJUSTMENTS.

Running the baler PTO at above 500 RPM the gauge should read 400 PSI. If you find that you do not have 400 PSI when the power is off and the baler running at approximately 1/2 speed. Shut the baler down and call you dealer or the service department at J. A. Freeman & Son, Inc. (800-627-0429) for further instructions.

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