HMS HEAVY MOVABLE STRUCTURES, INC.

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SESSION WORKSHOP PRESENTATIONS

"THE GALATA BRIDGE IN ISTANBUL, THE BIGGEST BASCULE BRIDGE IN THE WORLD"

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The Galata Bridge in Istanbul

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The Biggest Bascule Bridge in the World

As a result of the increasing traffic and higher maintenance costs for the old pontoon-bridge, a bridge across the "Golden Horn" became a necessity. Fig. 1 "The New Galata Bridge".

Instead of the previous 25 m wide pontoon-bridge, it was decided that a wider bridge should be built. It was to be of the same geometric structure, the prerequisite being that it did not clash with the surrounding historical monuments.

In the beginning it was planned to locate the new pontoon bridge next to the old pontoon bridge built by M.A.N. in 1912.

In the course of tender the consortium STFA/Thyssen worked out a special-proposal, which contained the construction of a fixed bridge. The fixed bridges rest on 114 tubular steel piles with a diameter of 2 m each, which were driven into the seabed. Figures 2 and 3.

A Bascule Bridge with a clear opening of 80 m consisting of 4 flaps, is used as a gate to the Harlic-Harbor. The closed flaps have a clear-opening to the sea-level of 6 m. Furthermore, the 4 flaps can be opened in 3.5 minutes in order to allow vessels of up to 8,000 dead weight tons to pass the bridge (see figure 1).

The piers for the bridge flaps are buoyant hollow box structures with the dimensions 44 m x 15.6 m x 43. Each of these are supported on 12 off 12 m diameter steel tube piles filled with reinforced concrete.

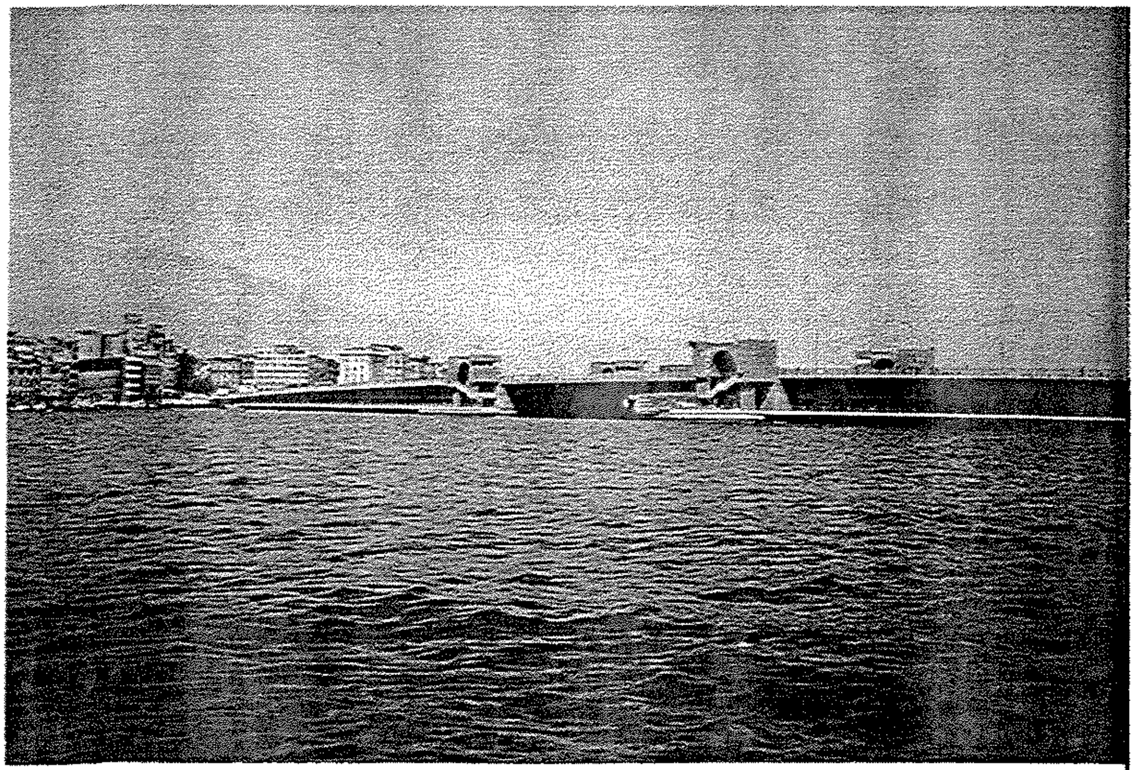


Figure 1. The New Galata Bridge

These bridge type owns in comparison to the old pontoon bridge may ecological and technical advantages, which were significant for the selection of this design.

Beside other points, this bridge design allows the water to flow nearly freely between Harlic - Harbor and Marmara-Sa, which is not the case with a pontoon-bridge. The bridge was designed with a double deck in the approach spans. The lower deck of the approach spans are allocated only for the use of pedestrians and there are also a six thousand square meter shopping area. On the upper deck there are 7.5 and 5.5 meters of walkways on the Marmara and Harlic sides respectively, in addition to the six traffic lanes (three on one side, three on the other). On top of this, there are two more lanes in the middle, reserved for the future LRT (light railway transit) system crossing over the bridge which are currently being used as ordinary traffic lanes (Fig. 2).

The bascule bridge in the middle consists of 2 double bascule bridges, t.m. total of 4 flaps with a free opening of 80 m. Data of steel structure of a flap: (Figures 4 and 5):

- Length between pivot and flap-top: 46 m
- Length between pivot and backarm: 11 m

  t.m. a total flap length of 57 m
- Width of flaps 20 m & 22 m respectively

  At one flap the pedestrian walk is 2 m wider
- Weight of steel construction 400 tons per flap (metric)
  440.6 Tons
- Counterweight 1000 tons per flap

  t.m. a total weight of 1400 tons per flap

$$\frac{\text{Steel}}{\text{Area}} = \frac{440.6 \text{ Tons} \times 2000}{46\text{ m} \times 20\text{ m}\ (3.2808)^2} = 90 \text{ lb/SF}$$

[redacted]

SCHEMATIC REPRESENTATION OF THE BEARINGS AND BUFFERS

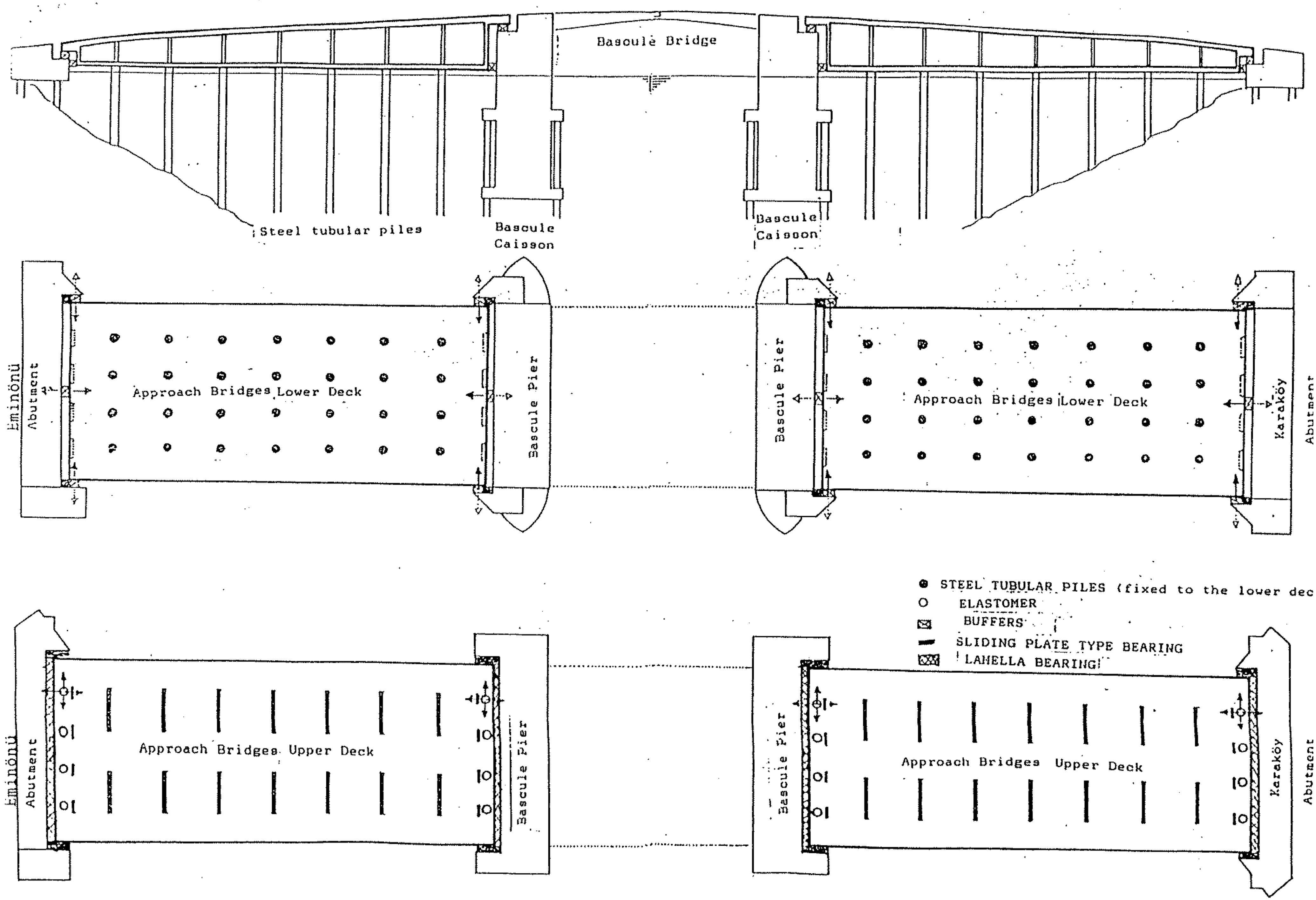
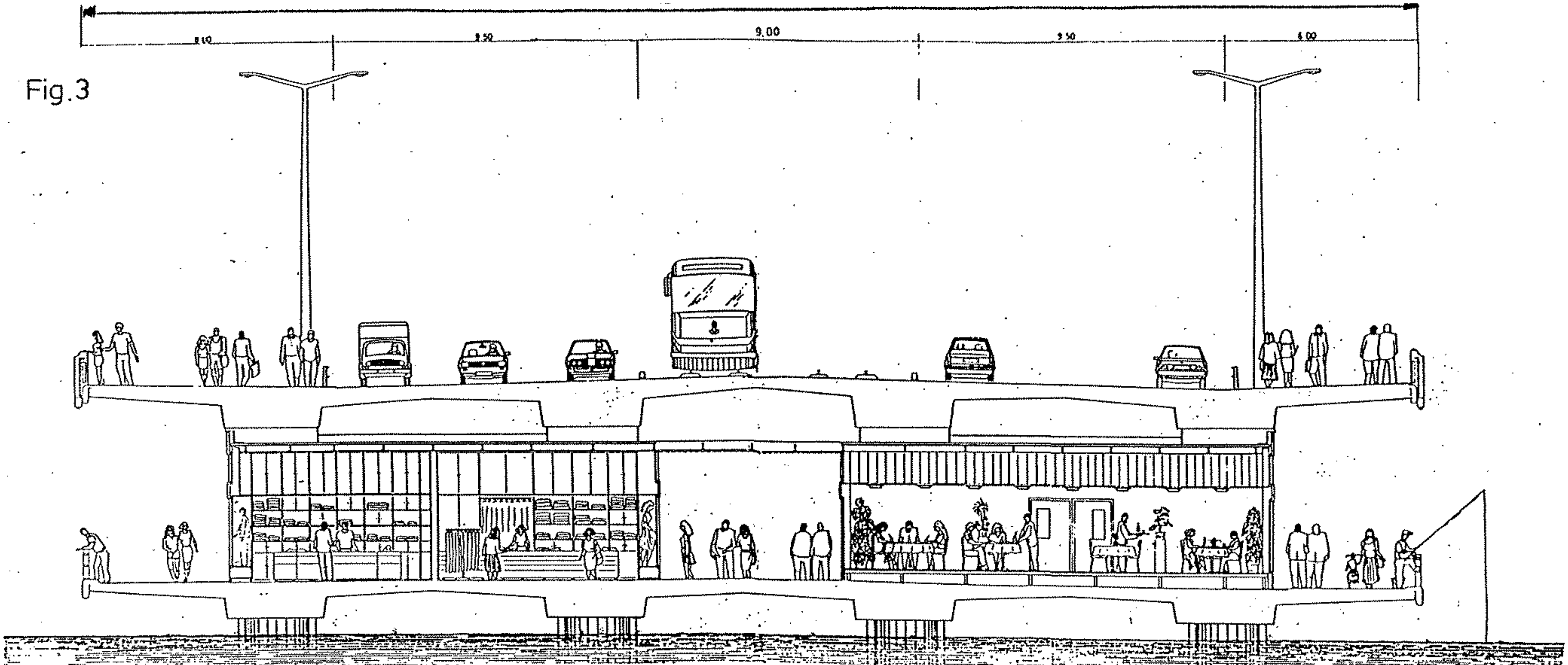
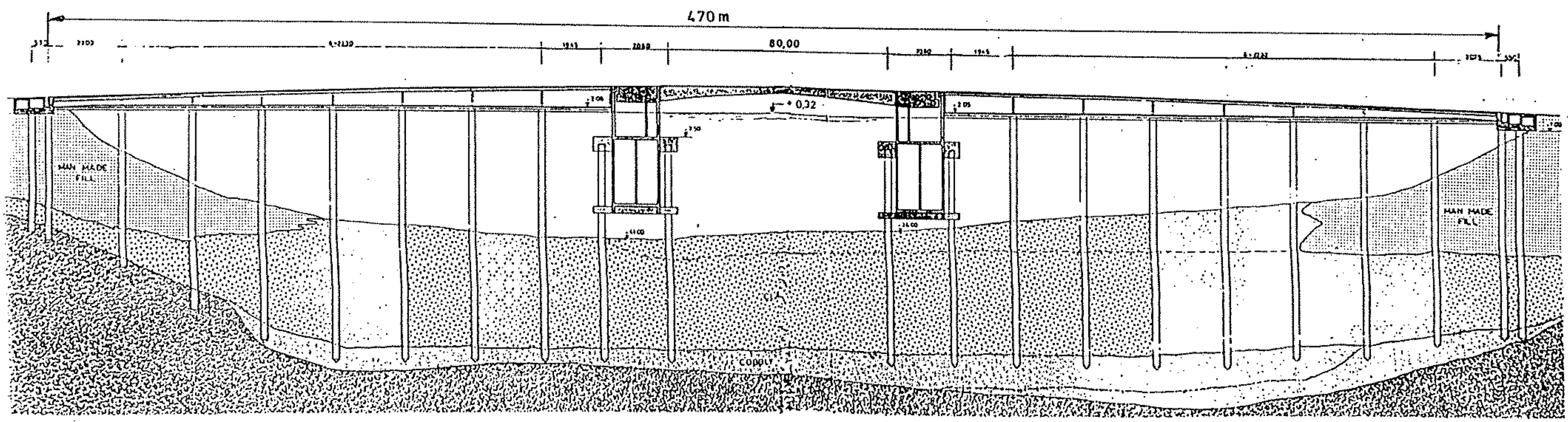


Fig.3



KESİT GÖRÜNÜŞ



BOYUNA KESİTİ

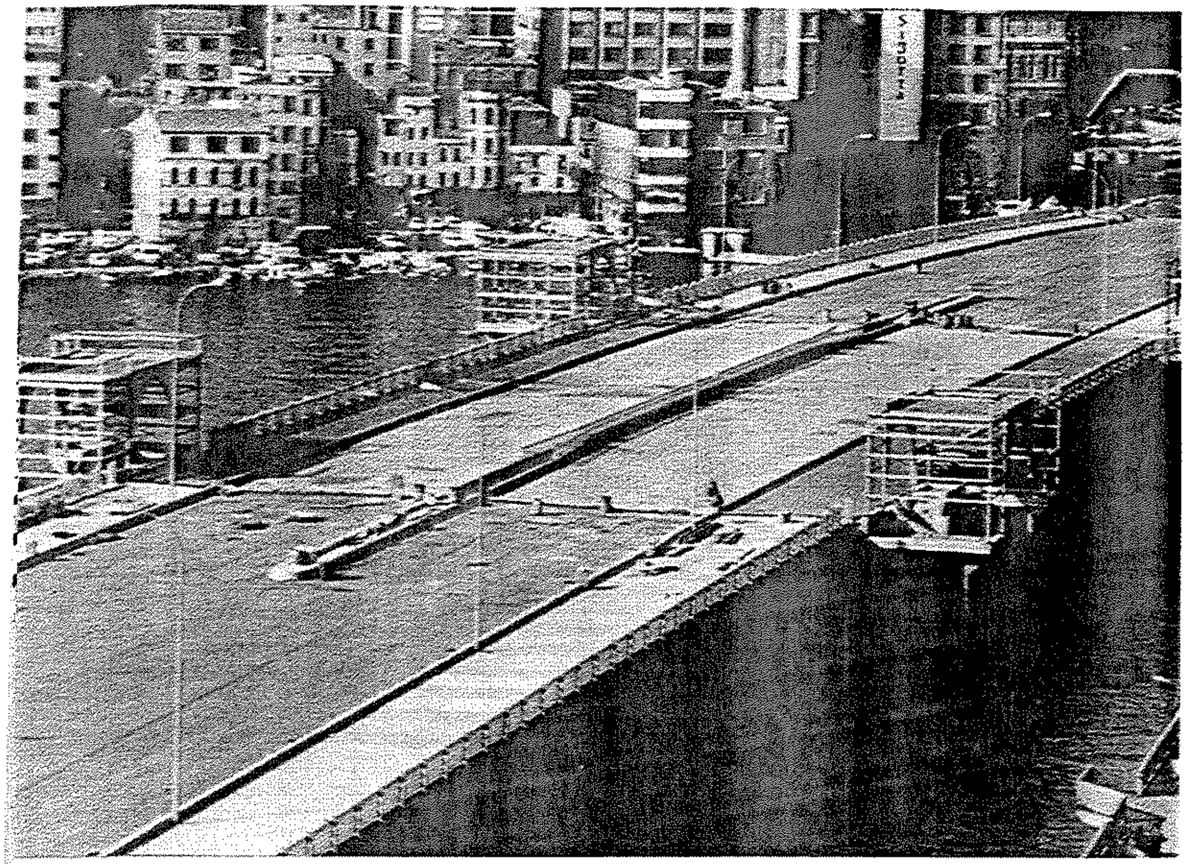


Figure 4.

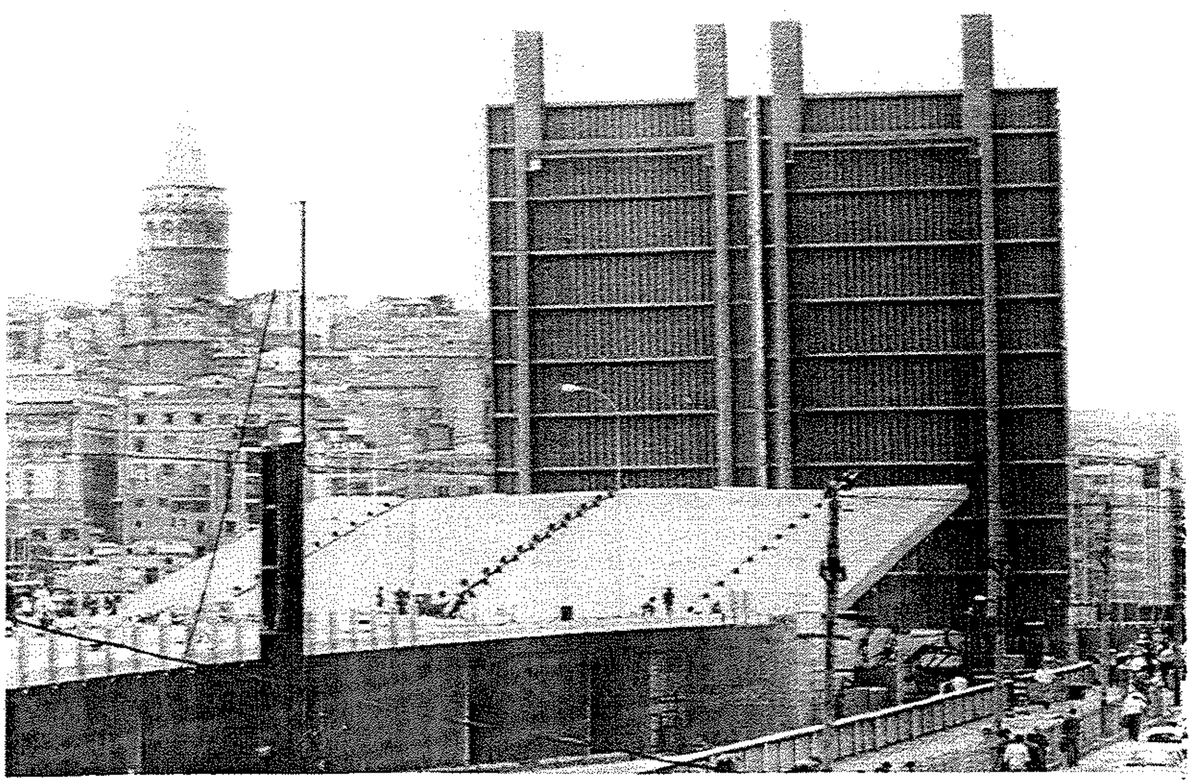


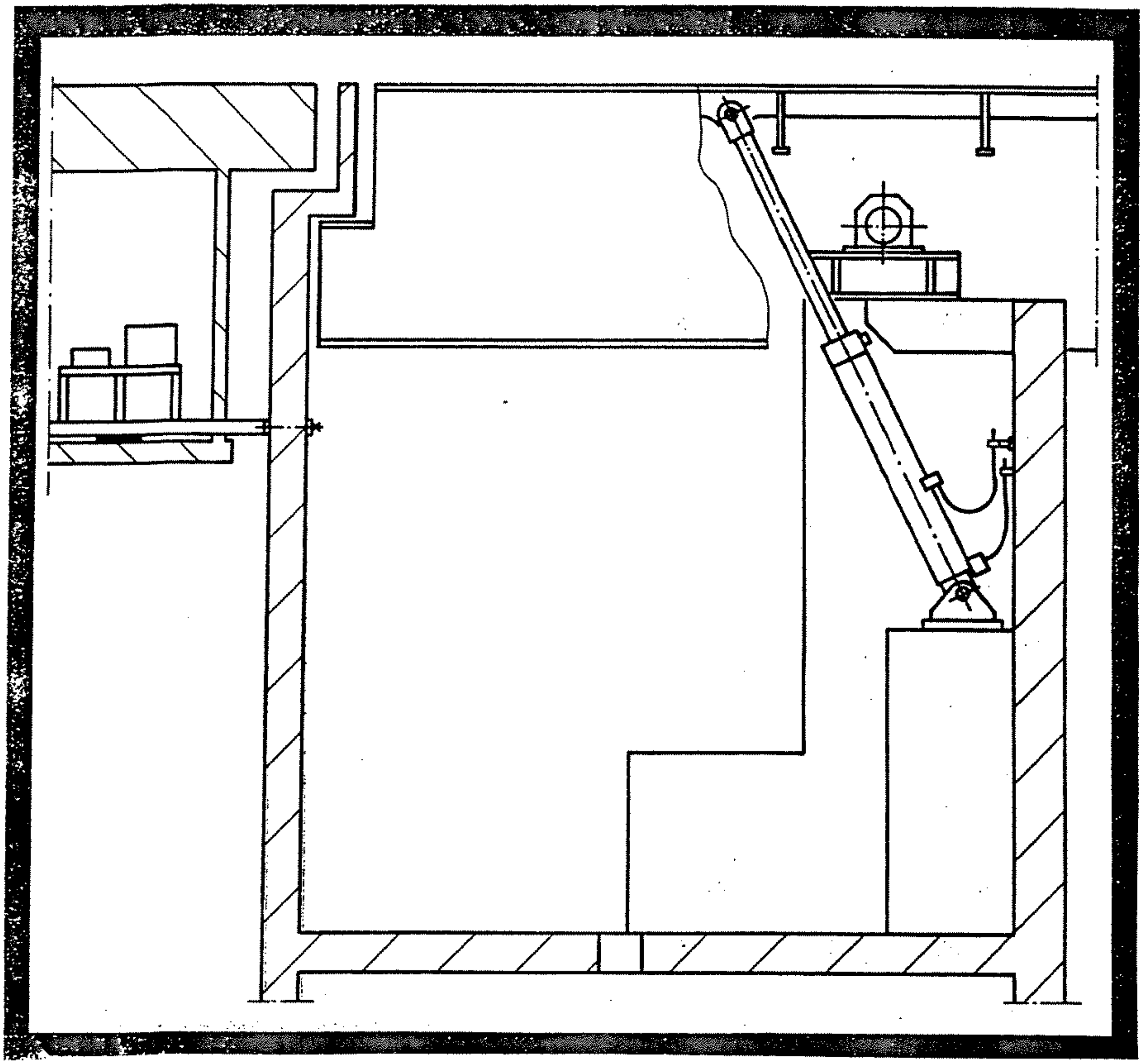
Figure 5.

In reference to the drives of the two types of bridge (Pontoon or Bascule Bridge) there are vast differences between the two.

The drive of the pontoon bridge is by means of a propeller. While in the closed position the mobile part of the bridge is locked to the stationary part of the bridge. The plan is to use a momentum locking device with hydraulic cylinders. In the event that the propeller drive does not work, the bridge could be operated by a boat pulling it open or close, without a problem. Wind plays a minor role with regard to Pontoon bridges.

With a bascule bridge, however, the bridge must always be held taught by the hydraulic cylinders, in order to deal with the wind and the change in weight. If both flaps of one side of the bridge are open, a total front area between the pivot point and peak are 46m high and 42m wide. This gives wind an area of 1932 m^2. For comparison to this area, it would compare to an apartment building approximately 16 stories high.
The weight in bascule bridges is nearly equally distributed around the pivot point, compared to the back arm with counter weight. That means the drive of the bridge must mainly absorb the wind on the total area of the flap. It was planned to have two cylinders per flap. (Figure 6.)

FIGURE 6



After the kinematics for the hydraulic cylinders was established, the following force of the cylinders were derived.

NB: Wind speed/velocity < 26 m/s

Pull and pushing force on cylinder = 1600 kN

BB: Wind speed/velocity <30 m/s

Pull and pushing force on cylinder = 2600 kN

AL: Wind velocity/speed <40 m/s

Pull and pulling force on cylinder = 3300 kN

A cylinder: 480/280-4400 was used as the drive was to be built according to DIN19704 for Civil Engineering construction applications.

In order to take over the changing force of the movement of the bascule bridge due to wind currents, the cylinders were fully restrained on each side with a Check-A-Meter. In addition, the cap areas of the two cylinders and the annulus areas of the two cylinder of one flap are connected together by pipes. This ensures that the working force on both cylinders is similar.

The total opening and closing time in NB (normal operational cases) and BB (specific operational cases) is five (5) minutes.

In this time is included: Closing/opening of gates

Locking bar in and out movement

Flap movement

In order to adhere to this time-frame, the movement time of the flap must be within three (3) minutes. The total opening and closing time in AL = (exceptional load cases) is 15 minutes.

This extended time for movement was established so that the electrical motors did not have to be increased in size unnecessarily, as this hurricane type wind velocity of 140 km/hr does not occur in Istanbul but once every 100 years.

In order to accelerate the massive flaps slowly, from a standstill to a maximum speed without swinging, and just prior to the final position desired, and to bring it into resting position with ease, the hydraulic drive was equipped with variable displacement axial piston pumps with flow control via proportional valves.

Because the opening-and-closing time is the same, and the pull-and-pushing force at the cylinder also, the advantage to this is when the piston rod swings, there is a small amount of flow and great pressure in the annulus area. In the same manner when the piston rod swings out, there is a large amount of flow and small pressure in the annulus area.

This results in the same horsepower needed for opening and closing:

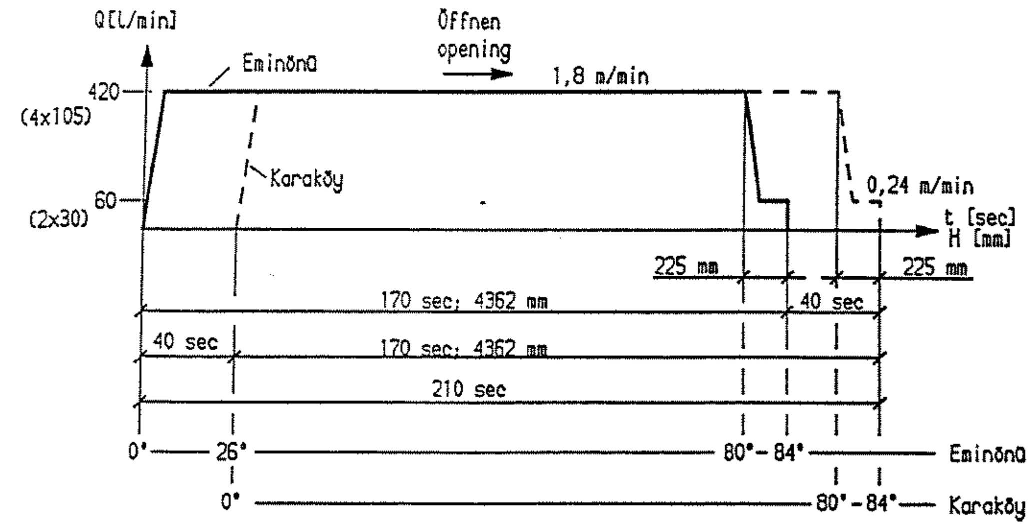
-- opening: 420 *l*/min., 220 bar, 160 kW

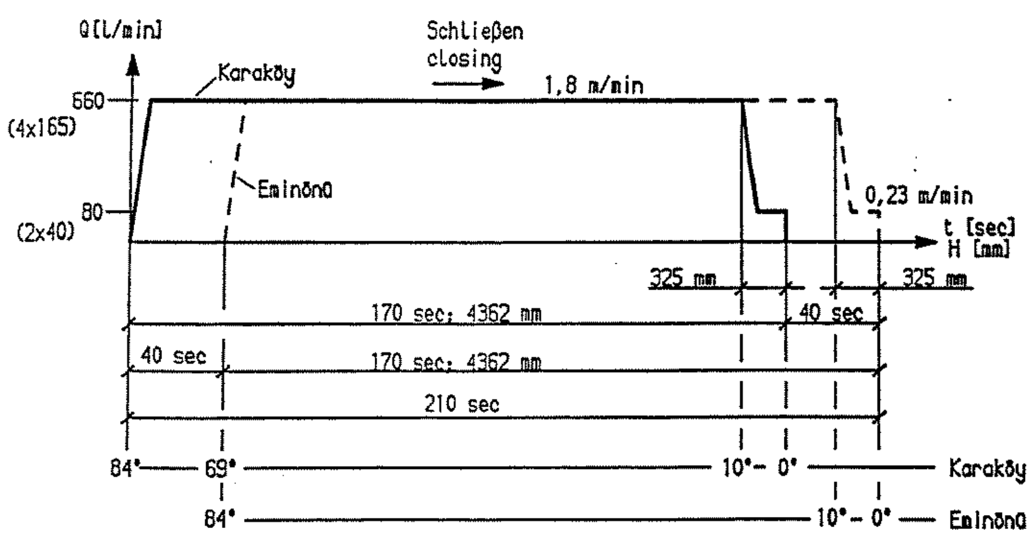
-- closing: 660 *l*/min., 140 bar, 160 kW

Figure 7.

FIGURE 7

Fahrdiagramm
Cycle diagram





In order to use the rather small area intended for the drive station constructively, and be able to access the large components such as E-Motor and pumps, the flow per flap was divided amongst 4 motor pump groups.

The size is:

-- Variable pump: Size 125 (max. 180 *l*/min.)

-- E-Motor: 45 kW; 1450 rpm

The drive station was divided into three groups and those are:

-- Oil reservoir

-- Pump stand Figures 8 and 9

-- Valve stand

which are interconnected with pipes and hoses. These are necessary so that the drive station can be taken apart at the test stand area and reassembled at the site with great ease. The steel construction of the bridge flaps is such that the flap tips overlap. When opening the bridge, the upper flap is started 15 seconds prior to the underlying flap. When closing the bridge, this is done exactly in reverse. (Figure 10). Limit switches are installed to control the opposing sides of the flaps to avoid a possible jamming of the two flaps.

As is usually done in Civil Engineering, every single pump is watched closely. If one or more pumps should fail on one side of the flaps -- the same amount of pumps are cut out on the other side automatically, so that both flaps move with the same speed.

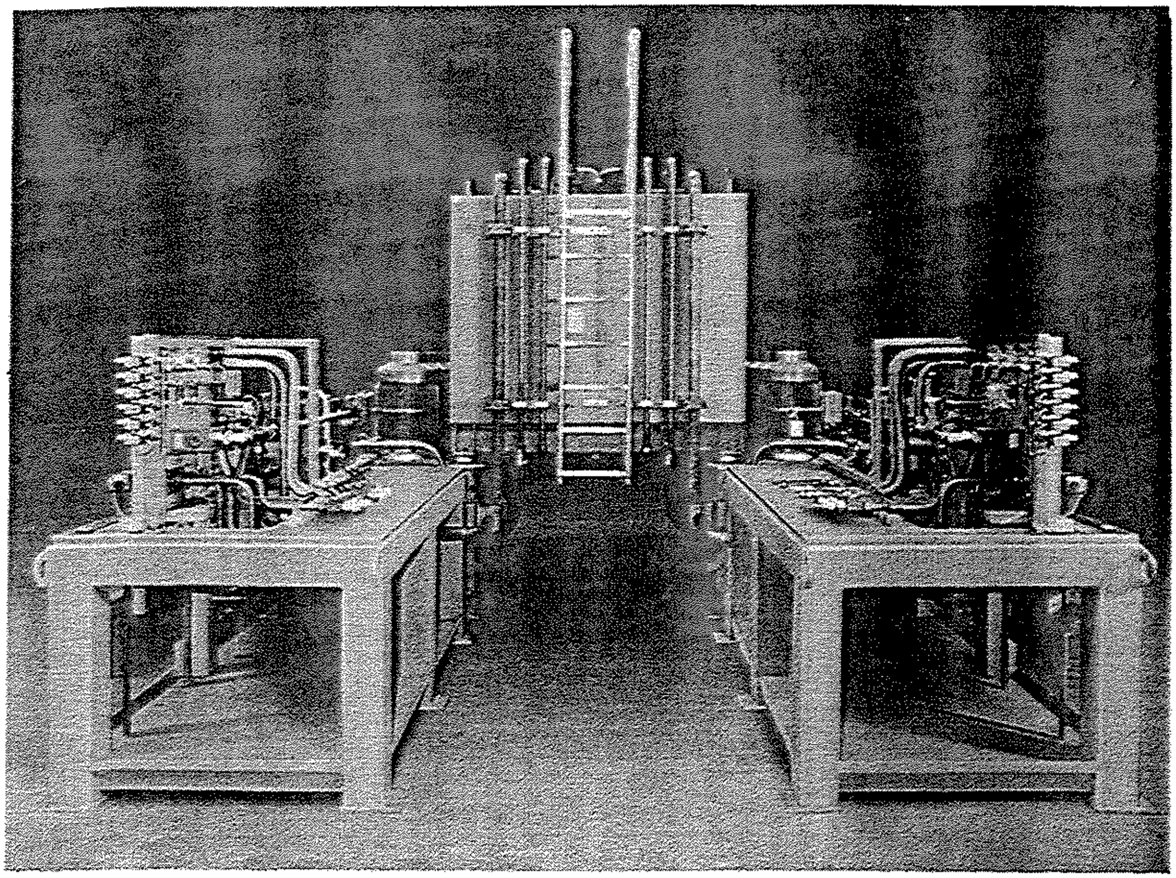


Figure 8.

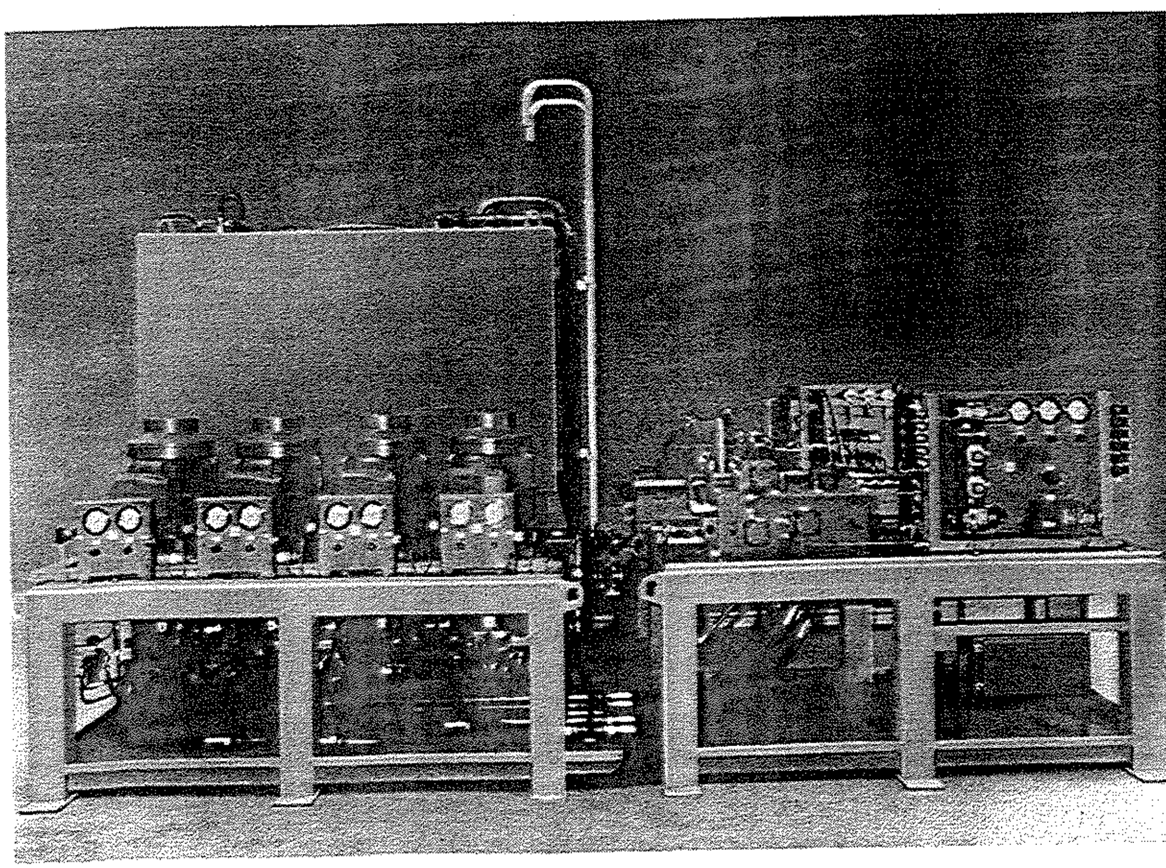
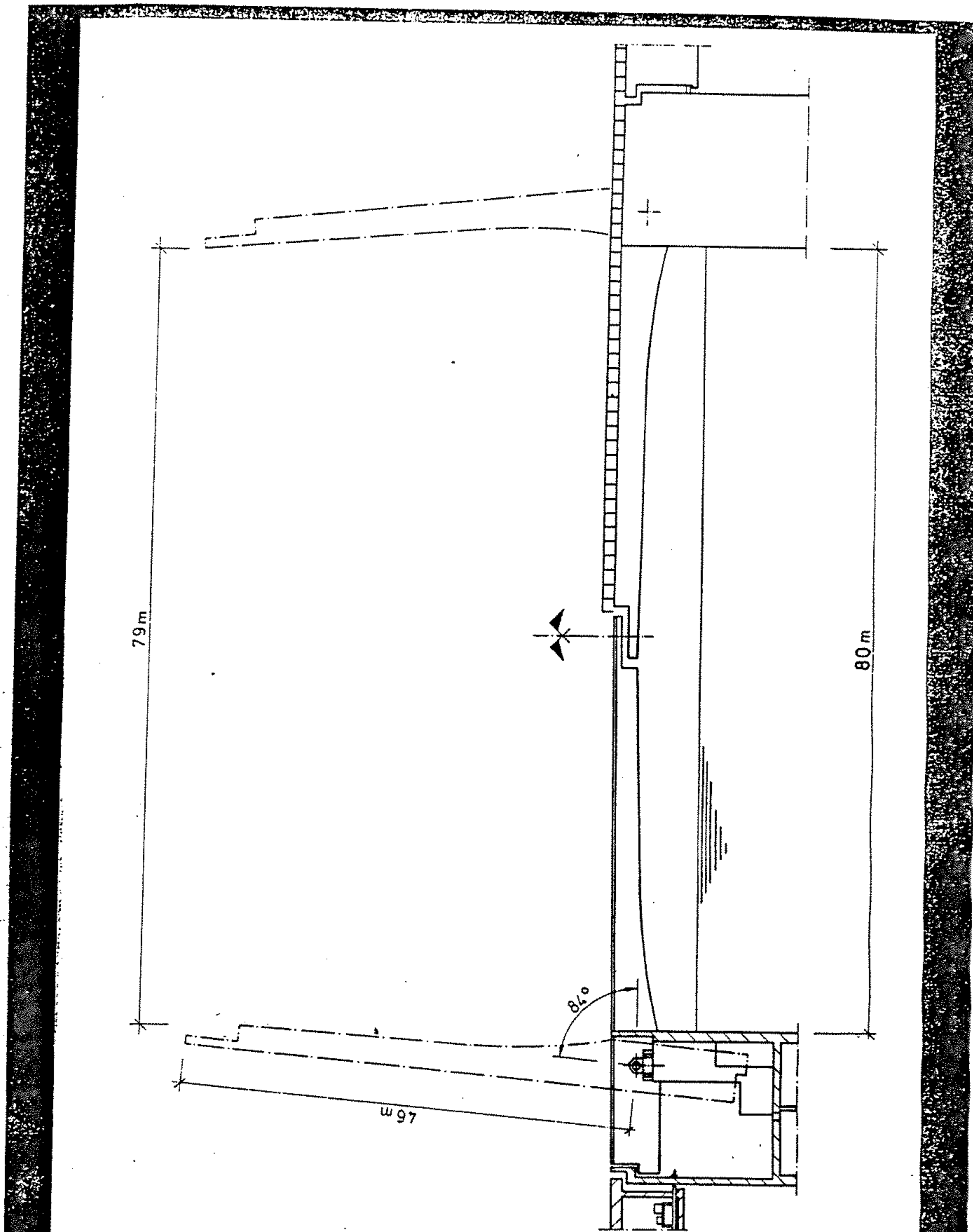


Figure 9.

FIGURE 10



In the end position of the bridge setting -- be it opened or closed -- the flaps are locked into place.

In the closed position the bridge flap ends are locked together with a total of 4 locks and the back arm is locked to the pylon with two locks.

So that the vibration of the traffic, by locked bridge, is not carried over to the cylinders, the cap and piston end are short circuited over a directional valve and connected to an overhead reservoir, so that in this position the cylinders will be pressureless and are able to swing free.

In the open position the back arm of the flap is locked to the pylon. All the locks are operated by hydraulic drive with cylinders. The special characteristic of this bascule bridge is that this prototype concept was seen as a double decker pre-land bridge, as well as the layout of the steel construction of the flaps and their respective hydraulic cylinders in the bascule bridge pylon. This one stands, by its own weight, on the already framed steel pillars with 2m diameter, however, is not connected to the pre-land bridge.
This type of construction was necessary to absorb the shock from either earthquakes or the possibility of a boat bumping into it.

Due to the strong undercurrent this pillar is in constant *mm-range* movement. It was not possible to install the drive station in the pillars, so that this would be located in the stationary bridge. Instead of the elastic connection with many, many and large hosings the drive station was mounted on a steel frame which was connected to the mobile pylon and erected to the stationary bridge on a sleeve bearing made of plastic. (Figure 11).

The solution is right, as the steel frame with the drive station moves on the stationary plastic bearings in varying time frames, up to 4 mm.

The hydraulic control can be seen on the attached basic circuit. This basic circuit only shows the various parts to the drive. Of course, maintenance information and measuring devices are supplied along with the hydraulic drives such as the manometer, pressure switches, etc. (Figure 12).

FIGURE 11

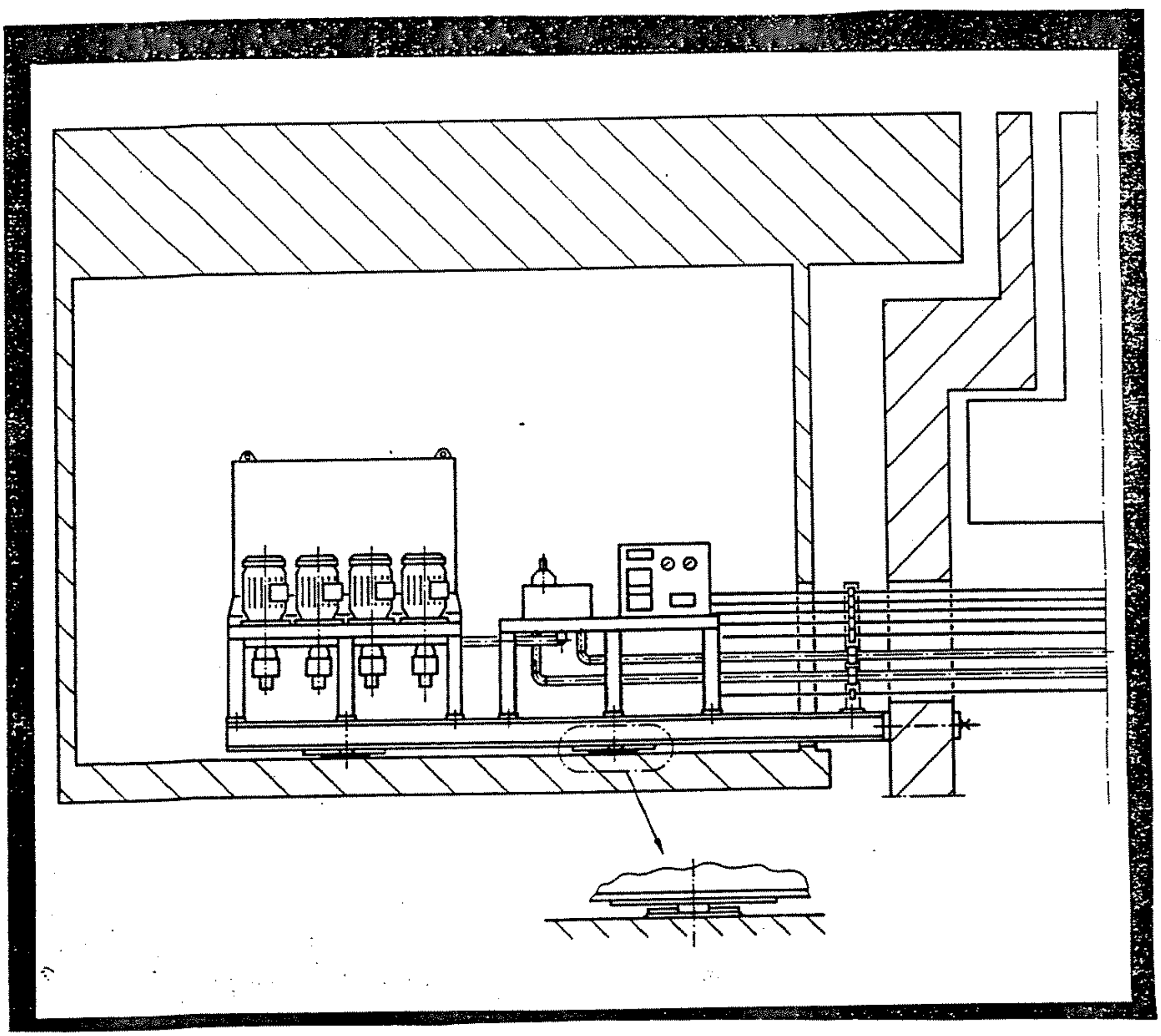


FIGURE 12