Shuaiba Maqal Road Bridge

Ernst Herz

1 General Description

In the course of building the expressway in the vicinity of Basrah, Iraq, it was necessary to build the Shuaiba Maqal Road Bridge. This bridge is a swing bridge of steel construction, allowing navigation along the Basrah canal when in the open position. The company Waagner Biro received an order to supply and assemble the complete bridge from the specifying authority, the Ministry of Communications, Republic of Iraq.

The construction followed a design produced by the engineering consulting from Secom in Grenoble. An overall view of the bridge is shown in *Fig. 1.*

This swing bridge has a length of 86.2 meters, carries a four lane highway with a total width of 15 metres, and also two footways with a width of 1.65 metres on each side, so that the overall width of the bridge is 18.3 metres.

As the bridge operating system differs from that normally found, this will be described in some detail.

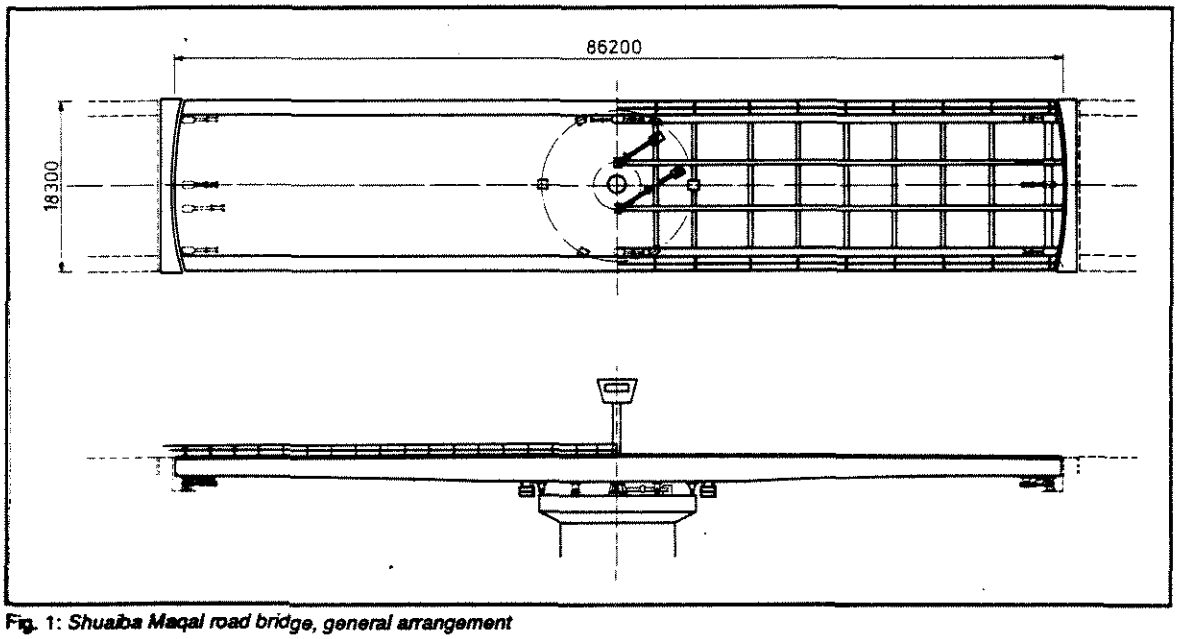

Fig. 1: *Shuaiba Maqal road bridge, general arrangement*

2 Bridge bearings

Traffic loads on the bridge, and also the weight of the bridge are carried on a centre pivot. This type of support has been used since the turn of the century on various swing bridges. The centre pivot carries both vertical and radial forces. While the bridge is swinging and also while it is in the open position, the entire weight of the bridge is *carried on the centre pivot.*

In order to stabilise the bridge, an additional 6 balance wheels are brought into play on a pitch circle of 16 metres diameter. These rollers are unloaded when the bridge is in the traffic position and are only operated during the slewing operation. The load is placed upon them by means of an hydraulic cylinder *(see Fig. 2).*

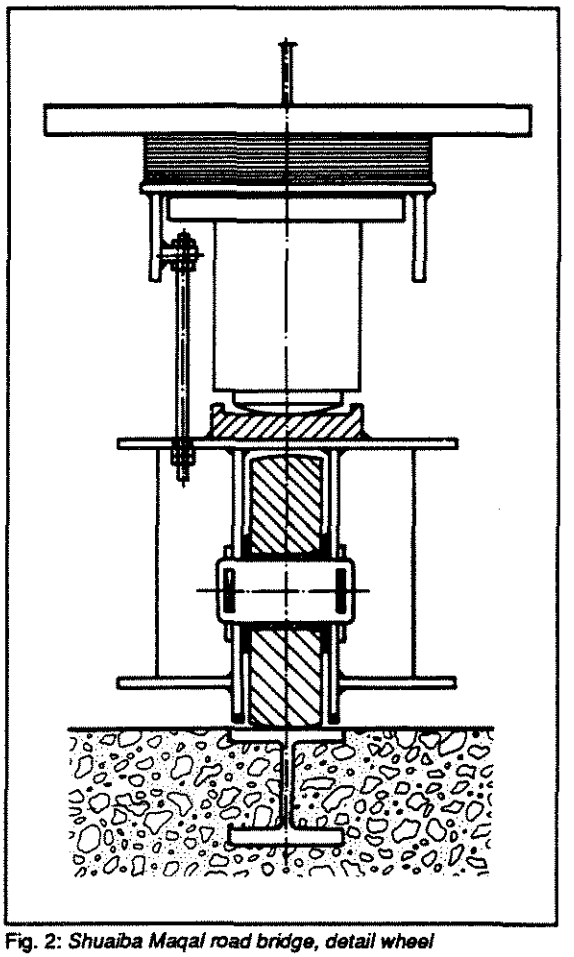

Fig. 2: *Shuaiba Maqal road bridge, detail wheel*

3 Locking system

In the traffic position, the bridge is supported on the centre pivot as already mentioned. In order to stabilise it on the longitudinal axis, external main carriers are installed. In the lateral direction at the bridge centre, two locking mechanisms are installed. At both ends of the bridge three other locks for both locking and supporting *the bridge are also installed. Thus there is a lock at the* bridge centre pivot that takes the load of the weight of the bridge plus that of the traffic. The locks are designed as combined lifting and locking devices, that is, while the locks are being pushed into position, they simultaneously lift the bridge in order to position it accurately in the traffic position. A centering lock is installed at each end of the bridge. *Fig. 3* shows the construction of such a lock.

4 The slew drive for the bridge

The rotary drive to the bridge is achieved by two double-acting hydraulic cylinders. The arrangement of the cylinders is illustrated in *Fig. 4.* From this diagram the arrangement of the six balance wheels described in point two can also be seen. The hydraulic cylinder has the following dimensions:

Piston diameter	250 mm
Piston rod diameter	180 mm
Stroke	2680 mm
Damping	2 x 90 mm

During slewing operation, the cylinders work in opposition one cylinder extends while the other retracts.

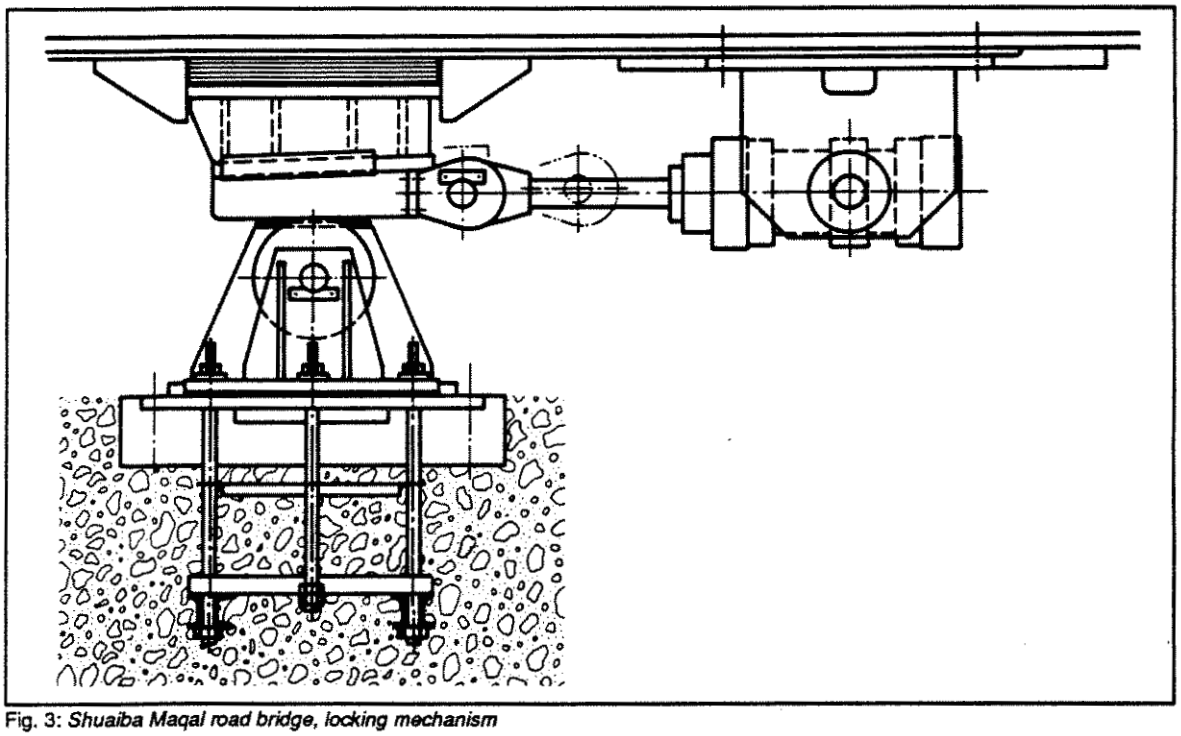

Fig. 3: *Shuaiba Maqal road bridge, locking mechanism*

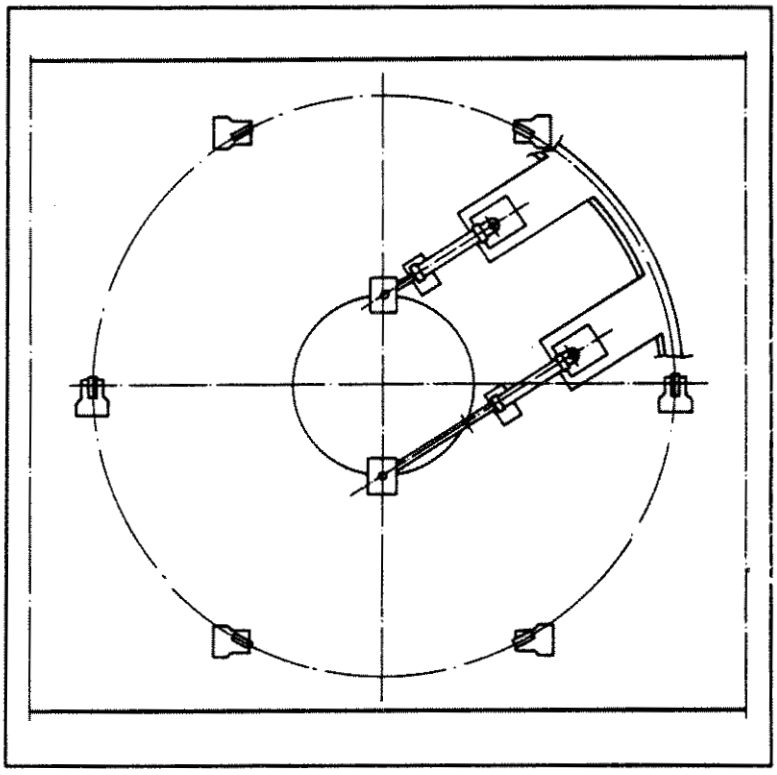

Fig. 4: *Shuaiba Maqal road bridge, rotating drive system*

Should a problem occur, the bridge may be operated with a single cylinder. The construction of the hydraulic system can be seen in *Fig. 5.*

At both the full bore and the annulus sides of the cylinders special counter balance valves are installed directly in the cylinder heads. It is thus ensured that during the entire movement operation, the bridge is hydraulically supported and can not "run away" due to wind loads, or effects of inertia during the deceleration process.

Pressure is supplied by a variable displacement axial piston pump. Pump displacement is varied by a mechanical gearbox driven by an electric motor.

Acceleration of the bridge is by swivelling the pump from 0 to maximum displacement. Swivel time is adjusted so that the bridge take 22 seconds to reach maximum slewing speed. On approaching the end position, the pump is swivelled back in 22 seconds to a creep speed.

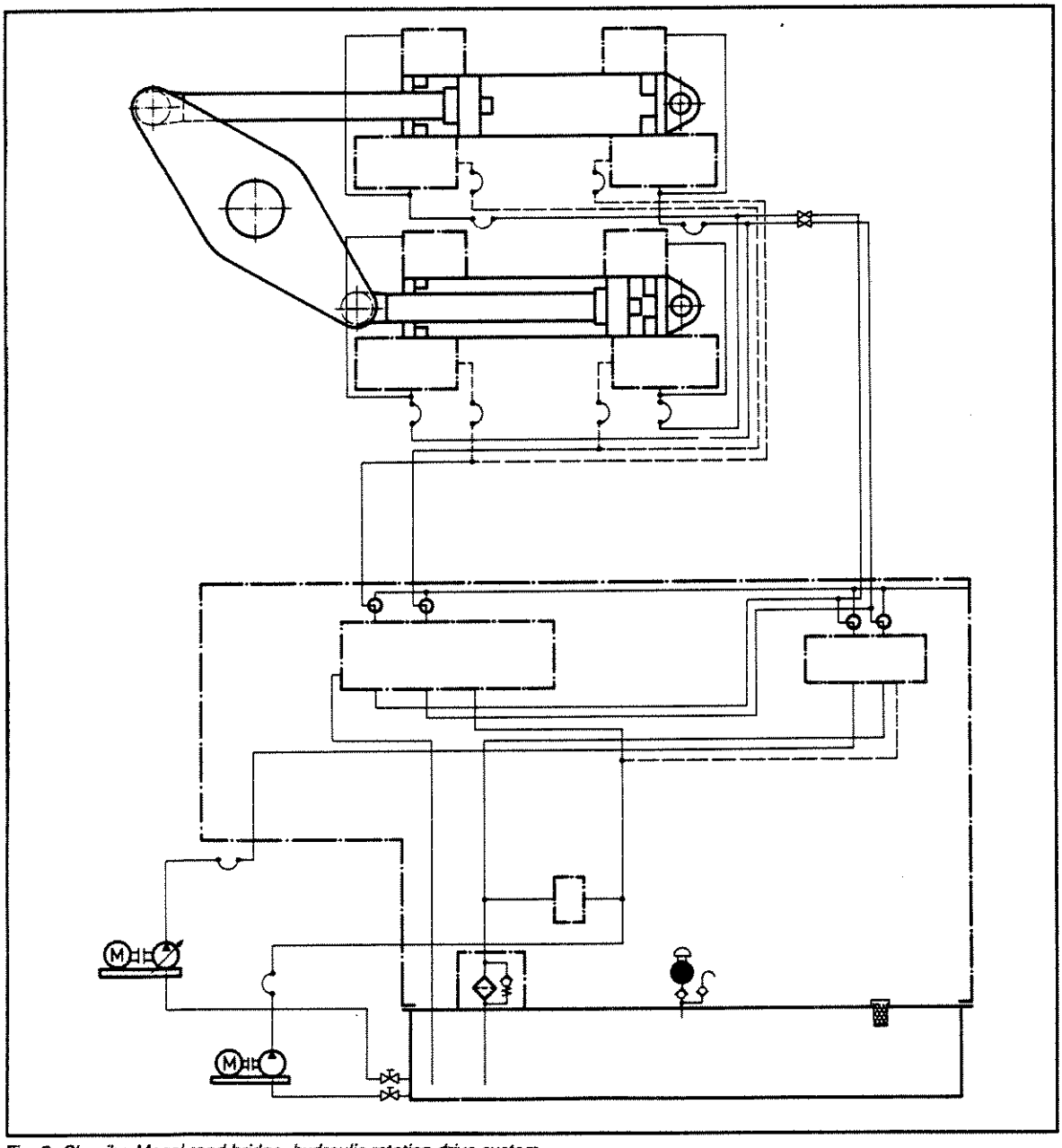

Fig. 5: *Shuaiba Maqal road bridge, hydraulic rotating drive system*

As shown in *Fig. 6*, the creep speed is approximately 10% of maximum speed. This speed is used to move the bridge slowly into either the open position or the traffic position.

The cylinder stroke has been so designed, that the bridge comes to rest within the normal operational stroke. Should a failure occur, and the pump not swivel back, the emergency damping built into one of the cylinders becomes effective. This emergency damping is capable of bringing the bridge gently to a standstill even though the pump is delivering full flow. In order to prevent shock occurring when the bridge is being stopped together with the resulting large forces which would occur.

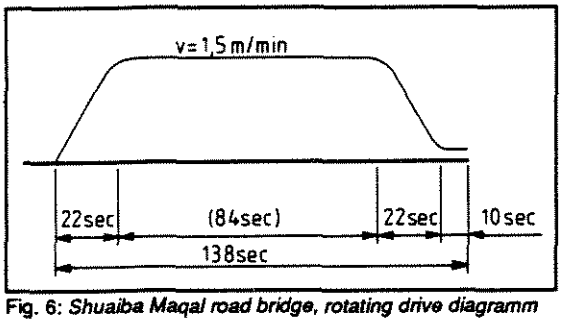

Fig. 6: *Shuaiba Maqal road bridge, rotating drive diagramm*

As mentioned, the bridge is hydraulically retained during the entire hydraulic operation. When the bridge has been placed in the traffic position, the hydraulic tensioning of the bridge is released via special valves, so that the centering lock can position the bridge accurately.

During this process, the drive cylinders can be extended and retract at almost zero pressure.

5 Hydraulic locking system

For the control of the locking cylinders and balance wheels, a separate hydraulic system is installed. The design of this system may be seen in *Fig. 7*. Pressurised oil to this system is supplied by 2 fixed displacement axial piston pumps. The cylinders are individually controlled by suitable solenoid valves. As some of the cylinders extend and retract together, each cylinder is equipped with flow control valves so that the pump output is divided correctly and simultaneous operation of the cylinders is ensured. In addition, each cylinder is equipped with 2 counter balance valves so that the locks can be held in any required position.

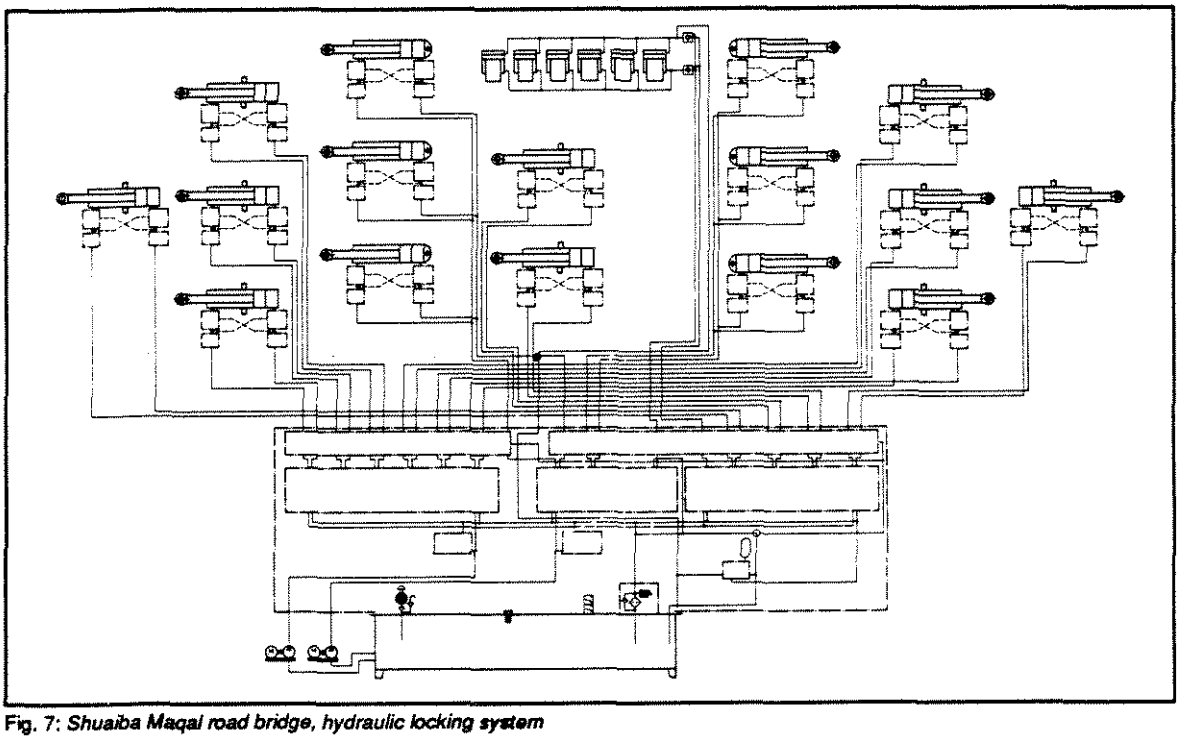

Fig. 7: *Shuaiba Maqal road bridge, hydraulic locking system*

Fig. 8 shows one of the hydraulic cylinders for the locking system built on counter balance valves and flow control valves.

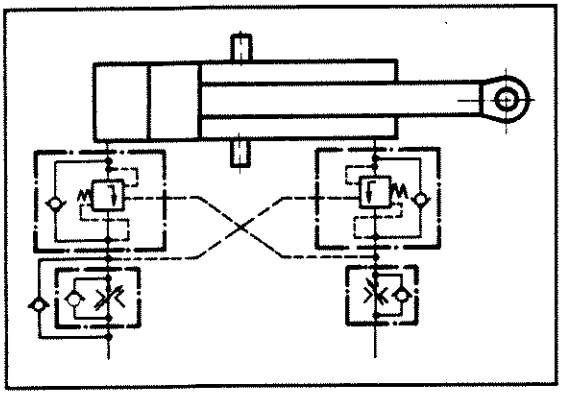

Fig. 8

6 Power unit design

The power units for the slew drive and for the operation of the locks are mounted on the centre pivot. The oil feed from the centre pivot to the rotary bridge is via a hose system.

The arrangement of the power units in the centre pivot is shown in *Fig. 9*.

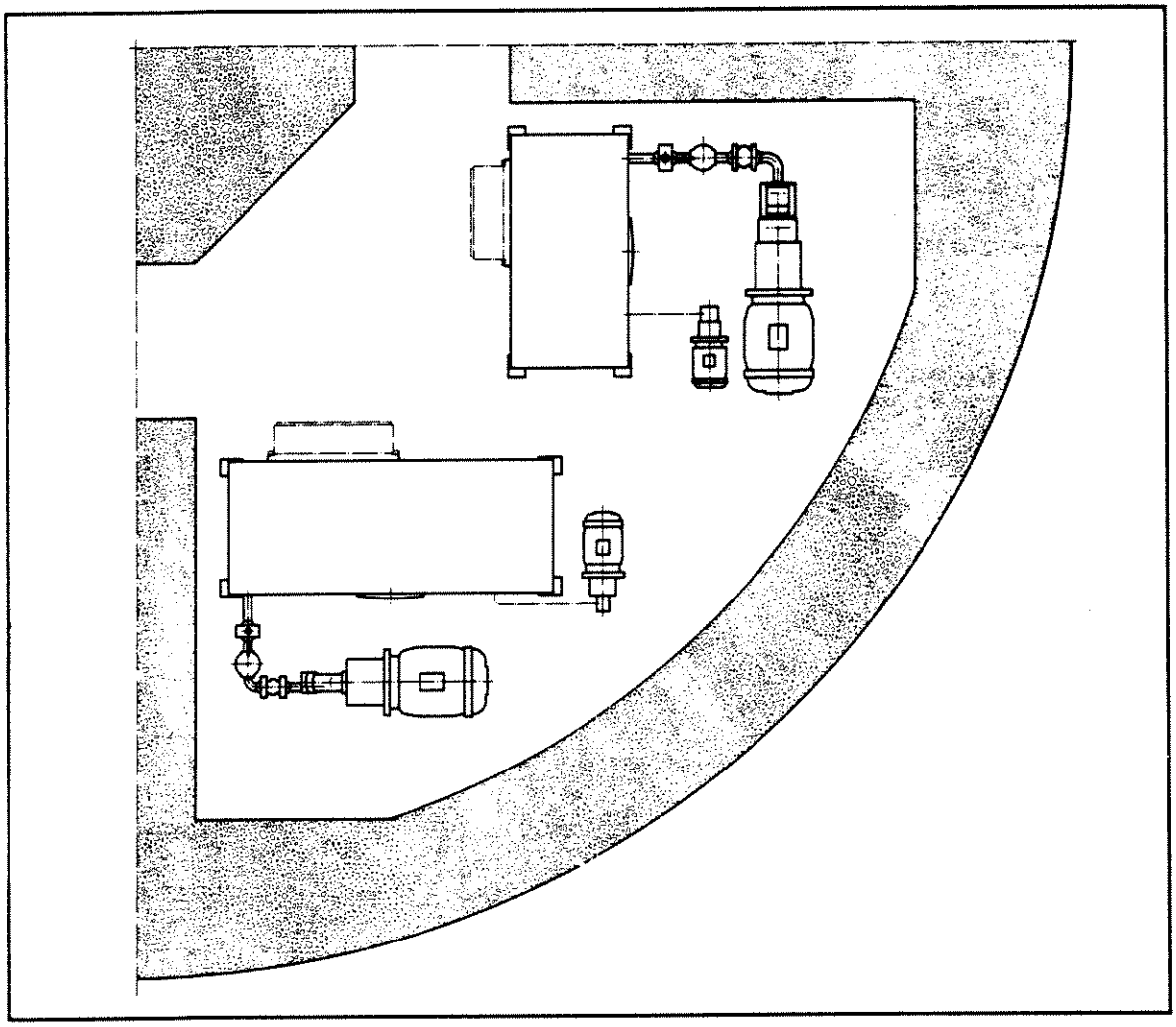

Fig. 9

Notes

Notes