HYDRAULIC SYSTEM MAINTENANCE

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Maintenance Approaches

Typical Maintenance Approaches include:

Reactive,

Preventive

Predictive Maintenance.

Reactive Maintenance

- is the **Least Efficient Method** because, plant personnel take **Corrective Action only after** some type of **Breakdown** has **Already Occurred**.

- **In Process Industry**, allowing **Failures** to happen means that **Consequences** and **Costs** of **Failure** will be **Greatly Magnified** due to **Lost Production** associated with having **Equipment Out** of **Service**.

Preventive Maintenance

With this Approach, **end user** tries to **Prevent Failures** by

Scheduling Regular interventions on **equipment** to

Repair,

Replace,

or **Rebuild Equipment** or **Components**.

The **Timing** for these **Interventions** might be **based on** **Vendor Recommendations** or **Past History**.

This is **Better than a Reactive Approach** because it **Cuts Down** on the **On-Line Failures**,

but it does **Involve Higher level** of **Maintenance Activity**, and **some Work** may be **Done Unnecessarily** on **Equipment** that was **Still** in **Good Condition**.

Predictive Maintenance

Predict Failure and **Schedule Corrective Action Before** it can **Occur**.

This is a little **like "Just-In-Time Maintenance"** there is

No Wasted Effort since the **interventions** are based on **Impending Failure**.

The **Predictions** are the **Difficult Part** of this **Approach** and are Based Upon the **Combination** of

Nondestructive Examination and **Past History**.

This is the **Most Cost Efficient** means of **Addressing Maintenance** concerns

To these **3 Traditional Maintenance Techniques**,

New Technique called **Preemptive Maintenance** can **added**.

Preemptive Maintenance

it is Very Important to get the **Equipment Set up Correctly**.

Experience has shown that many **Problems** that
eventually require an intervention by the **Maintenance Group**
can be **Traced to** the **Fact** that the **Equipment**
wasn't Set up Properly to **Begin with**.
is based upon the **Total Quality Concept** that:

if one takes the **Time** to **Do** a **Job Right** the **First**. **Time**,

Many Problems can be **Corrected Before** they **Occur**.

HYDRAULIC SYSTEM MAINTENANCE

Many hydraulic systems are designed without any consideration being given to the maintenance of the system once it is in use. Frequently the prime requirement is minimum initial cost without thought of the running and maintenance costs. Consequently it is possible that:

- The filtration in the system will be inadequate.
- There will be a lack of test points.
- There will be no facilities for monitoring wear.
- Valves and other components will be mounted in inaccessible positions.
- It may be necessary to empty the oil reservoir before certain components can beexamined or replaced.

7.1 EQUIPMENT AND PRACTICES WHICH BENEFIT MAINTENANCE

- 7.1.1 Good housekeeping practice
- 7.1.2 Fluid storage and handling
- 7.1.3 Installation and commissioning of hydraulic systems
- 7.1.4 Routine maintenance

7.1.1 Good housekeeping practice

- System filtration and cleanliness
- Test points and testing
- Condition monitoring
  - COMPONENTS
  - FLUID
- Component wear
- Component position
- Records and information

7.1.2 Fluid storage and handling

- Storage
- Handling

- Remember: The benefit of good clean storage can be completely nullified if the fluid becomes contaminated in transit from the drum to the machine.

7.1.3 Installation and commissioning of hydraulic systems

- Power-pack installation
- Filling the system
- Initial starting and commissioning

7.1.4 Routine maintenance

- Operator tasks (to be undertaken during operation of plant):
- Periodic maintenance (weekly or monthly etc., dependent upon operating conditions)
- Annual maintenance

7.2 TROUBLE SHOOTING IN HYDRAULIC SYSTEMS

- 7.2.1 Test equipment
- 7.2.2 General rules for hydraulic maintenance engineers
- 7.2.3 The concept of logical fault finding

7.2 TROUBLE SHOOTING IN HYDRAULIC SYSTEMS

In far too many instances the method of fault-finding in hydraulic systems is by trial and error. The maintenance engineer removes components in a random manner and replaces them with new ones hoping to cure the fault. This can be a very time-consuming and expensive exercise, and can indeed introduce additional faults into the system. Every time a joint is broken, contaminants are introduced.

7.2 TROUBLE SHOOTING IN HYDRAULIC SYSTEMS

Using a simple logical fault-finding technique can considerably reduce down-time and case the task of the maintenance engineer. To use this technique, it is essential to have the following:

- A good understanding of the function of all the hydraulic components in the system.
- A complete and up-to-date circuit diagram.
- A parts list showing full part number and manufacturer of each component
- An operational schedule giving details of sequence of operations, cylinder speeds
- motor speeds, setting pressure of relief valves, pressure-reducing valves etc

7.2.1 Test equipment

Ideally every user of hydraulically-operated machines should have the following equipment available to the maintenance engineer:

- A flow meter
- Test gauges
- A hydraulic test unit
- A contamination measuring device

7.2.2 General rules for hydraulic maintenance engineers

- Before working on a machine check the effect on interlocked parts or machines.
- Chock up all cylinders and parts which may fall under gravity.
- Isolate electrical supply and lock control cabinet.
- Isolate pump and ensure it cannot be started accidentally
- Bleed fluid to relieve any pressure in system by cracking fittings - cover with cloth 10
- prevent oil spray. Particular care must be taken in the case of accumulator circuits.
- Plug all pipe ends and ports of components to keep out contaminants.
- Ensure that components stripped are marked to facilitate correct assembly.
- Wash components in the correct fluid. If in doubt use clean hydraulic Quid as used on the machine.
- Use torque wrenches for tightening components. Do not over tighten.
- Use extreme care when starting machine for first time after overhaul - a pipe left off can cause a flood of oil; a valve spool reversed may cause a cylinder to fall instead of rise; actuators may operate out of sequence.

7.2.3 The concept of logical fault finding

This is a diagnostic technique in which all the symptoms have to be carefully considered so the fault can be localized to one section of the circuit. If the fault affects all cylinders and motors it must be something common to them all, i.e. a failure in supply either of hydraulic fluid - a fault in the power pack - or in the electrical control system. Should the fault be unique to one actuator, start by considering the components associated with that actuator.

7.2.3 The concept of logical fault finding

To determine the possible cause of a fault, the exact function and effect of each component associated with the system must be known. Consider the action of each component in turn, with respect to the symptoms. Make a note of the component or components which if maladjusted or malfunctioning could result in all these symptoms.

7.2.3 The concept of logical fault finding

When this has been done select the component which can be most easily tested, for example adjusting flow or pressure settings, manually operating solenoid valves and limit switches. Only when all the simple tests have been completed should any attempts be made to disconnect pipework or remove components. Every time a joint is broken, contamination will enter the system; always plug pipes and manifolds when components are removed.

7.2.3 The concept of logical fault finding

Foult finding procedure:

- INITIAL INFORMATION
- INITIAL CHECK ON MACHINE
- FAULT DIAGNOSIS
- FAULT-FINDING USING FUNCTIONAL BLOCK DIAGRAMS AND TROUBLE SHOOTING CHARTS
- TREE-BRANCHING METHOD OF FAULT-FINDING

INITIAL INFORMATION

This is from the machine operator

1. Where and when does fault occur?
   (a) On all cylinders and motors.
   (b) On one only.
   (c) Under all load conditions
2. Type of fault
   (a) Complete stoppage.
   (b) Reduced speed or thrust.
3. How soon did fault occur?
   (a) Suddenly ... (breakdown)
   (b) Gradually ….. (general wear)
   (c) Periodically ... (intermittent fault)
4. Unauthorized adjustment
   (a) Has someone adjusted the machine?
   (b) Has any attempt been made to repair unit?
   (c) Has machine recently been modified or repaired?

INITIAL CHECK ON MACHINE

- Check electrical supply is switched on to both power and control circuits
- Check oil level, condition, temperature.
- Check pumps for correct running.
- Check filters.
- Check pressures.
- Check visually for broken or burst pipes, leaks from components.

FAULT DIAGNOSIS

If fault is localized to part of circuit, only that area need be considered. If fault is general to all the circuit the cause must be something common to whole circuit, e.g. pump, main relief valve, suction line. Initially trace the fault to a particular part of the circuit so that only components in that part need to be considered. Next consider each component and determine which components could cause the fault. Only when possible causes of the fault have been determined should any components be tested. Carry out the easiest tests on suspect components first, i.e. tests which can be done in situ, e.g. manual operation of solenoid valves, pressure settings, low settings, and oil leaks and damaged pipes. If this fails to locate the fault, remove the component most likely to be faulty and check that first.

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- Next consider each component and determine which components could cause the fault.
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EXAMPLE 7.1

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System specification:
The cylinder shown in Figure 7.1 is to traverse under load in both directions. Cycle duty 6–8 cycles per hour, 24 hours per day.

Fault occurs

Initial information

Cylinder extends but will not retract. Can be forced back using separate jacking cylinder.

EXAMPLE 7.1

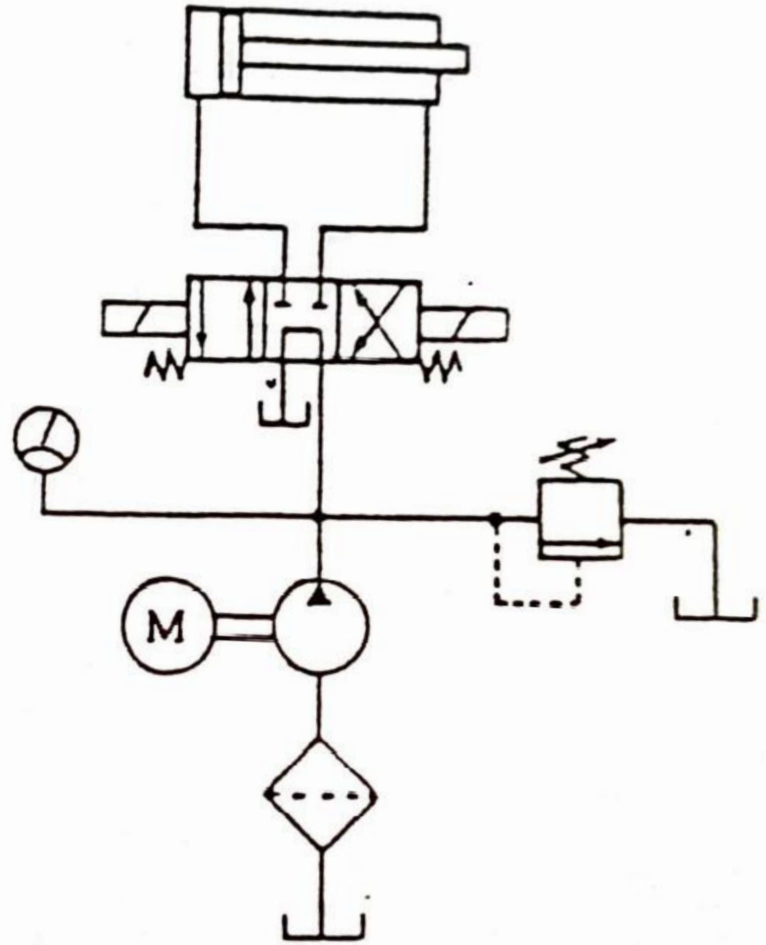


Figure 7.1

EXAMPLE 7.1

Initial check

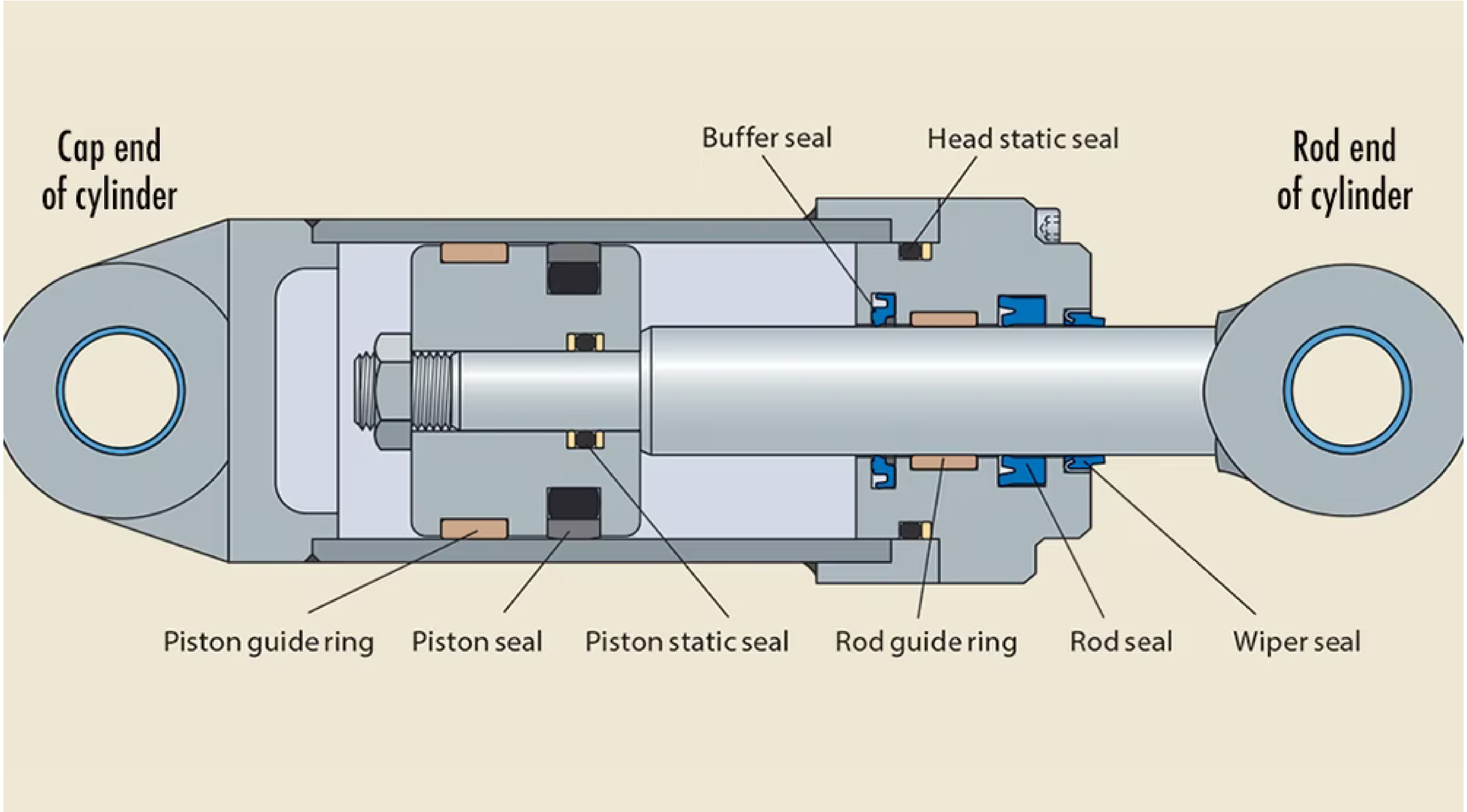
(a) Steady pressure on extend stroke, pressure rises to relief valve setting at the end of stroke prior to solenoid being de-energized.
(b) On energizing retract solenoid pressure rises to relief valve setting after a short time delay.
(c) Condition normal in center condition.

As this is a simple circuit, the whole circuit can be considered.

EXAMPLE 7.1

Unit	Possible fault	Comments
Pump	No	Fault is one direction only Pump would affect both directions
Suction filter	No	As for pump
Relief valve	No	If the pressure setting is too low for retract, the cylinder will stall. This would not cause the delay in reaching relief valve pressure on retract
Solenoid valve	No	Retract solenoid may not be moving spool fully over, causing a restriction to flow. Will not cause time delay
Cylinder	Yes	Seals could be faulty. External guides loose. Piston detached from piston rod

Possible cause is: Piston detached from piston rod. (The symptoms assume there is no hole through the piston.)



Cap end of cylinder
Buffer seal
Head static seal
Rod end of cylinder
Piston guide ring
Piston seal
Piston static seal
Rod guide ring
Rod seal
Wiper seal

FAULT-FINDING USING FUNCTIONAL BLOCK DIAGRAMS AND TROUBLE SHOOTING CHARTS

- A hydraulic circuit can look very complex to the uninitiated and make fault-finding almost impossible. Although it is preferable for maintenance engineers to have a working knowledge of power hydraulics it is possible by using charts and block diagrams to simplify trouble shooting.
- There is considerable work involved in designing and drawing up the appropriate charts, so this method may only be viable if a number of similar machines are involved.
- The complete system should be broken down into sections which can be considered individually, for example an actuator or group of actuators and the associated control valves.

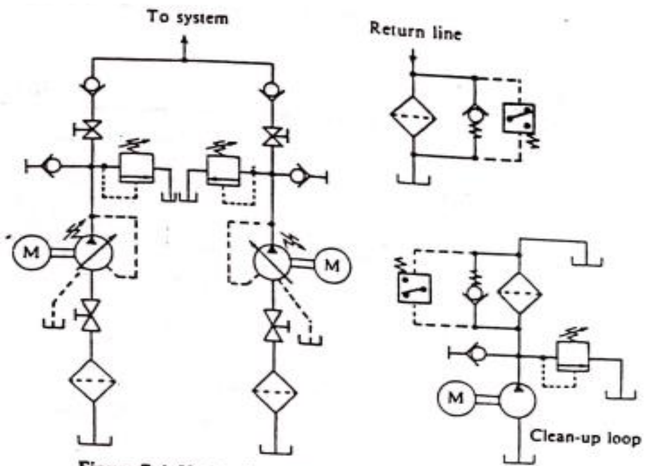


Figure 7.4 Hydraulic power pack (symbolic circuit).

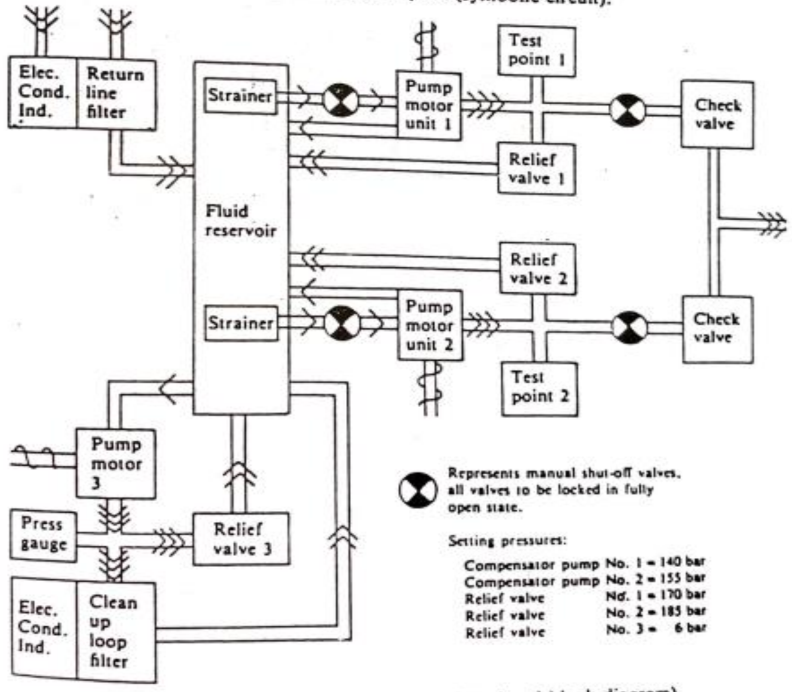


Figure 7.5 Hydraulic power pack (functional block diagram).

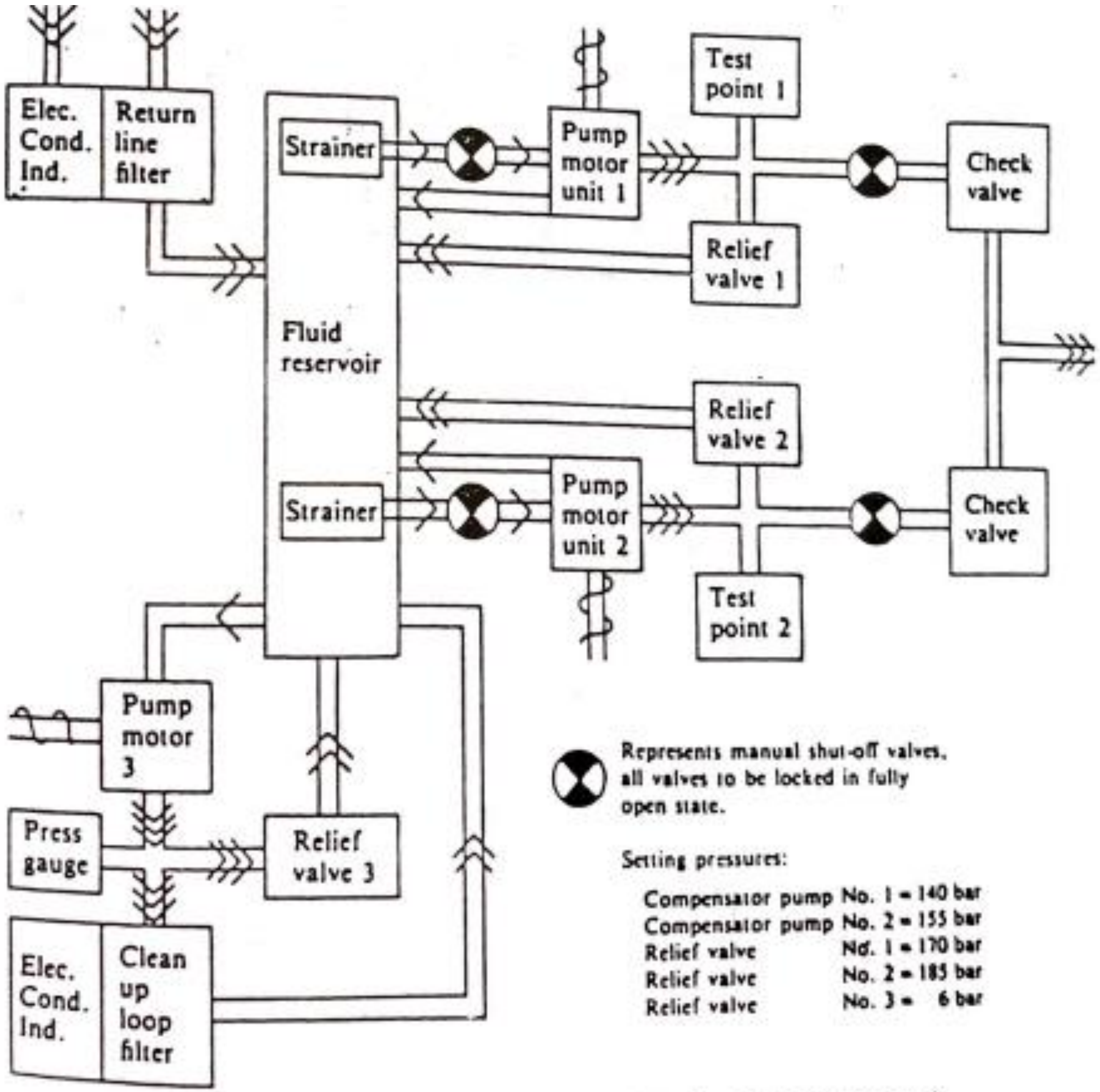


Figure 7.5 Hydraulic power pack (functional block diagram).

FAULT-FINDING USING FUNCTIONAL BLOCK DIAGRAMS AND TROUBLE SHOOTING CHARTS

Complete loss of hydraulic power	Check electric motor	×	Start electric motor	×	Check interlocks										
		✓	Check pump suction valve	×	Open immediately										
				✓	Check pump shaft rotating	×	Check coupling								
						✓	Check direction of rotation correct	×	Reverse immediately						
								✓	Check pump compensator settings	×	Adjust settings				
										✓	Check pump delivery correct	×	Worn pump – replace		
												×	Check valve faulty flow going through 2nd pump. Check if 2nd pump rotating when electric motor off		

FAULT-FINDING USING FUNCTIONAL BLOCK DIAGRAMS AND TROUBLE SHOOTING CHARTS

Hydraulic pump noisy	Pipework vibrating after pump	×	Pump running hot – higher than oil temperature	✓	Damaged pump – replace										
		✓	Cavitation check suction valve open	×	Open immediately										
				✓	Fluid level correct	×	Top up with correct oil								
						✓	Oil temperature high	✓	Check oil cooler						
						✓	Oil temperature low	✓	Check oil heater						
								×	Oil temperature correct	✓	Air leaks on pump suction	✓	Tighten or change fitting		
												×	Check oil tank for oil frothing	✓	Find cause of foaming and eliminate

Figure 7.6 Hydraulic power pack (trouble shooting chart). ✓ = Yes, × = No.

TREE-BRANCHING METHOD OF FAULT-FINDING

- This is basically another method of presenting the fault-finding chart. It asks a question which has only two possible answers, 'yes' or 'no'; the answer determines the next step to be taken.
- It is said that on average it takes four times as long to locate a fault as it does to rectify it and this technique helps develop a logical and rapid approach to fault diagnosis.

TREE-BRANCHING METHOD OF FAULT-FINDING

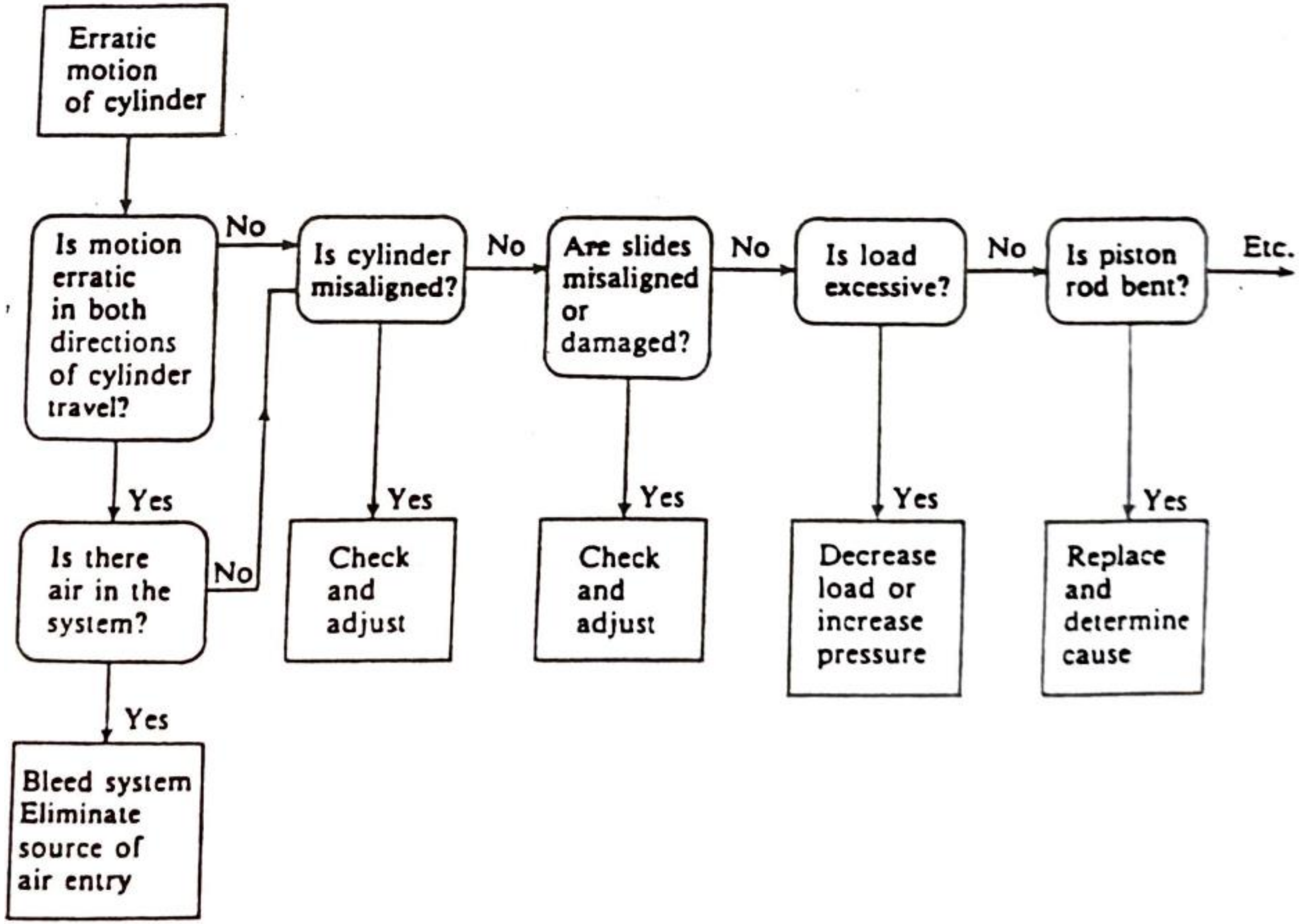


Figure 7.7 Tree-branching chart.

EXAMPLE 7.2 THEORETICAL LOJICAL FAULT FINDING

EXAMPLE 7.2: THEORETICAL LOGICAL FAULT FINDING

The hydraulic circuit for a hydraulically operated lift table is shown in Figure 7.2.

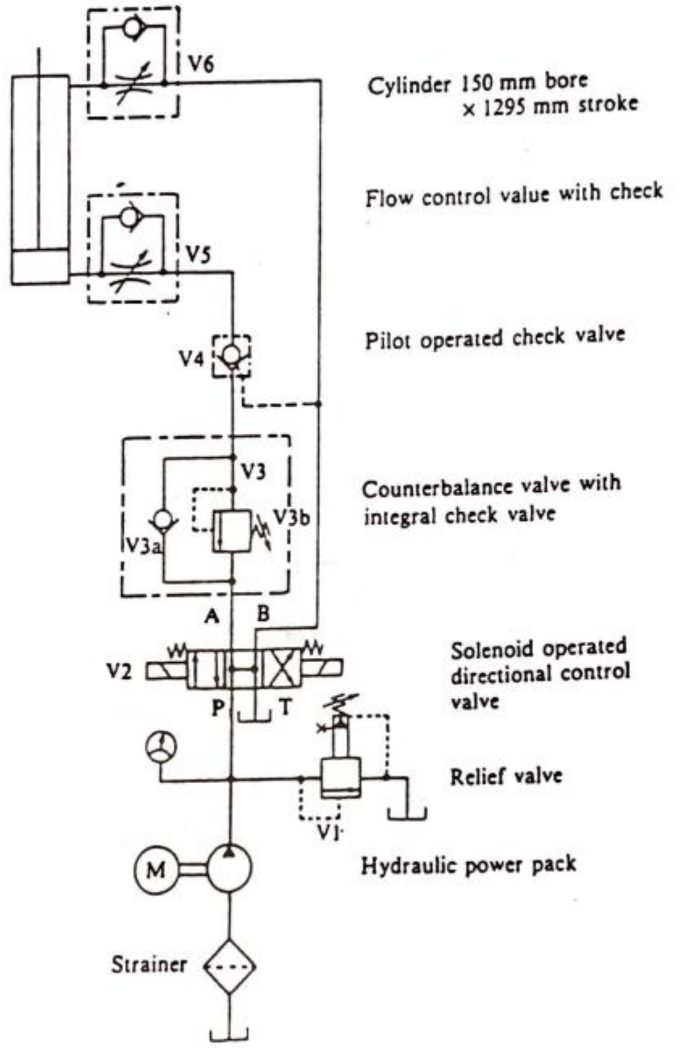


Figure 7.2 Hydraulic circuit for lift table.

EXAMPLE 7.2 THEORETICAL LOJICAL FAULT FINDING

Symptom	Cause	Initial checks
Cylinder extends at normal speed, retract speed is slow		
Cylinder movement is erratic and noisy		
Cylinder movement is jerky when retracting		
Cylinder extends but will not retract. System pressure is up to the relief valve setting		
Cylinder will not extend. System pressure is low and cannot be adjusted by the relief valve		

Figure 7.3 Lift table – fault finding exercise (a suggested solution is given in Figure 7:14)

EXAMPLE 7.2 THEORETICAL LOJICAL FAULT FINDING

Symptom	Cause	Initial checks
Cylinder extends at normal speed, retract speed slow	V5 flow control set too low	Adjust
	Internal leaks across piston seal (retract)	Retract piston. Disconnect full bore port. Apply pressure to annulus and check for leaks
	V6 check valve jammed closed	Adjust V6 flow control and check if it affects retract speed
Cylinder movement erratic and noisy	Air in cylinder	
Cylinder movement jerky when retracting	V3b set too low and cylinder overrunning	Adjust V3b
Cylinder extends but will not retract. System pressure up to relief valve setting	V5 flow control closed	Adjust V5
	V3b set too high	Adjust V3b
	V4 not opening	Check pilot to V4
Cylinder will not extend. System pressure low cannot be adjusted by relief valve	V1 damaged	Check control spring
	V2 not operating	Manually operate V2
	Pump malfunction	Check pump

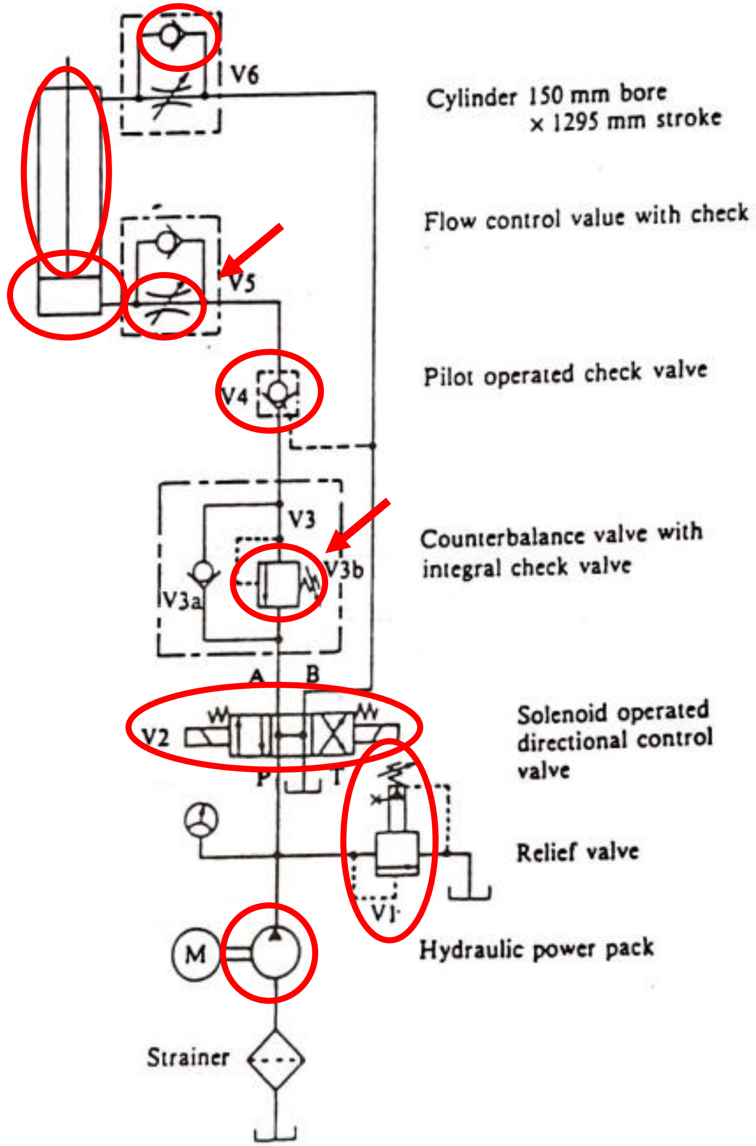


Figure 7.3 Lift table – fault finding exercise (a suggested solution is given in Figure 7.1

Thank you

Any Questions ?