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FORTIFICATIONS OF OLD GDANSK

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The fortifications of old Gdansk belonged among the biggest ones in Europe. To build them it was necessary to overcome many technical obstacles. Erecting heavy buildings on slimy ground required proper foundation engineering. To raise huge bastion fortifications it was necessary to transport incredible masses of soil. It was also indispensable to ensure a stable water level in the moats. Properly working drawbridges had to be constructed in front of the gates. The most important thing, however, was to develop and modernize the outworks so they could cope with the growing force of the enemy's artillery fire.

The medieval brick fortifications, begun in 1343, were 5 km long at the beginning of the 16th century. They included double moats, at least 50 towers and 22 gates. Every district had its own walls, which were not pulled down although the city developed into one urban organism. The modern fortifications erected in the years 1534 – 1685 consisted of 20 bastions and 4 gates of the inner ring, and 10 bastions and 3 gates in the outer row. The two entrenchment lines along the Vistula river connected the city fortifications with the Wisloujscie stronghold, which consisted of the lighthouse tower from 1482, the surrounding Wreath (1563), both encircled by a 4–bastion Fort Carré (1587–1611), and of a 5–bastion Eastern Entrenchment (1624–1626). The other side of the river was strengthened by the Western Entrenchment (finished in 1688).

A very unusual technical device connected with the Gdansk fortifications was the Stone Flood–Gate. Already in the years 1598 and 1603 experts suggested building a flood–gate at the mouth of the Motlawa River, up to the outworks, to make it possible to flood Zulawy. It was also suggested to straighten the Motlawa bed, which was done in 1615. On 22 August 1619 a contract was signed with Wilhelm Jansen Benning and Adrian Olbrants, both from the Netherlands, behind the back of the City Constructor Hans Strakowski. In reply to his complaint the Council gave him a higher salary and made him responsible for the supervision of the construction. Among 73 articles of the contract with the Dutch 49 concerned the

Figure 1. *Gdansk fortifications on the Schmidt's city map from 1795*

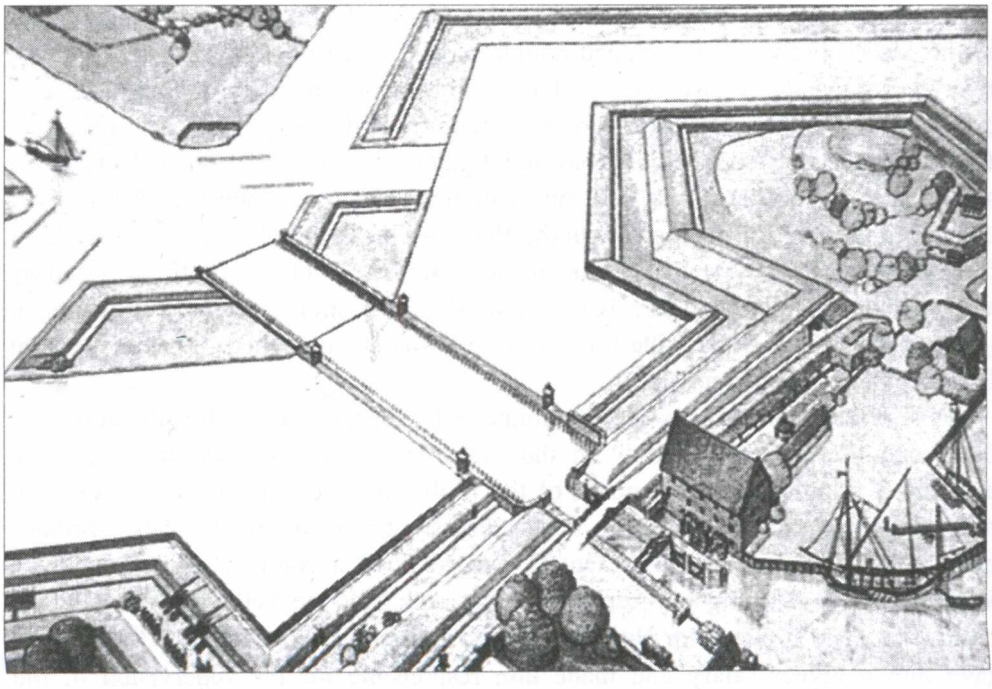

Figure 2*. The Stone Flood–Gate — a bird's eye view*

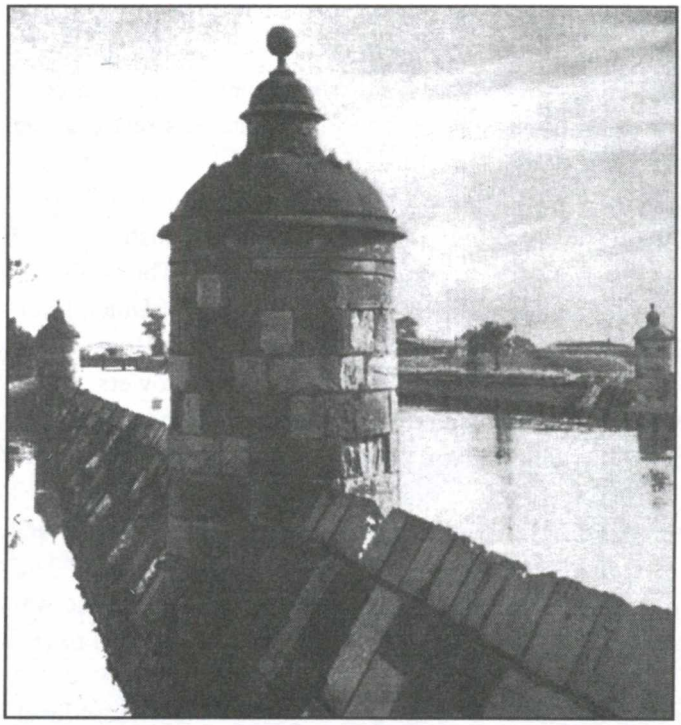

Figure 3. *The Stone Flood–Gate's bulkheads in a photograph taken before the war*

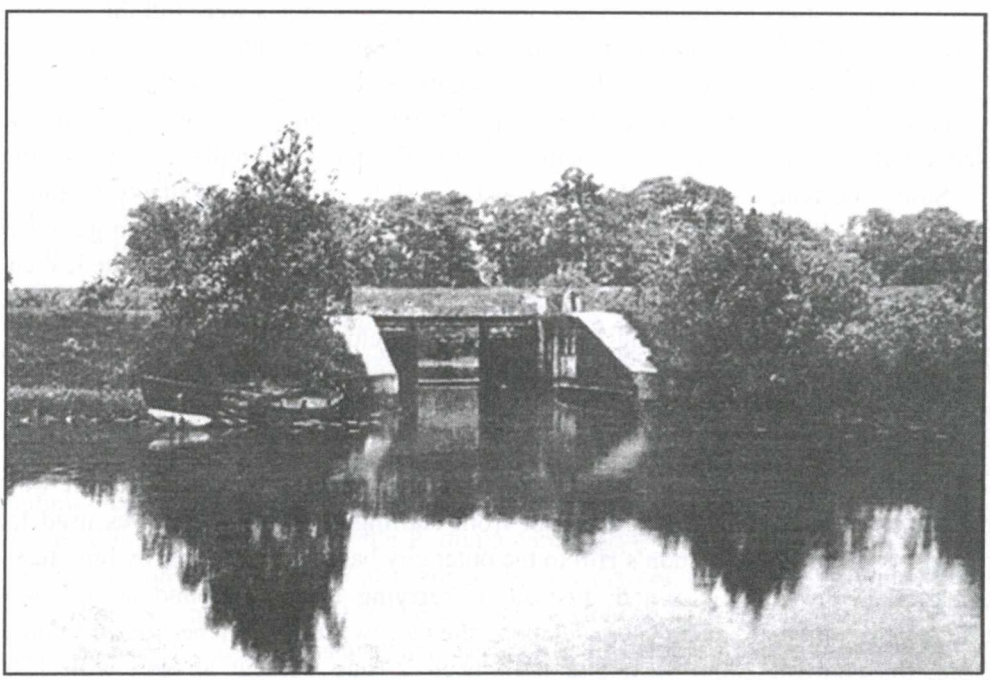

Figure 4. *The old flood–gate by the Unicorn bastion*

foundations, and 24 – the masonry and stonework. The digging was started in May 1620. 80 workers were employed for the job. 3–6 dehydrating gears were used to get rid of water. In summer 1621 they started putting the foundation framework, strengthened by wooden piles placed close one to another, and covered with boards. In June 1622 the walls were started. The flood–gate was ready in September 1623, yet the final acceptance was confirmed a year later.

The Stone Flood–Gate consists of the proper flood–gate of 43x27m and of two 90m long bulkheads, leading to semiravellins, constructed in1549/50 and reconstructed in 1701 and 1710, and called Pig's Head. The walls of the flood–gate which were 7,7m high and 2m thick, were constructed of Dutch brick and laid with 20cm thick plates of "blue stone" (granite) brought from Belgium. A similar lining was given to the pointed bulkheads and to their round towers, called "virgins" for their inaccessibility. The inner wall divided the flood–gate into two sluices: the wider one (8.6m) for vessels, and a narrower one (5.7m) directing water to the wheels of a mill constructed nearby (since 1945 in ruin). The chamber of the flood–gate was equipped with four gates (only one survived to our times). The distance between the inner gates was enough to receive a 20m long ship (or a barge). The bottom depth of the flood–gate was 2.9m below the water level marked on the water–meter. The mill sluice dammed water up to 2m. A drawbridge was placed over the inlet of the sluice.

The main task of the flood–gate was to regulate the water level in the moats. After the gates were closed, the dammed waters of the Motlawa River overflowed the bulkheads and went to the moats on both sides of the city, up to the bulkheads closing their outlets to Motlawa below the city. After the moats were full the surplus of water overflowed the bulkheads and went with Motlawa into the Vistula River. Some of the water went into the outer moats to the other flood–gates by the Knipawska Gate (Elblaska) and by Lazaret (at present the area of Railway Headquarters), and then through channels to the Vistula. By simultaneously closing the Stone and Knipawska flood–gates it was possible to flood the Zulawy region a mile from the fortifications, and thus make it impossible for the enemy to get near the city. This trick was used in 1656, 1734, 1807, and in 1813. The flood–gate had an additional function during a so–called backwater. When the Motlawa River was dammed by northern wind the lower gates were closed to protect the city. The flood–gate, which is not functioning today, was of very high importance for draining the Lower City. This extremely important monument of hydraulic engineering is unfortunately underestimated today.

A cable railway was connected with the construction of fortifications. It was built by a royal engineer Wiebe Adam from Harlingen in 1644, and was used to transport soil from the Bishop's Hill to the outer city bastion heightened by him, near the present Provincial Council. Instead of carrying the soil around across two bridges, through the Upland Gate and along the narrow streets, Wiebe stuck 12 poles along the shortest 200m way, and introduced a rope without an end with 120 buckets, and powered by 4 horses walking in a treadmill. The rope with full buckets

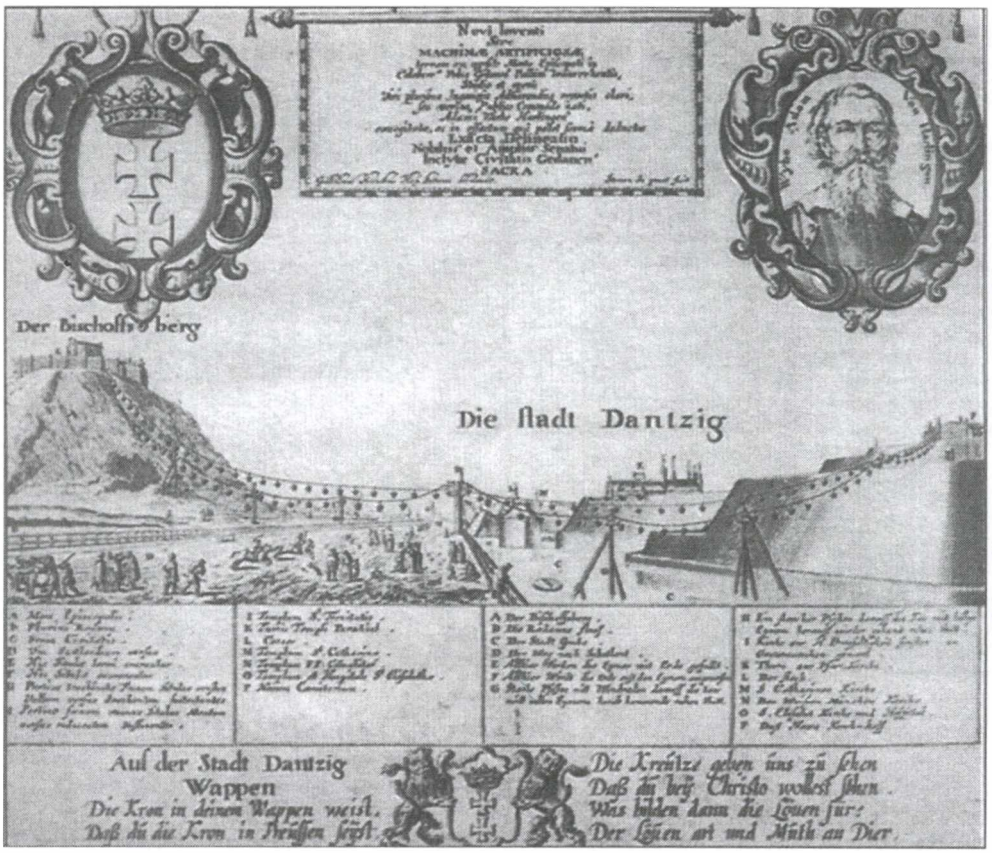

Figure 5. *The Wiebe Adam's cable railway from 1644*

rested on 9 poles with pulleys, while the rope with empty buckets was supported by 3 poles. The common thick middle post was additionally equipped with a large horizontal wheel. From today's point of view the problem of the buckets' passing the supports was solved in a very primitive way. There was a man sitting on each of them, whose job was to displace the buckets as they approached the pulleys. Physical labour was much cheaper in those days. The Wiebe's railway was the first cable railway with several supports. It was such a sensation that there were poems written about it. To acknowledge the merits of the constructor the outer city bastion was called after him, and then the name was also given to the street, which was built on its place (since 1945 Okopowa). Among other Wiebe's works we should mention: the project of feeding the Neptune fountain water system (1625), lifting a submerged dredger with the help of two ferries (1629), deepening the so–called Kluge ditch (the final part of the Radunia canal 1634–38), inventing a machine for cutting ice on the Vistula (1638), preparing street decorations with moving figures for the queen's arrival (1646), and many others. He died in 1653.

The Radunia canal was a technical construction crucial for the city. According to Pruszcz chronicle its construction was begun in 1310. Already in 1338 it crossed Orunia–below the road to Gdansk. It was called "molengraben". It entered the city

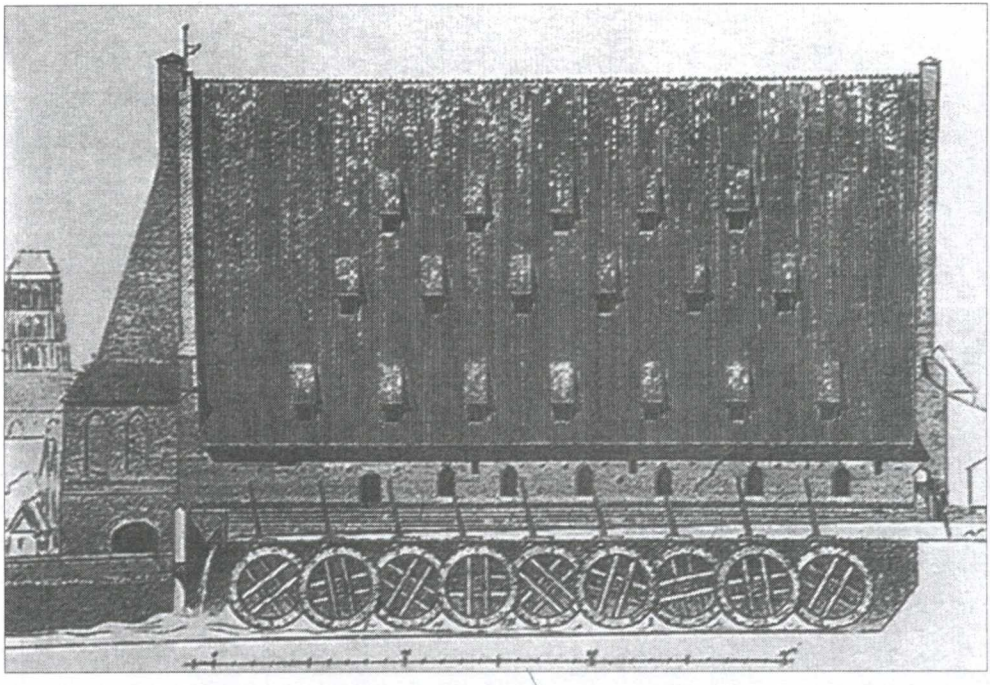

Figure 6. The Great Mill's cross section

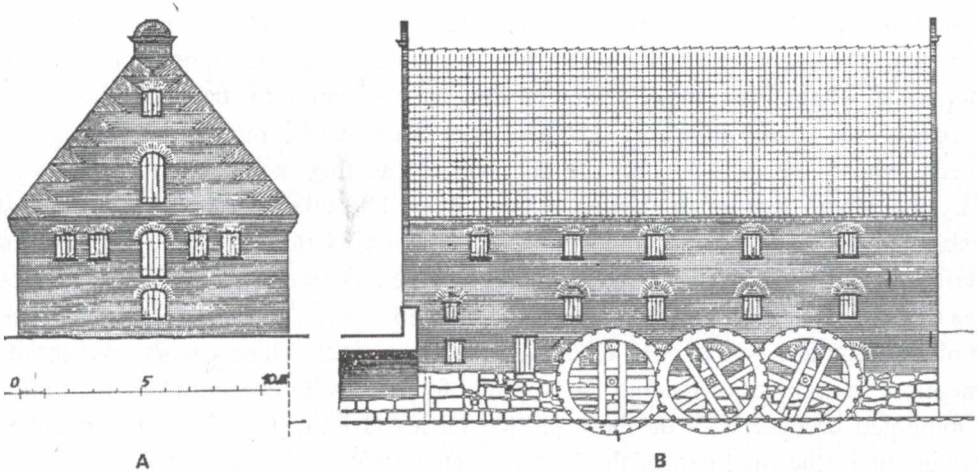

Figure 7. The mill by the Stone Flood–Gate — a reconstruction

Figure 8. *The sluice gate letting water into the Small Mill Canal on Piaski — the present state*

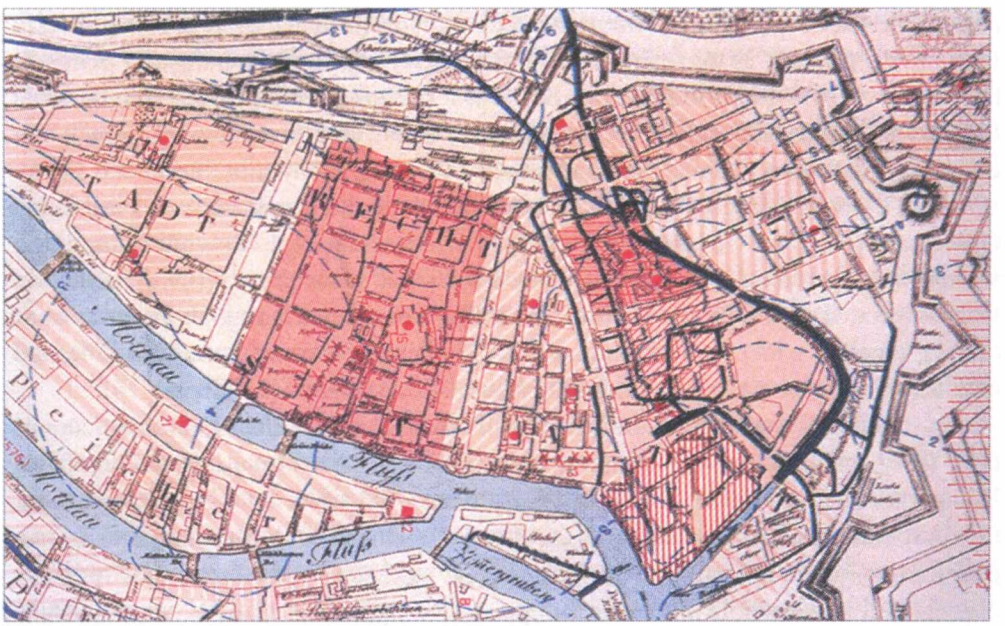

Figure 9. *The Old and New Radunia canals on the map from 1822*

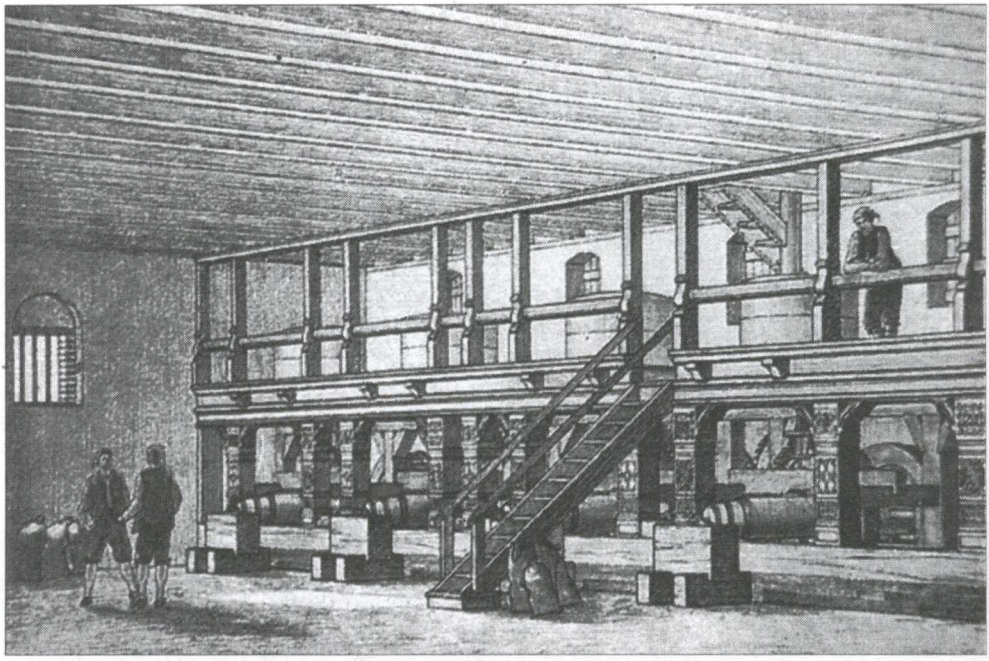

Figure 10. *The inside of the mill by the Stone Flood–Gate*

near the later Timber Market, and went further along the northern side of the Old City Ramparts, and to the moat of the castle which was being constructed since 1339/40 on the site of the prince's stronghold. It had several functions: 1) to feed the moats (the Motlawa appeared not to be good enough for that), 2) to provide the city with drinking water, 3) to clean up the impurities, 4) to power the industrial plants. It had, however, too small inclination for the last purpose, which forced the Teutonic Knights to build a so–called New Radunia's Canal (the present one), which ran above the road from Pruszcz, and had almost the whole inclination in the Old Town. In 1355 a copper–forging shop was built on it (at the crossroads of Piaski and Garncarska). In 1364 we have the Great Mill mentioned for the first time, although it seems from the context that it had existed for some time already (its construction was mentioned in the privilege from 1342/43). Also two grinding shops were built (1363), together with clothiers' fulling mill (1371), redlethermen tannery (1374), and outside the city – a tannery and a fulling mill of purse makers (1397).

By the Old Canal there were: an oil mill (1363), a polishing workshop, cereals mill (in Kowalska street), grinding shop (Podwale Staromiejskie – Old Town Ramparts), and a sawmill (1367). In 1432 we have the silver foundry mentioned for the first time, hence the name of the street — Hucisko. Altogether both canals powered some 20 industrial sites. The biggest of them — the Great Mill was the biggest mill in the whole medieval Europe. At the beginning it had 12 water wheels. In those times a mill with 6 wheels was considered to be big. It was burnt down in 1391, and was then rebuilt with already 18 wheels. The canal branches at the

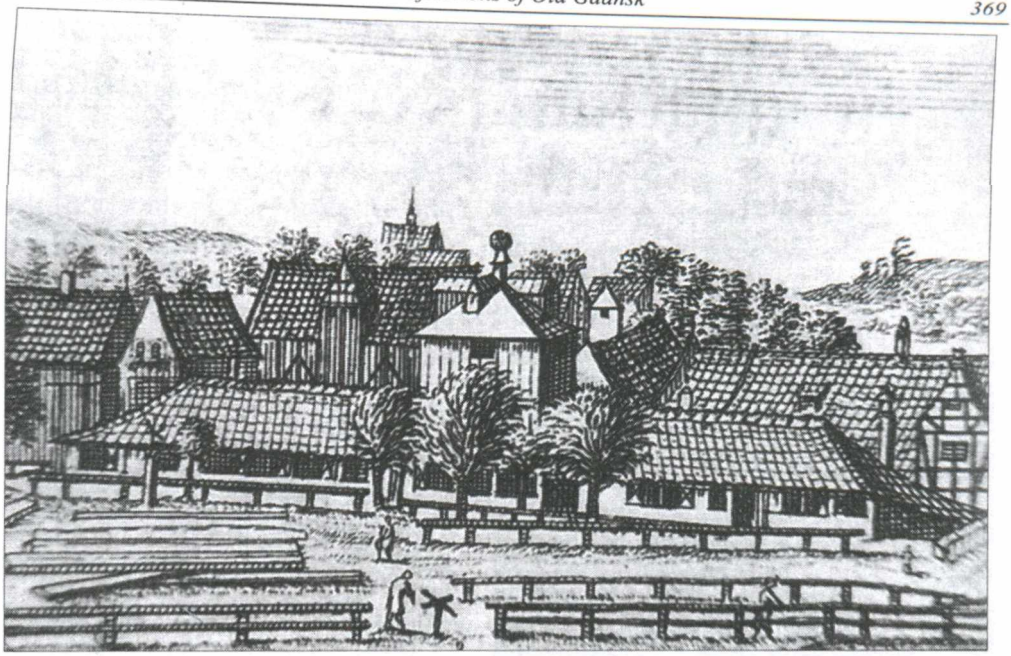

Figure 11. *Water craft by the Lobster Market in 1687*

promontory of the island on which there is the Mill. The water went to the 35m long, 4m wide, and 2m deep wooden aqueducts placed on both sides of the building. At the bottom, above each point there was a gate moved by a lever. With it, it was possible to direct water onto the blades of the wheel. The total water fall was 5m. At each side of the mill there were 9 wheels turning, 5 m in diameter each. They were placed in two rows, in partly overlapping. Inside the building comb wheels transferred the power onto the axes of millstones placed on two lower storeys. The upper floors served to store grain and flour. The old wheels functioned up to 1880, when they were replaced by American turbines. This great monument of medieval technology worked till its destruction in 1945, producing up to 200 t flour a day. It was also used for malt production. The annexe on the east side of the building, with a tall chimney, was used as bread baking oven. The rest of the island was taken up by administration buildings belonging to the mill.

In 1612 a so — called Little Mill was built on the site of the old copper forging shop. It had 3 wheels and was used for milling wheat. Unfortunately it was also destroyed during the last war. The only remaining part was the gate letting water into Radunia branches. The third mill was built by the Stone Flood–Gate and also had 3 wheels. It was used as a reserve one, during the sieges, when the enemy immobilized the other mills by cutting off the water flow into the Radunia canal. It was equipped with 3 undershot water wheels, which powered 4 pairs of millstones. Up till the time of its destruction in 1945 it was possible to admire its workshop made of oak boards decorated with beautiful wood–carvings.

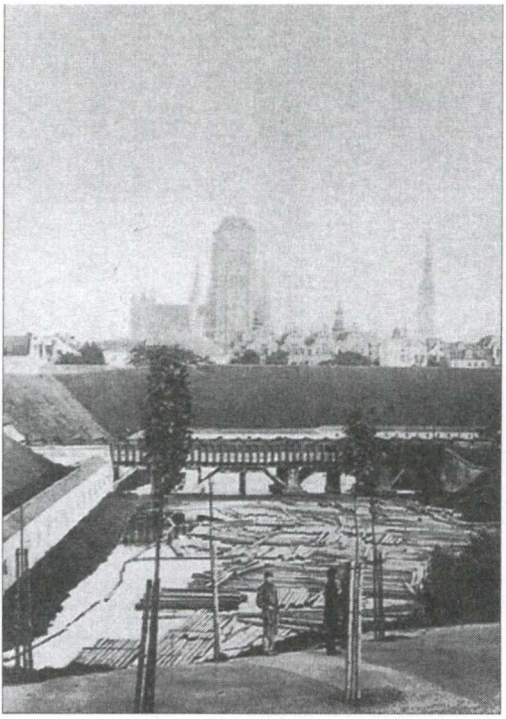

Figure 12. *The Radunia Canal aqueduct*

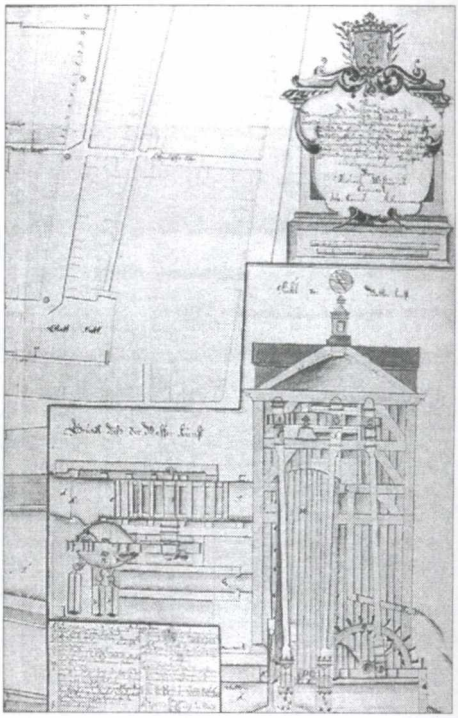

Figure 13. *The water tower cross section from 1737*

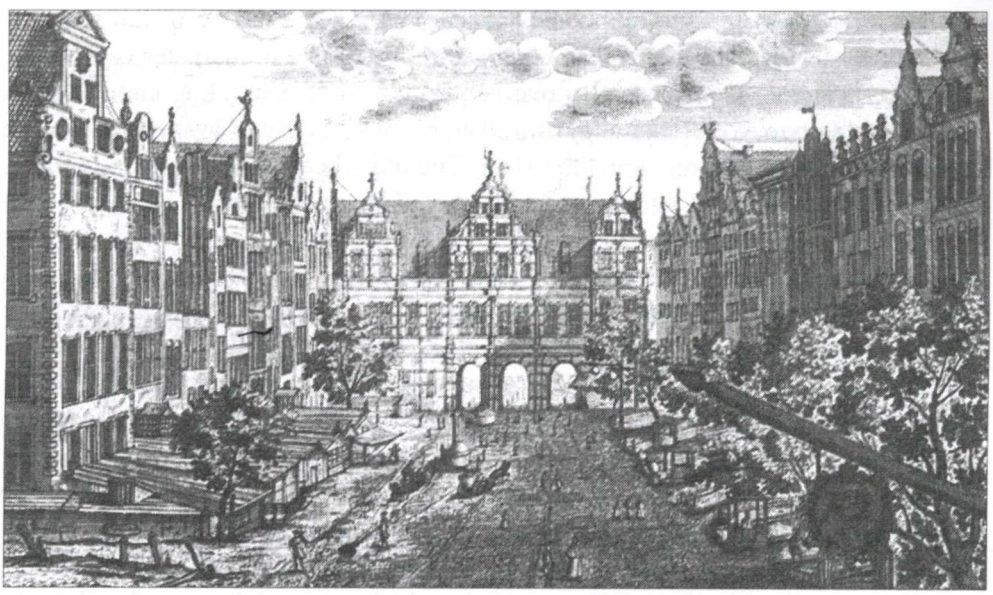

Figure 14. *The well in the Long Market in the 18th century*

Another function of the Radunia Canal was to supply the wells and water supply system in the city. In the times of the Teutonic Knights the citizens of the city had the right to draw water through pipes from the "Mill Canal" (Muhlgraben) to their own wells on condition that they don't harm the Order. The pipes were made from hollowed tree trunks and sealed with lead. The Dominican Friars' Convent used water from the Siedlecki stream, which was dug under the Radunia Canal and then went by the moat and along the walls to the Motlawa.

The city took care of the public wells. In the registry from the years 1379–1381 we can see recurring notes about the expenditures for this purpose. Among others the well in Szeroka Street opposite the Town Hall in the Fish Market was built. The note "for preparing the boards for wells" is probably connected with the framework of the turnstile for pulling up the buckets with water. Other records deal with the following: "the canal, which brings water into the city and many expenses for sewage canals". One of the wells was probably beautifully ornamented since it is mentioned among the most wonderful monuments of the city. Among them were: "a tower, a bell, a bridge, a truly golden well (turris, campana, pons, fons, scilicet aurealana)". Another list from the same time, however, (1378) mentions a golden cross, not a well.

The city protected the wells from impurities. It was forbidden to wash clothes in their vicinity. In 1443 a special commission responsible for the condition of the wells was formed. In 1450 the Teutonic Knights didn't like the fact that every citizen could draw water from the Radunia, and used this as a pretext to keep high fee for milling grain in the Great Mill. The high consumption of water caused its low quality. This state was only improved in the Polish times. In 1536 king Sigismond I allowed the city to draw water from the Jasien lake. Directly opposite the High Gate (the present Torture House) the city constructed a pump, powered by the Radunia canal and pumping water into the water supply system. "That year the water craft was constructed near St. Gertrude's, and also the construction by the New Tower was started". We should explain that St. Gertrude's church stood in the present Hay Market, and the New Tower — at the corner of Okopowa and Augustynska. The pumping station in that region pumped Radunia's water into the wells of the Old Suburb. The pipeline was laid a year before. In1539 "the pipeline through Siedlce was laid from the city up to the mill pond on Krzyzowniki, and the pond was built in the same year; together with the stream that is going from Krzyzowniki mill to the city, underground to the wells of the Right City." In 1548 the city spent 8 and 1/4 marks "to pay for the steel for 16 rings for pipes, and one wheel band for waterpost". The "Artman" (Hans Meckelborch) received 42 marks a year. The construction of waterpost — a well — in the Long Market in 1549 cost 30 marks, cleaning the wells in 1551 — 11 marks. The work lasted one and a half days and was done by 54 people.

The waterpost by the High Gate didn't work for a long time. It was taken down and rebuilt in 1563 because it stood in the way during the development of fortifications in that region. In1567 a new, brick, Radunia aqueduct was built over

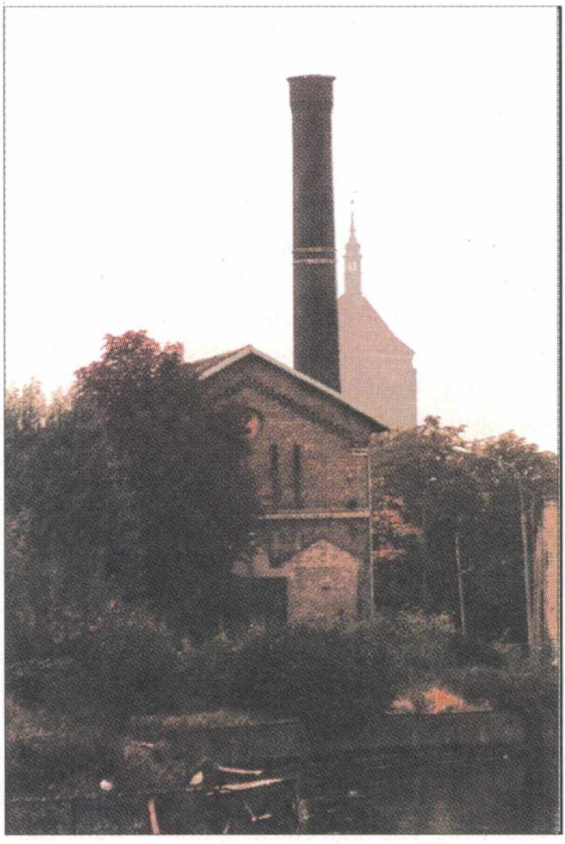

Figure 15. *The historical sewage pumping station on Kepa — the present state*

the moat. In 1571 the old Radunia Canal was changed before entering the city and the water was directed into the new canal (the present one). There was not enough money to transfer the waterpost. It was burnt down during the siege in 1577, and later rebuilt on a new site, near the present Lobster Market. In 1584 specialists from the Netherlands gave it the final shape of a quadrilateral building with an ornamented bulgy helmet, crowned with a gilded sphere. From the technical point of view it was a water – tower. The push shovel wheel, powered by the current of the Radunia canal and with the help of comb gear and an eccentric, moved two pistons inside the lead cylinders. They pushed water into an 8.16m tall cylindrical container made from oak boards bound by girdles, of 51.2 cubic meters capacity. According to the description from 1690: "In Gdansk [...] the crane standing by the moat pumps the pistons from the top in the bearing sleeve. And the river water goes under the wheel." The pump's output was 3.41 cubic meters per minute. Water went into the pipes through the holes in the bottom of the tub, equipped with meshy filters. The pipes then brought the water to 564 wells in the city. The most beautiful one was the Neptune's Fountain, which had been prepared for many years, and finally constructed in 1633. It was opened on 26 March 1634 to commemorate the triumph

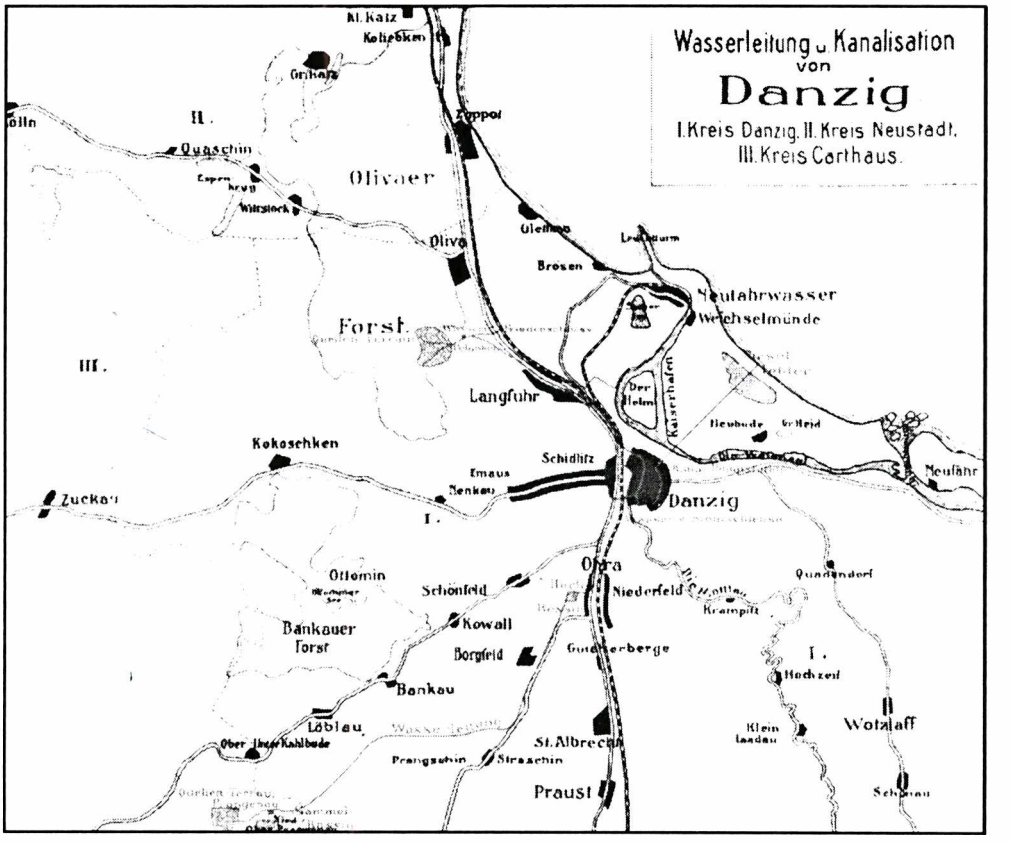

Figure 16. *The water and sewage pipeline system in 1904*

and victory of King Wladyslaw IV. Further up the Long Market stood a far more modest wooden well. Another beautiful well marked the border point of four districts the city was divided into — at the crossroads of St. Spirit Street and Dike I. It was adorned with figures holding the banners of the districts, and at the top there was the flag with the city's coat of arms. It was taken apart after 1867. It was quite expensive to use water in those days (in the 17 th century in was 450 marks a year). The richest people had taps installed in their houses. They also had to pay for cleaning the sewage canals and taking away the impurities at night. In the years 1593–1598 the average annual income of the city from those was about 52 marks per year, and in 1719–1789 208 zlotys a year.

In comparison with other Polish cities Gdansk solved the sewage problem quite well. They were discharged into Motlawa by covered gutters. In front of every threshold there was a wooden flap, and it was possible to see early in the morning a servant, or even sometimes the lady of the house, go down the stairs, open the flap and empty into the gutter the contents of a dish or a bucket. Other impurities were disposed of outside the city.

The whole system was constantly being improved and modernized. The outcome

of the wells was getting bigger. In 1822 the water–tower in the Lobster Market fed one well of the old type (with a bucket and a drawing machine), three wells with pumps, and 40 wells with running water. A modern water pipe and sewage system was built in 1868–1871. Gdansk was the first city in Europe (apart from England) with a sewage purification system on the irrigation fields. To pump the sewage in the canals under the Motlawa and Dead Vistula bottoms out into the irrigation fields between Wisloujscie and Stogi there was a special steam powered pumping station on Kepa (Olowianka promontory). On the irrigation field there were excellent farms. Asparagus shoots were grown here, for example. The water pipelines and sewage system developed together with the growing number of the citizens of the city. Between the wars new water intakes were constructed, and a water purification plant was opened in 1930 in Zaspa. The water demand grew from the initial 3,5mln cubic meters per year, to 4,6 mln cubic meters in 1914 and to 7,5 mln in 1925 (at present 45.5 mln cubic meters). The amount of sewage grew from the initial 5.4 mln cubic meters per year to 7.5 mln in 1920 (at present 63.6 mln a year).

Translation: *Anna Kucharska*