AMERICAN CONSULTING ENGINEERS COUNCIL'S

HEAVY MOVABLE STRUCTURES MOVABLE BRIDGES AFFILIATE

3RD BIENNIAL SYMPOSIUM

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ST. PETERSBURG HILTON & TOWERS ST. PETERSBURG, FLORIDA

SESSION WORKSHOP NOTES

Session (4-10)
"Bascule Bridge over the Oste at Geverdorf", R.Ortmann/D.Laging,
Waterwy Auth., Rendsburg, Germany

Bascule bridge over the Oste at Geversdorf

Robert Ortmann

While expanding the road network and taking some of the load off the national roads from and to the Elbe ferry between Wischhafen and Glückstadt on the Lower Elbe, a bascule bridge had to be built over the river Oste at Geversdorf.

The small ferry that had been used up to that time had already become something of a bottleneck especially as heavy traffic had to find alternative routes.

The bridge was to be built in a flat landscape and therefore great importance was attached to good design and good appearance of the steel structure and the construction in total.

To avoid elaborate foundation work and other work below ground level, the bridge was designed as a pivoted bascule bridge. The steel structure of the two pylons, the balance arm and the counterweight on the balance arm were designed in accordance with the principles of classical steel structures and the mechanical components are well integrated in them.

The arrangement of the control house allows the bridge attendant to see the bridge and the structure in front of it from the control console.

For the overall concept, this bridge was awarded a prize from the German Roadmaking Engineers for „Exemplary good harmonization with the landscape".

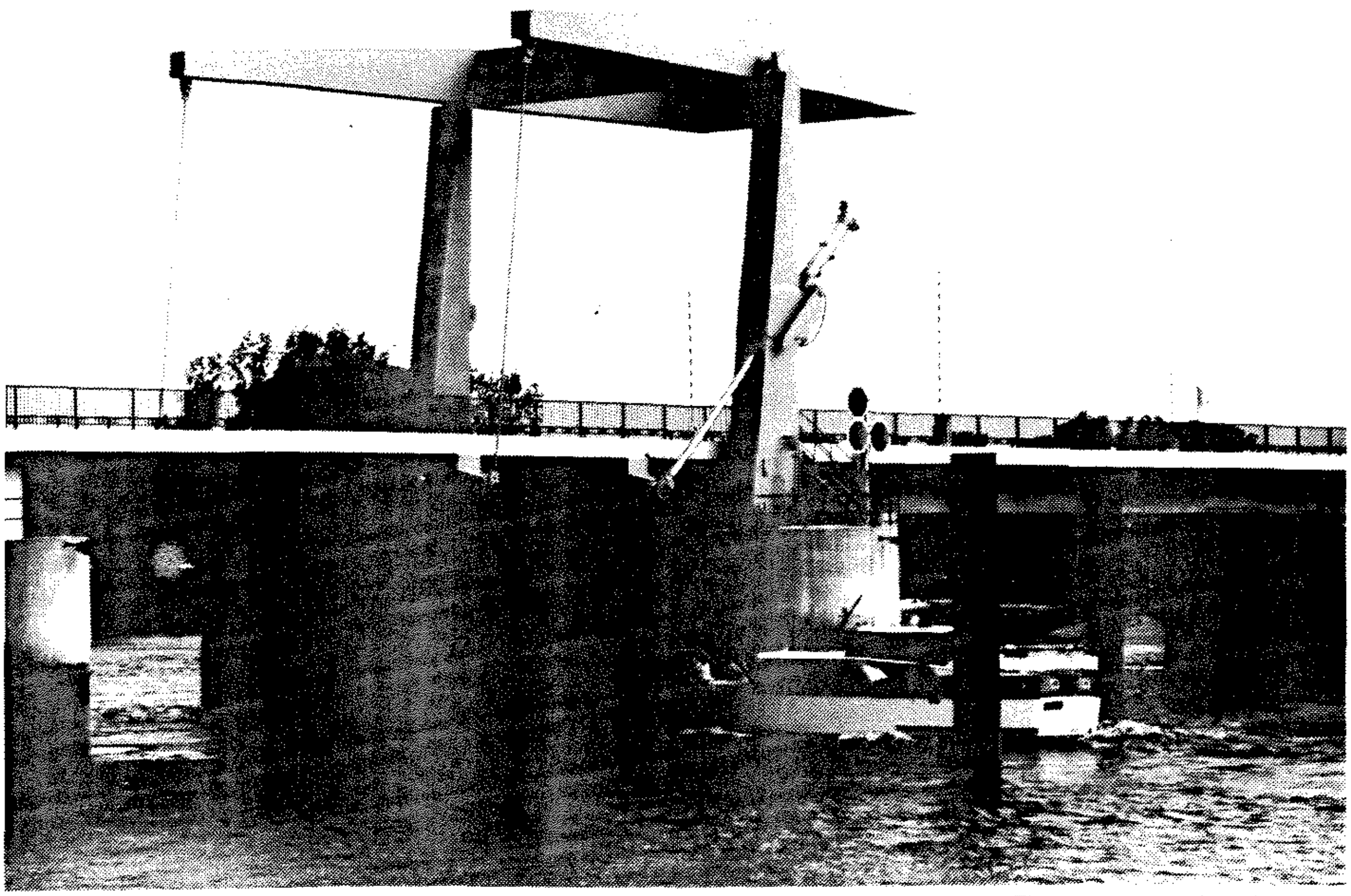

Fig. 1: Brigde in closed position

The bridge has the following dimensions:

- Bridge span: 29.94 m
- Clearance height for traffic between the piers: 26 m
- Overall width of the bridge: 11.5 m
- Road width: 6.5 m, two lanes
- Footpath: On one side 3.5 m, on the other side 1.5 m

The bridge is driven by one double-acting hydraulic cylinder which is held by trunnion at the cylinder barrel and by a Cardan frame at one pylon and is attached to the steel structure of the bridge directly by an eye and spherical bearing on the piston rod.

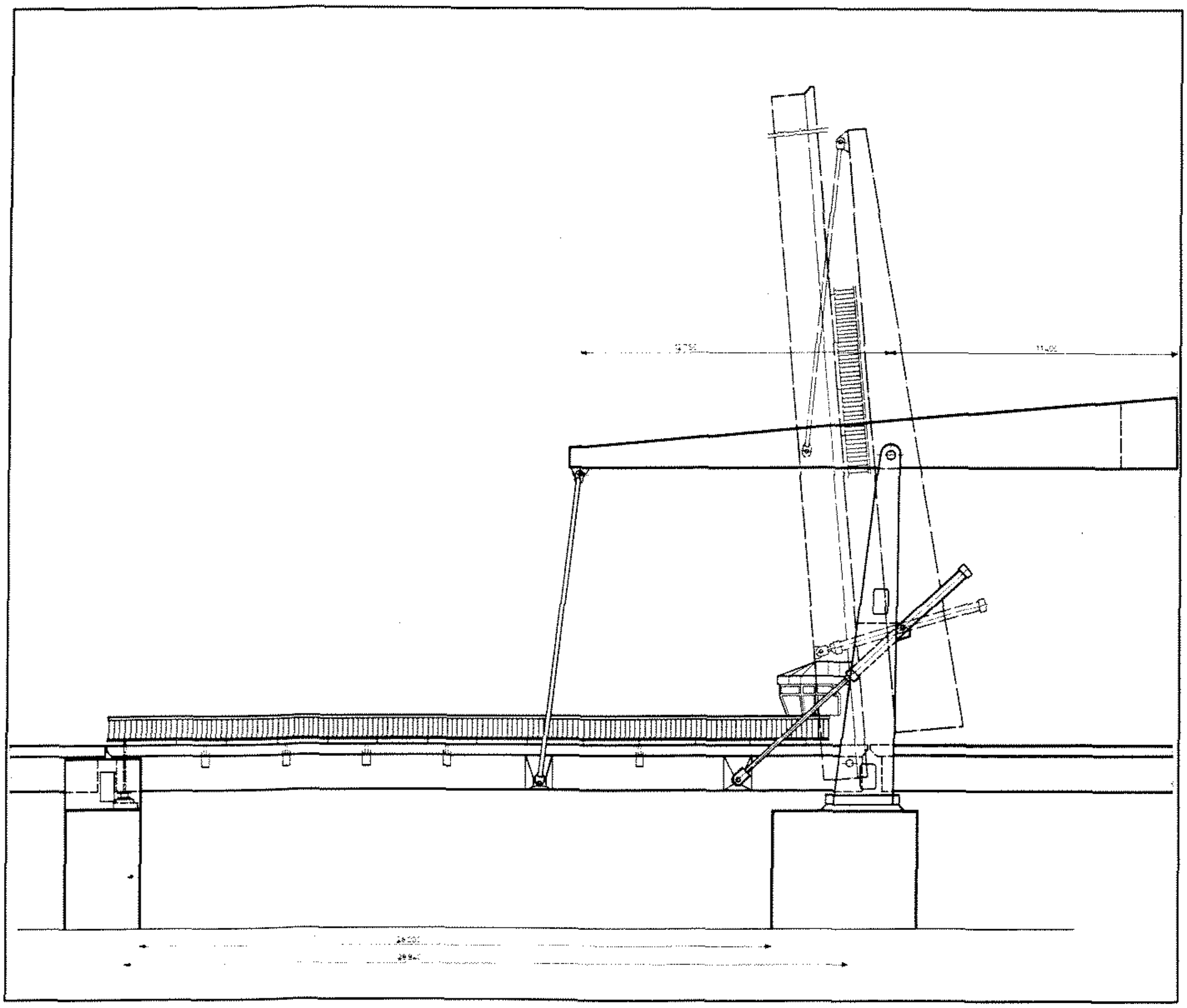

Fig. 2

Because of this one-sided arrangement of the hydraulic cylinder, the steel structure of the bridge had to be designed with torsional stiffness to make sure that the tip of the leaf bears uniformly on the abutment when it comes down.

Owing to the pivoted mounting of the cylinder, transverse forces on the cylinder are avoided but in exchange the piston rod must take up the sag of the bridge resulting from the road traffic when the bridge is down.

To avoid the full force of this acting on the cylinder and its mounting, the piston chamber is connected to the annular piston rod chamber and this in turn is connected to a high tank so that the piston rod in the pressureless cylinder can absorb the deflection without damage when the bridge is in the closed position.

In the closed position, the tip of the bridge is locked at the abutment by a latching pin. This latch is operated by an electric cylinder, the so-called Raco cylinder.

In the open position, the bridge is locked by means of a hook latch at the second pylon. This latch is operated by a hydraulic cylinder.

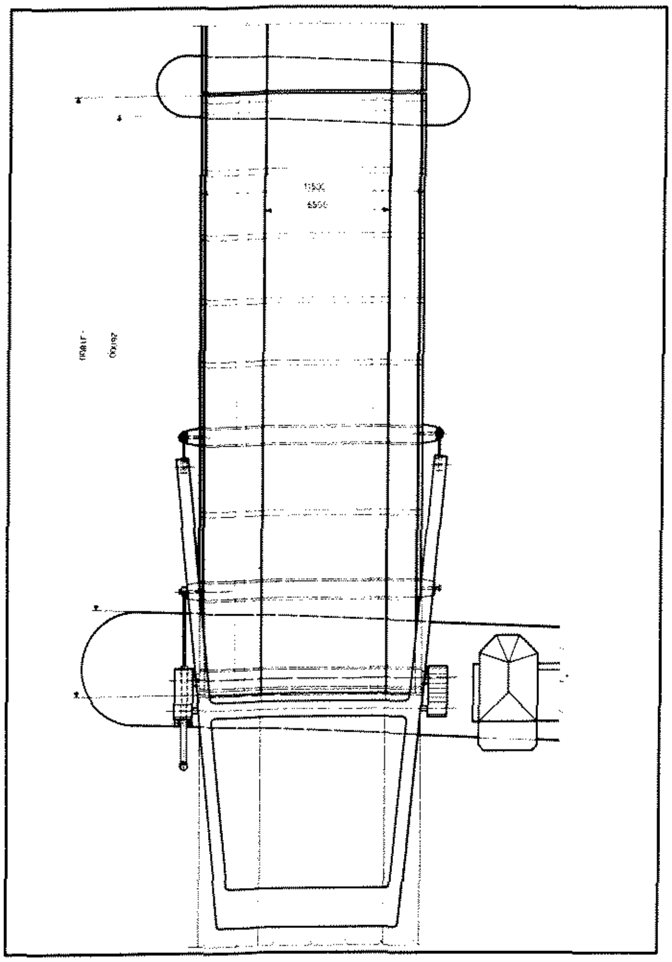

Fig. 3

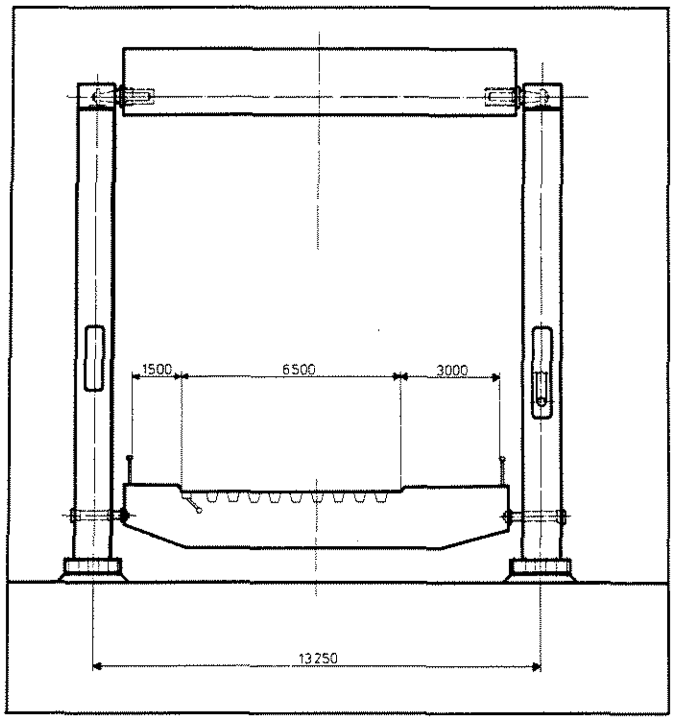

Fig. 4

Oil-hydraulic drive system

The complete drive system has been built to provide maximum operational reliability.
The installation consists of two motor-pump groups, which operate in parallel independently of each other, and an additional gasoline pump power unit.
If one motor-pump group should fail, the bridge is operated at lower speed with the second pump, that is the travel time becomes longer.

Should the electrical/electronic control fail, the bridge can be moved with the residual delivery volume preset on the pumps and by emergency manual operation of the valves.
If the entire power supply fails, the bridge can still be moved using the gasoline pump power unit.

The motion times of the bridge are:

With both pump groups:
- Opening: 2 min
- Closing: 2 min

With the gasoline pump power unit:
- Opening: 40 min
- Closing: 60 min

As already mentioned, the bridge is driven by a hydraulic cylinder with the dimensions:
- Piston diameter: 420 mm
- Rod diameter: 250 mm
- Stroke: 5694 mm

and designed for
- Opening forces: 1700 kN
- Closing forces: 1900 kN

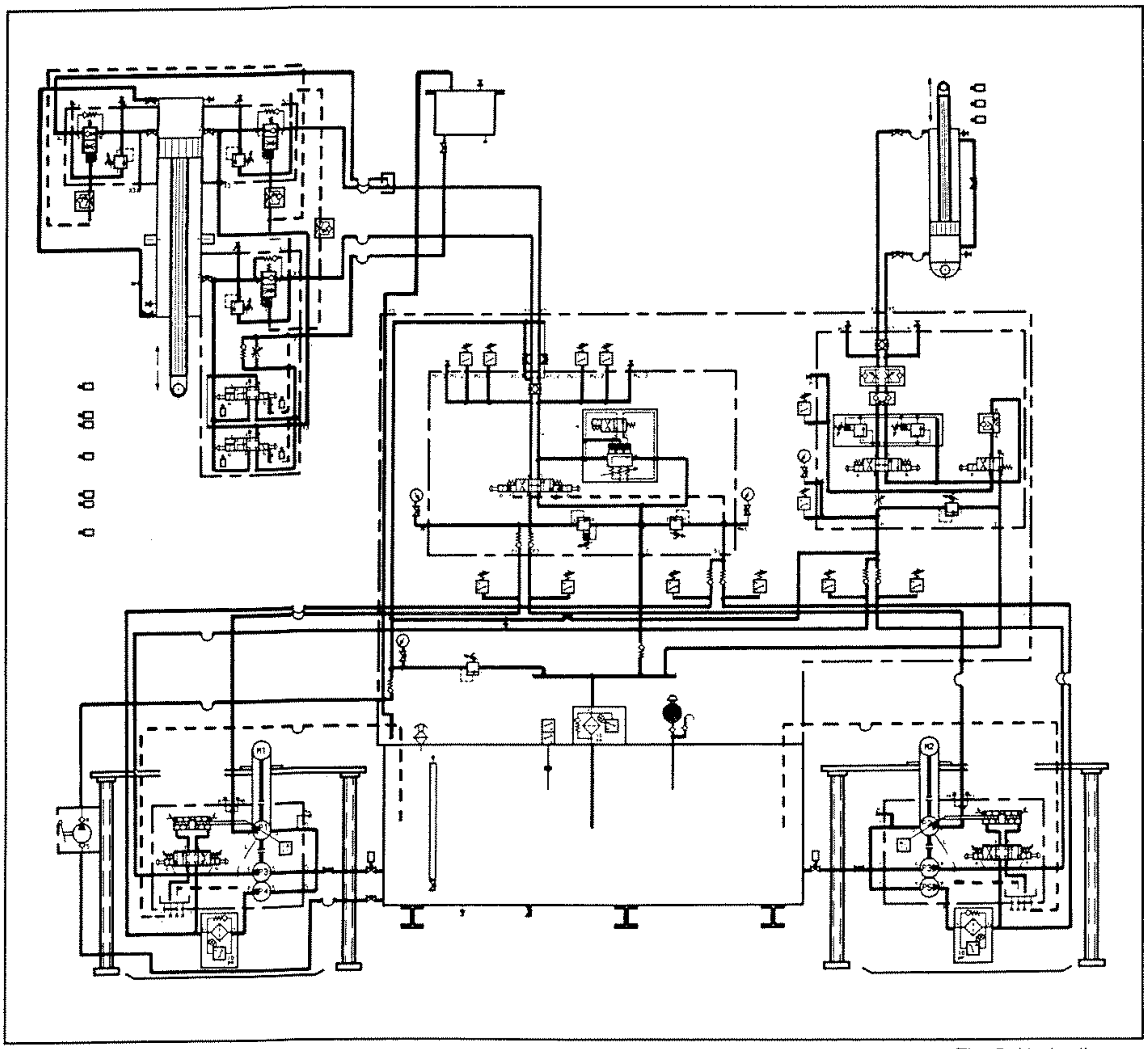

Fig. 5: Hydr. diagram

Since the wind forces in accordance with the kinematics of the bridge are not of equal magnitude over the entire stroke, the cylinder is operated at different working pressures over the stroke. When the piston rod is fully extended for instance, that is when the bridge is in the „closed" position and when the risk of buckling is greatest, the force needed at the cylinder is a minimum. This made it possible to keep the size of cylinder and piston rod relatively small. Suitable monitoring means are provided to keep the buckling force below the allowable maximum at all points along the stroke of the cylinder.
One control block is flanged onto the cylinder on the rod side and two control blocks on the piston side in order to supply via the valves the large volume of oil which is necessary in the piston chamber.

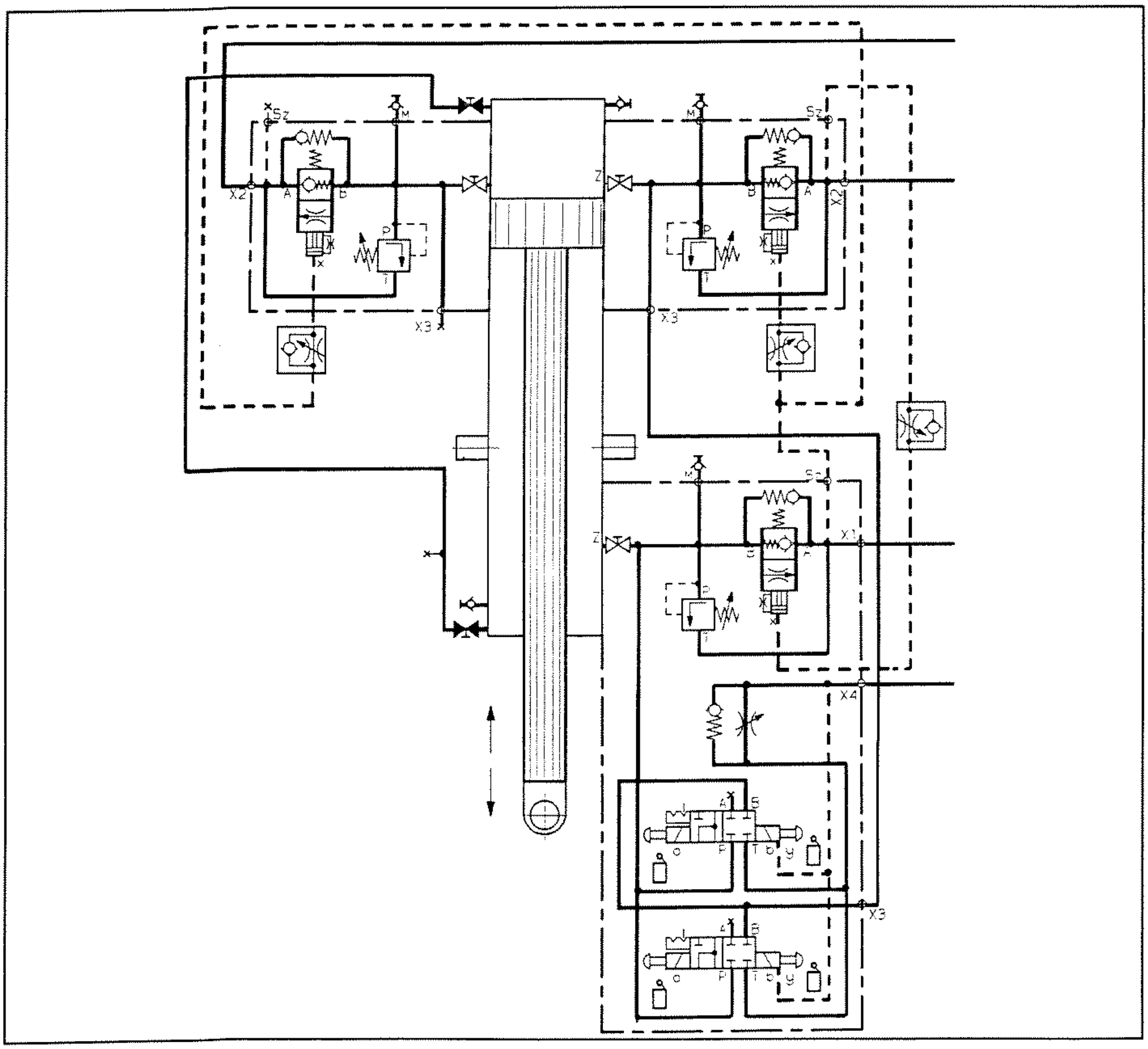

Fig. 6

The following are fitted on or in the control blocks:

Pressure relief valves:

to protect the cylinders against loads due to wind and motion.

Braking valves:

to load the cylinders hydraulically. These valves absorb every change in load without difficulty at all times and without causing vibration to set in on the bridge.

The pressure oil supply to the cylinder is through two axial piston pumps with gear pump flanged onto it for the latching cylinder and the gear pump for the control oil.

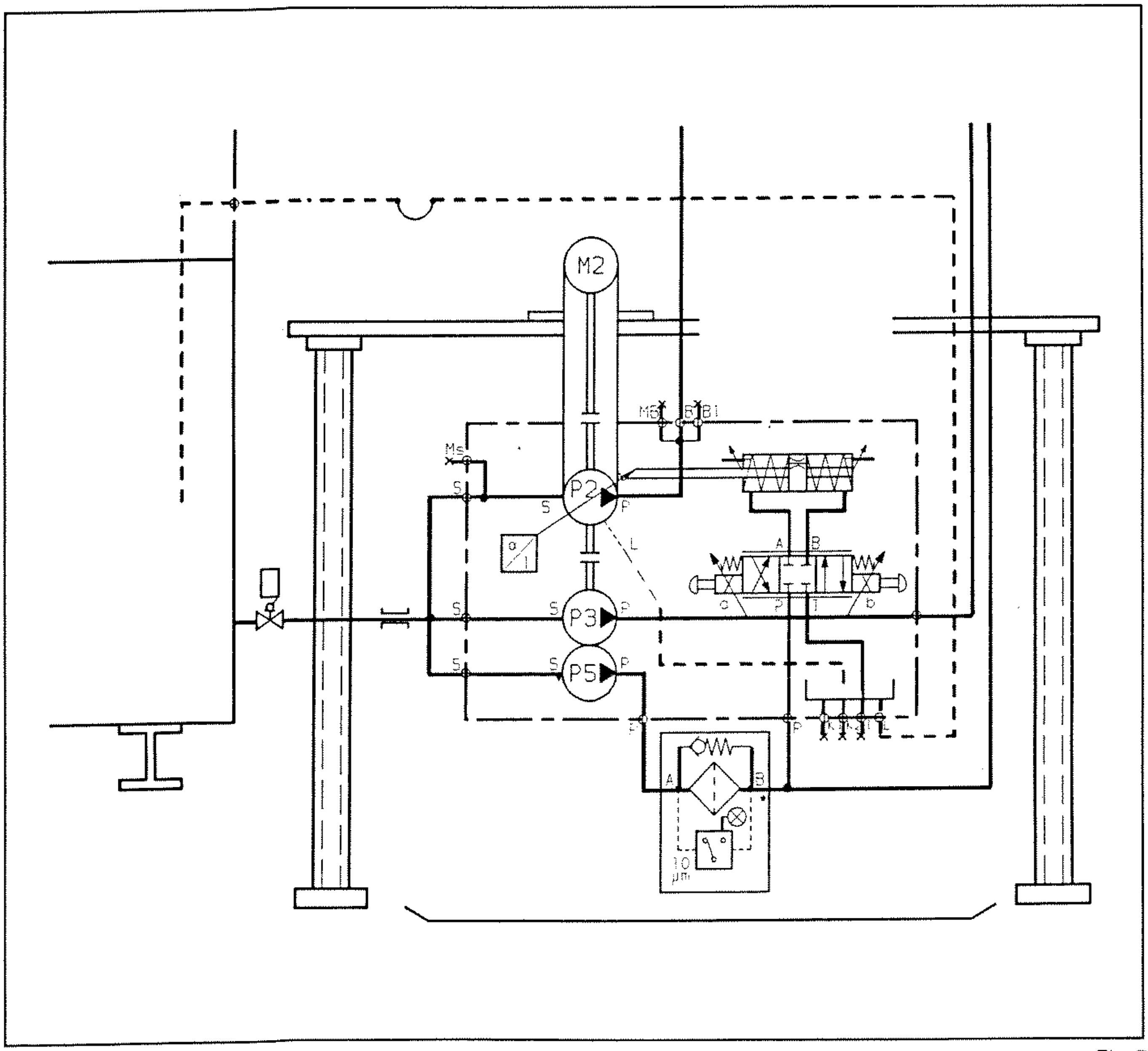

Fig. 7

The axial piston pumps are actuated hydraulically via a suitably designed pilot spool which is controlled from a proportional valve and this in turn is driven by an amplifier board or by pilot control electronics.
The proportional valve allows the pump to swivel out slowly until the maximum travel speed of the bridge is reached. Until the „open“ or „closed“ end position is reached, the pump swivels back slowly until creep speed is reached with which the bridge travels into the end position. The acceleration and deceleration times can be infinitely varied on the amplifier board ramp. The maximum speeds and creep speeds can also be set on the potentiometers fitted on this amplifier board without difficulty at the point of installation. It is necessary to do this in order to optimize the final resting movement of the bridge tip on the abutment and also to ensure that the bridge latches properly when it is in the „open“ position and the cylinder travels into the hard position.
The mechanism providing the movement is controlled by a 4/3-way directional valve with hydraulic pilot control.

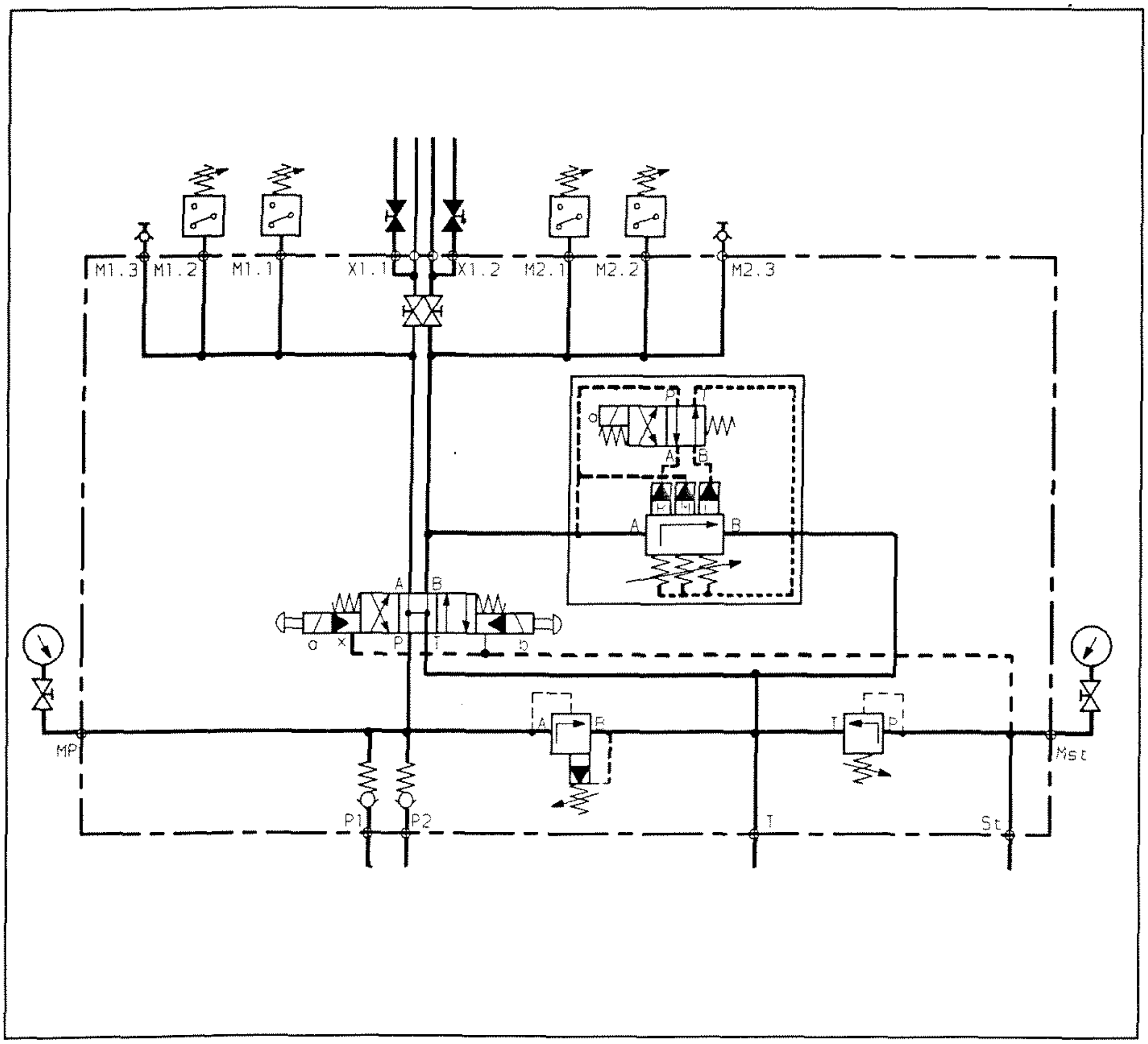

Fig. 8

The pressure relief valves and pressure switches are set to the maximum working force for bridge opening and closing.
To prevent the bridge from pressing in the closed position at maximum pressure, that is in order to avoid maximum buckling load on the piston rod each time the bridge closes, the pressure relief valve on the piston surface is switched over to a lower pressure stage during travel. Also, a pressure switch is provided which limits the pressure for this and, if operated, causes the bridge to lock.
To control the latch there is a 4/3-way valve and also pressure limitation by pressure relief valves, leakage-oil-free closure by pilot-operated check valves and throttle check valves in order to load the cylinder hydraulically.
The complete piping system for the lifting cylinder, the latching cylinder and the control is monitored for pipe breakage by a pressure switch.
As usual in all hydraulic systems, the oil level in the tank and the degree of contamination of the filters are monitored.
An important monitoring element is provided in the electronics for the pumps. This monitoring system prevents the bridge from travelling into the end position at full speed. When the command is given for the pump to swing back, in other words for the pump to reduce from travel speed to creep speed in accordance with the motion chart, this operation is checked by feedback potentiometers and monitoring elements in the electronics. If the pump does not carry out the command to swing back, an emergency closing operation is performed so that the bridge comes to rest with the necessary deceleration even before the abutment is reached in the „open" position or the cylinder reaches the hard position which represents the „closed" position of the bridge.
Owing to the limited space in the machinery room, the entire power unit was designed as a „compact" power unit.

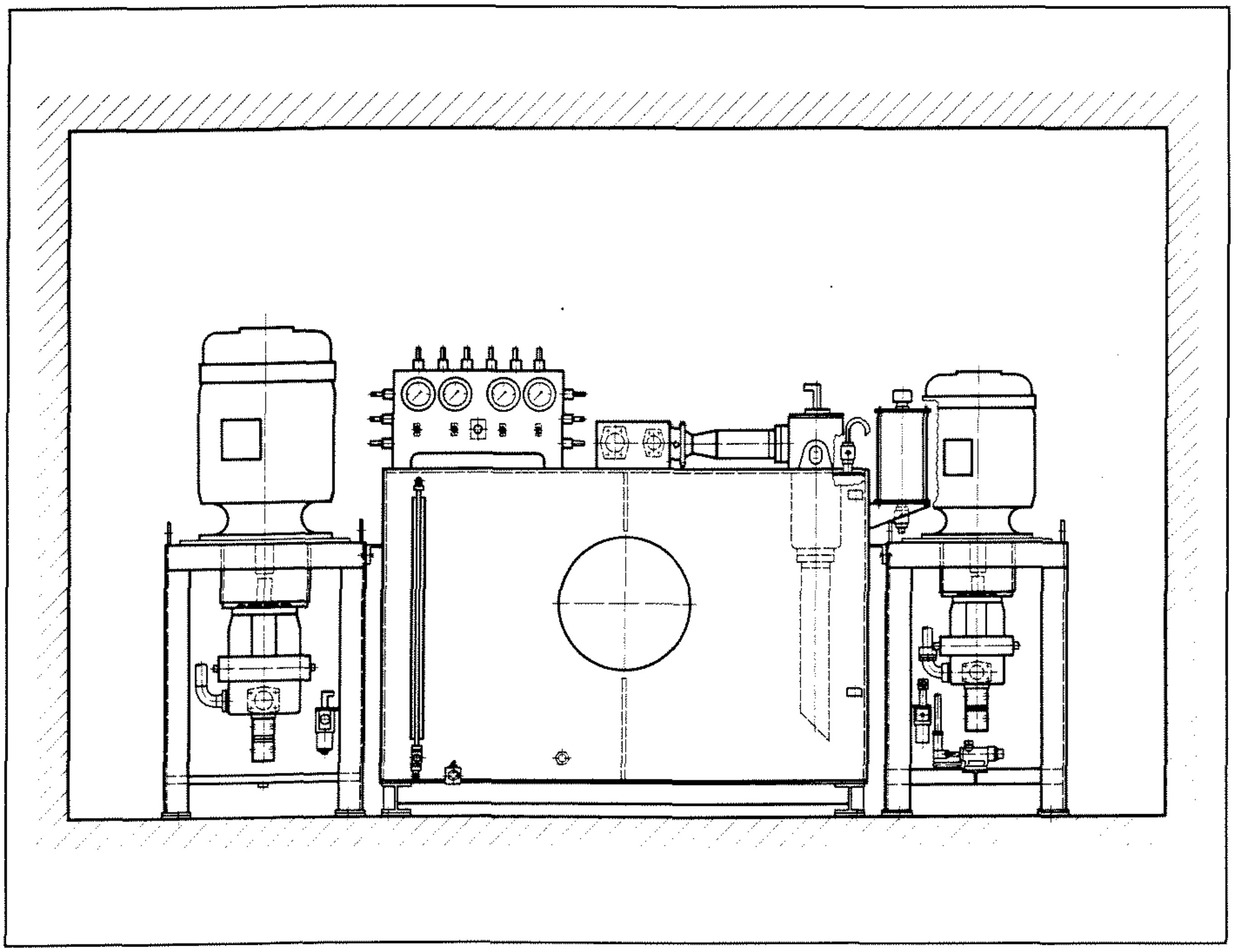

Fig. 7

The entire valve control is mounted together with filters and all monitoring elements on the oil tank which has an effective volume of 3000 liters. The size of the tank is such that the entire contents of the cylinder can be transferred to it during maintenance work. The two axial piston units with the coupled gear pumps for latching cylinder and control are bolted on to separate pump tables on the oil tank.
To make sure that everything functions properly, there is a return filter in the oil circuit as well as a pressure filter in the control system behind the control oil pumps. Consequently, clean oil is always supplied, especially to the proportional valves.
Because of the sea air, all pipes and joints are made of stainless steel. For reasons of safety, all pipes with an outside diameter of up to 38 mm were provided with welding cone joints and pipes above 38 mm with flanged joints and O-ring seals so that the entire piping system is leakproof.

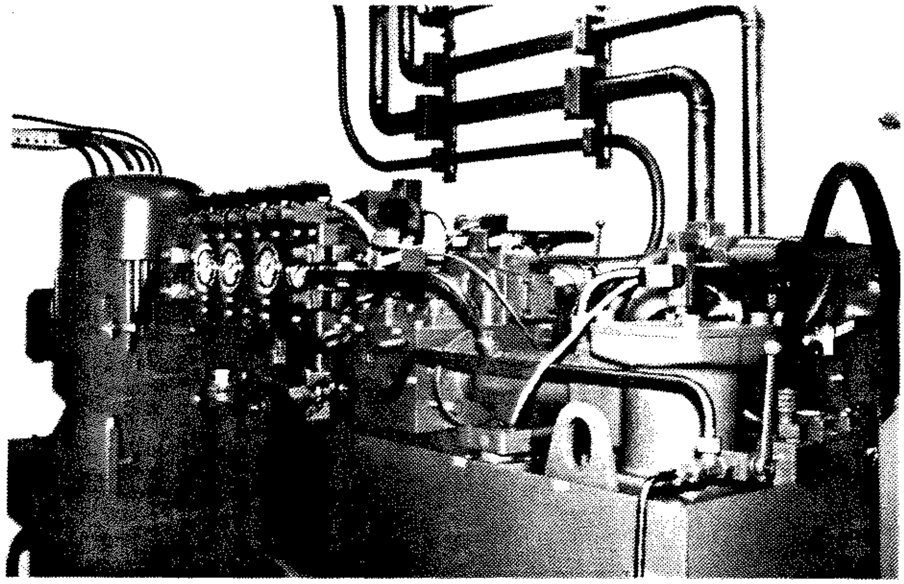

Fig. 10: Power unit

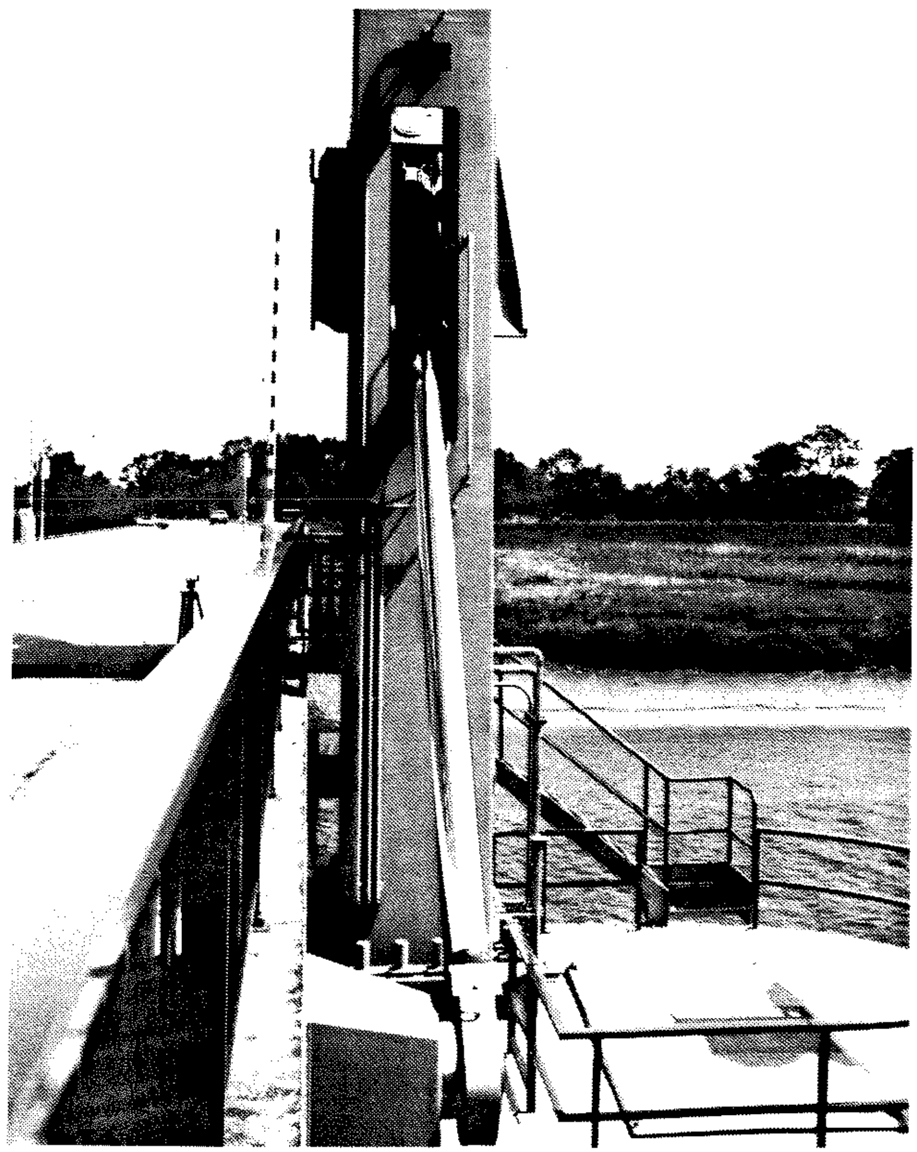

Fig. 11: Cylinder arrangement on pylon and bridge flap

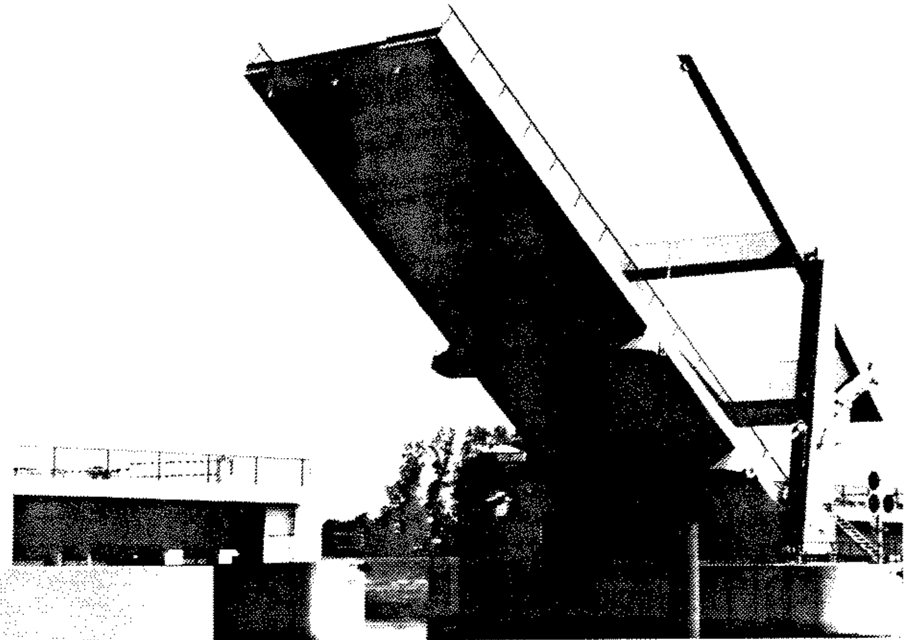

Fig. 13: Bridge in intermediate position

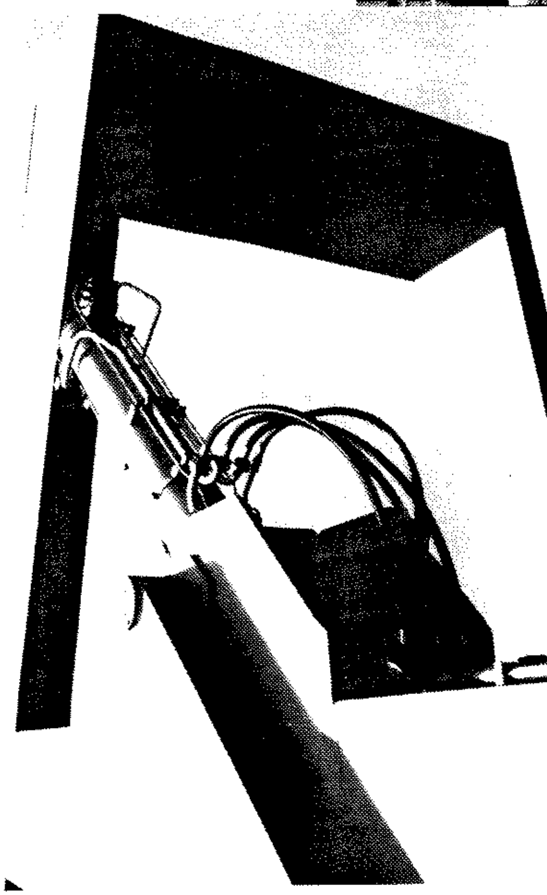

Fig. 12: Cylinder mounting on pylon
and piping on cylinder

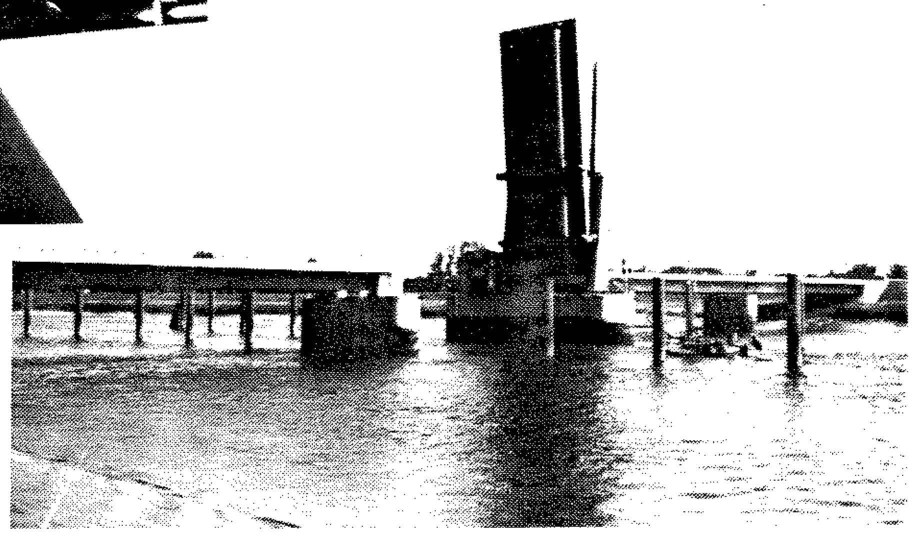

Fig. 14: Bridge in open position