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Understanding Thruster Technology and Performance Benefits

by

Scott Pastorius, Mondel Engineering, LTD

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UNDERSTANDING THRUSTER TECHNOLOGY AND PERFORMANCE BENEFITS

AUTHOR and PRESENTER
SCOTT PASTORIUS

SPONSORING FIRM
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UNDERSTANDING THRUSTER TECHNOLOGY

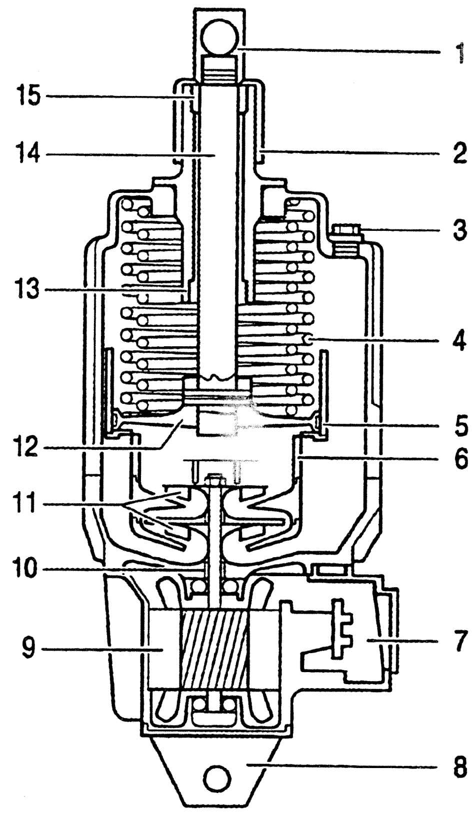
DESIGN

Electro-hydraulic actuators or linear drives consolidate all the basic elements of a hydraulic system into one single packaged unit. This integrated unit consists of a hydraulic pump with electric drive motor, working cylinder, piston and lifting rod. "The function of the actuator is to convert electrical energy hydraulically into a mechanical force, producing a smooth straight line thrust throughout the piston stroke". The working fluid of the hydraulic system serves as the operating medium for the generation of thrust.

The standard material for enclosures is cast aluminum alloy, fitted with gasketing and double shaft sealings, as a minimum, to make the units weatherproof and dustproof to IP65 standards. Special enclosures and paint finishes are typically available for heavily corrosive environments such as chemical or marine applications.

Modern designs generally include 100% unit testing including endurance run and a subsequent functional test with documentation of all technical data. A certified quality assurance program to DIN ISO 9001 and a 12 month warranty are also typical of modern electro-hydraulic actuator units.

Figure 1
Sectional View

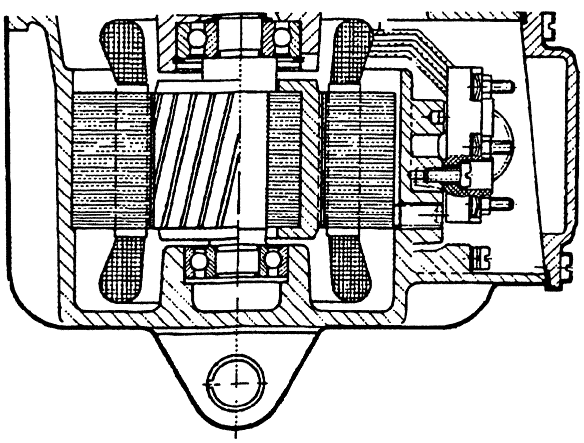


1. Pressure lug
2. Piston rod protection tube
3. Oil filler inlet
4. Resetting spring c
5. Hydraulic cylinder
6. Oil guider
7. Terminal box
8. Fixing lug
9. Three-phase AC squirrel cage motor
10. Motor shaft double seal
11. Hydraulic pump
12. Piston
13. Double seal to oil chamber
14. Piston rod
15. Dust proof double seal

METHOD of OPERATION

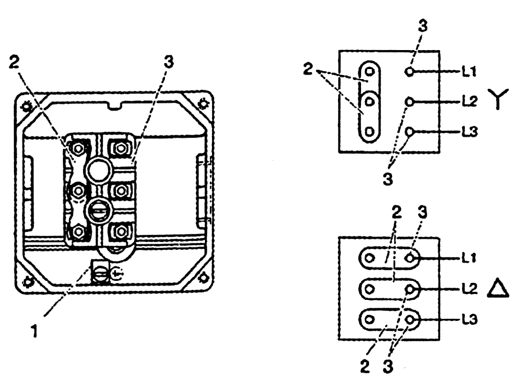
The motor casing (Figure 2) houses the stator of the drive motor which is typically designed as a three-phase asynchronous squirrel-cage motor (DC motors are also available).

Figure 2
Motor Casing



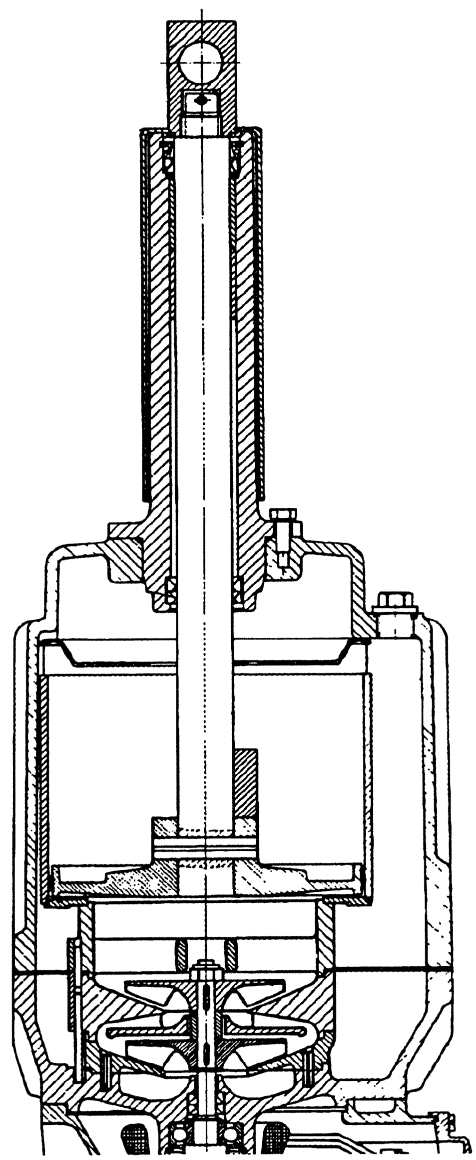
The electrical connection (Figure 3) is via a sealed terminal box with a 6-pole terminal board as a minimum.

Figure 3
Terminal Box with 6-Pole Terminal Board



The blade wheel (rotary vaned impeller) of the pump (Figure 4) is mounted on the motor shaft. With the motor in the "switched-off" state (de-energized) the hydraulic piston rests at the bottom of its stroke, i.e. the rod is at its lower limit of travel.

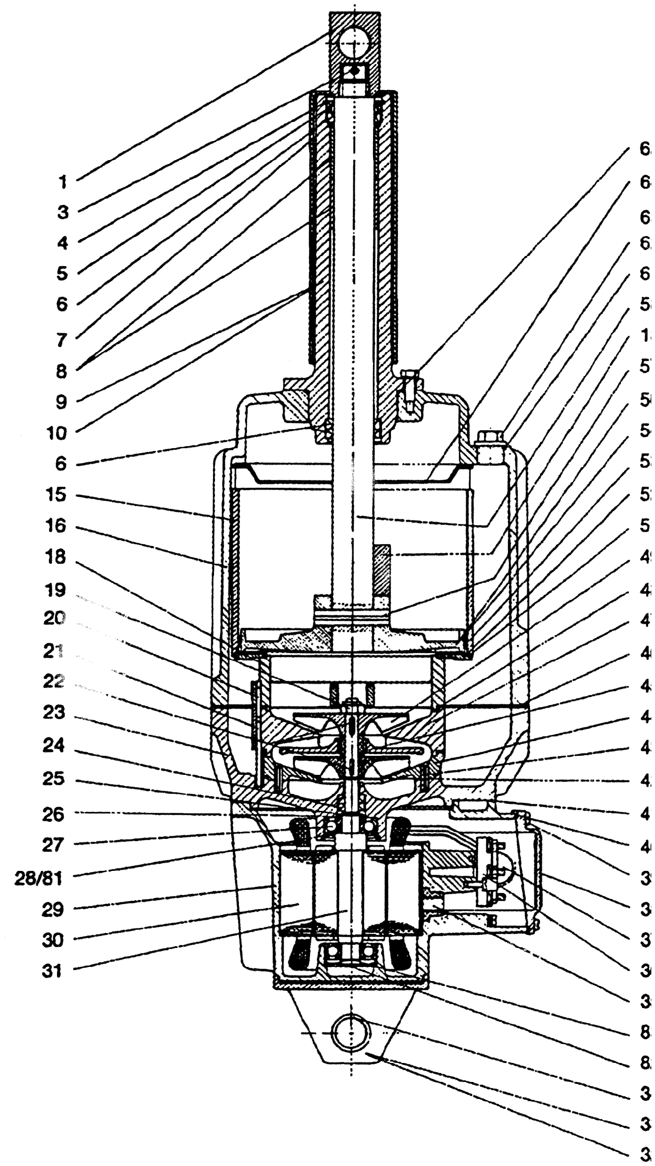
Figure 4
Rotary Vaned Impeller and Piston



METHOD of OPERATION

When the motor [30] is "switched-on" (energized) the working fluid is displaced by the vanes of the impeller [49/50] (centrifugal pump) and forced against the underside of the piston [54] producing the hydraulic pressure, i.e. the thrust of the electro-hydraulic unit. As a result the piston rod [58] extends, thus compressing the built-in spring or operating against the external spring or load. At the limit of piston travel [64], the power taken by the motor reduces to approximately half that required during the piston travel. Simultaneously the pressure within reaches its maximum value which is approximately 30% above the rated value. Therefore the driving motor is less loaded when the piston is at rest. The impeller runs freely inside the cylinder and even if the piston rod does not complete its full stroke, the motor is not subject to an overload condition since it is not stalled or in a locked-rotor condition. Therefore, an outside thermal protection circuit is unnecessary. Then , when the motor is "switched-off" (de-energized) the piston rod returns to the bottom [56] of its stroke due to the force exerted by the return springs or external load.

Figure 5
Electro-hydraulic Actuator



BRAKING SYSTEMS

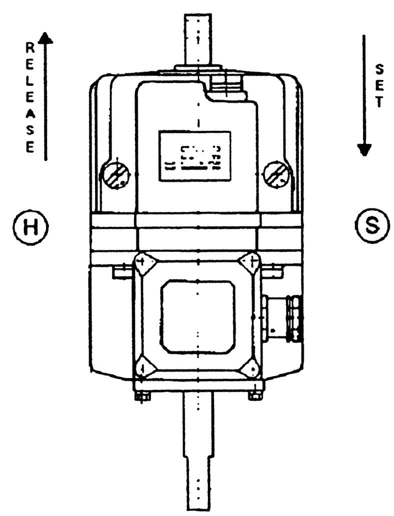
The use of electro-hydraulic actuators in mechanical drum or disc brakes leads to designs that are of simple, rugged construction, designed with a minimum number of parts to provide a long service life with reduced maintenance and downtime.

Under normal operating conditions, Hy-Thrust actuators have a minimum working life of 20 million switching cycles. Standard stroke actuators are rated up to a maximum switching frequency of 2000 (OPH) operations per hour and extended stroke actuators to 1200 (OPH) operations per hour. Frequency of operation can be increased at rated load if the total stroke is not used or the motor is always switched in the same direction of rotation.

The lifting and lowering times depend on the actuator stroke length, the internal or external torque spring ratings, the rated load and the viscosity of the hydraulic fluid. The fluid viscosity is in turn influenced by the ambient and operating temperatures. By fitting optional, externally-adjustable time delays, the basic brake operating characteristics can be altered to make it suitable for a different set of operating conditions. Versions with a lifting and/or lowering valve enable infinitely variable adjustment of the "acting" and "resetting" speeds (brake release or setting times) of the piston rod within a specific range.

By fitting the setting (S) time delay the operation of the brake is enhanced. This gradual action, with on-site adjustment capability makes this type of brake ideal for bridge applications where some of the kinetic energy can be dissipated in the system before the brake is fully applied. This feature can also be used to provide a simple method of discriminating between the service and emergency brakes on dual drive applications. When fitted with a time delay on the release stroke (H) the brake release can be delayed until the prime mover has started developing torque, thereby preventing run-back. If required, both the (S) and (H) time delays can be fitted to provide independent adjustment of brake release and setting times.

Figure 6
Time Delays

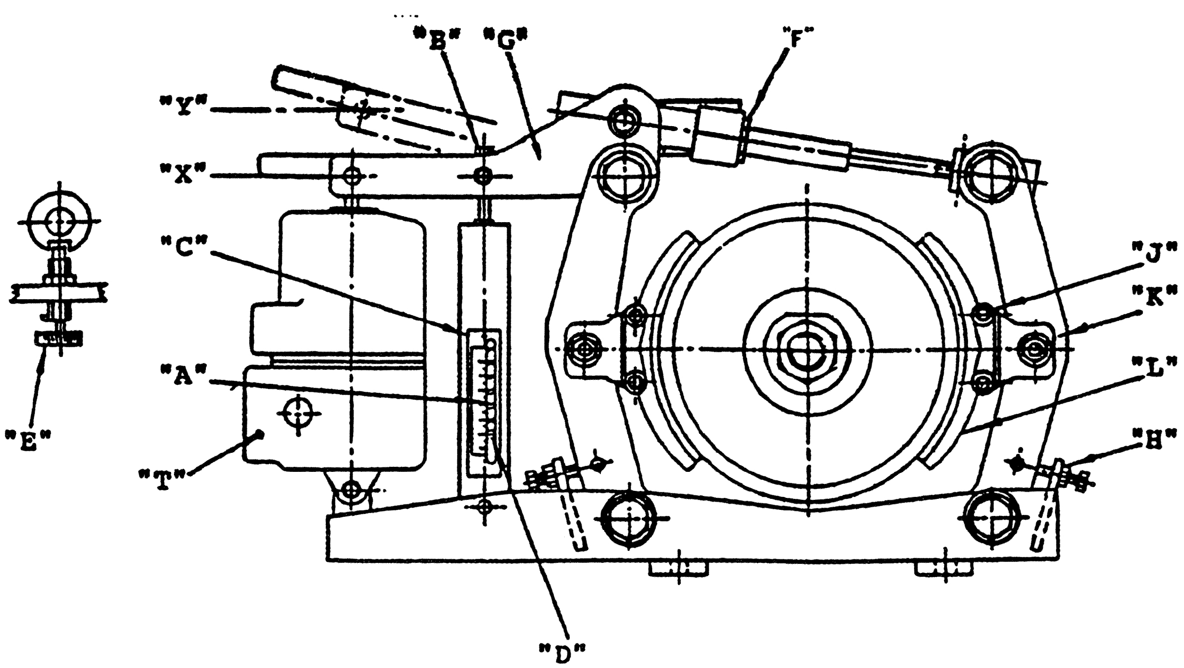


H- LIFTING VALVE (BRAKE RELEASE)
S- LOWERING VALVE (BRAKE SET)

BRAKING SYSTEMS

These versatile brakes with many standard and optional features can be used in a wide range of applications and environmental conditions, where smooth, responsive stopping and holding are desirable. They have become the standard braking system of choice within the movable bridge industry. Electro-hydraulically actuated brakes provide a "cushioned" braking action which reduces mechanical oscillation. Modern thrusters provide a fluid action in the release and setting of mechanical brakes virtually eliminating the mechanical shock loading problem which is a major factor in the wear and failure of brake components. Electro-hydraulic operated brakes are fast acting due to the inherent fluid damping effect, providing controlled applied torque to the drum or disc surface.

Figure 7
Electro-hydraulic Type Brake



Y - Brake Released

X - Brake Applied

T - Actuator

RETROFITTING

When reviewing the requirements and the specifications of a bridge upgrade, please keep in mind that the existing brake assemblies that are probably creating maintenance problems may be the result of an old design and/or obsolete actuator. If, for budget purposes, consideration is being given to overhauling the thruster units, don't. This course of action rarely provides a long term maintenance solution. The best course of action is a complete brake system replacement, but if the overall project or bridge usage does not warrant the additional expense, there is still an economical solution that will provide long term maintenance benefits.

Provided that the basic brake frame assembly is in good condition, an obsolete thruster can be replaced by a modern electro-hydraulic actuator. This has recently been accomplished on the Robert Moses Draw Bridge (N.J. Transit Authority) and the Pelham Parkway Bridge (N.Y. D.O.T.) projects.

The Robert Moses Draw Bridge brakes were fitted with new actuators, using mounting adapters on the existing brake frame assemblies. Mechanical and electrical requirements were reviewed and verified. Existing brake data and torque values were reviewed and re-calculated to maintain continuity in braking set/release times. The actuators were sized based on this data and by required stroke and extending (thrust) forces as well as the required return force. The cost was greater than the estimate to overhaul the obsolete thruster units, but far less expensive than that of a complete brake change-out.

The Pelham Parkway Bridge brake retrofits were taken one step further. The design of the existing obsolete thruster was such that the top brake arms had to be removed and a newly designed pair installed to allow for the taller profile of the new actuator. Base plate adapters were provided to facilitate the lower mounting connection. The new arms were designed to fit the existing hand release and limit switch positions. Even though the overall cost was more than the simple adapters provided for the Robert Moses Bridge, the cost was less than that of a complete brake assembly and associated hardware.

This may not be the best direction or solution for your particular bridge project, but it is certainly a far better solution to that of maintaining obsolete thruster units.