1824 ***Hydrotechnische Wanderungen in Baiern, Baden, Frankreich und Holland gemacht im Jahre 1821***, Batsch, A J G K.



P105-129 (Part II)

I only stayed in Saint-Quentin to visit the smaller underground section of the famous St. Quentin canal. I then continued my walk from St. Quentin to Cambrai by taking the Diligence to Riqueval, visiting the canal keeper there, looking at the large underground stretch of canal with him and then walking along the canal to where it crosses the road to Peronne (Probably near Bantouzelle Lock). From there, I took the road via Bonavis to Cambrai, because heavy rain prevented me from following the canal as far as Cambrai, as was my original plan.

Since this canal is one of the most remarkable works of human art, it would not be out of place here to preface the remarks I have had the opportunity to make with something historical about its creation.

The first draft of this canal, which connects Antwerp with Marseilles, was made by de Vicqu in 1727, when the Crozat canal, which connects the Oise at Chaunay with the Somme at St. Quentin, was completed. At that time, one had already realised the extraordinary benefit for internal navigation and especially for Paris, which one would have if a canal connection between the Oise and the canals in the French Netherlands were established. In particular, the ever-increasing demand for fuel in Paris made this desirable, because then the supply of hard coal from the mines near Valenciennes could be achieved without great expense. However, a mountain ridge, which was of great importance for this enterprise, posed almost insurmountable obstacles. The lack of sources that could feed a summit level, if one wanted to carry the waterway over this mountain ridge according to the example of the Canal du Midi, left no other way of execution than to construct a large section of this canal underground. The bold and insightful de Vicqu therefore first proposed to run the canal as we find it indicated on the map (Fig. 72. Taf. VI.) by A C D.[1] We see from this that de Vicqu, in order to run the canal as little as possible underground, used the valley between

[1] This map is taken from the cited work of Construction Director Schulz, (Schulz, Friedrich Johann Ernst: ***Versuch einiger Beyträge zur hydraulischen Architektur***, 1808). It agrees completely with the one I received at St. Quentin through the courtesy of an engineer for copying, only with the difference that it is smaller here by a third. Since this size is sufficient to explain the notes given here, I chose this smaller chart instead of the larger one.

Tronquoie[2] and Riqueval, where the River Omignon rises and which allowed the canal to be built in the open. However, no matter how plausibly de Vicqu had presented the possibility of carrying out his design, it was not thought possible at the time to decide the costs, and it was not carried out. Louis XIV, under whose reign this design had been made, died and his successor Louis XV's attention was again drawn to this enterprise, especially by the fact that the Crozat family, to whom the aforementioned Crozat canal belonged, left it to King Louis XV for future maintenance. He immediately ordered the connection of this canal with the Scheldt and Laureat de Lionne was given the task of examining the existing design by de Vicqu and then directing the work. Laureat, however, considered de Vicqu's design unsuitable and submitted a new design in which he significantly shortened the route of the canal by giving it a longer underground canal section, as indicated by A B on the map. This design was approved and Mr Laurent de Lionne was entrusted with its execution on 24 February 1769. Laurent had found many opponents who did not cease to put his design in a searching light and, in particular, the rebuke made only after the work had begun, that in such a long underground canal section the movement of the boats would be extremely difficult because of the small clearance, may also have found its way to the government, which soon no longer supported him with the zeal as at first. In 1773 Laurent died and in 1775 the execution of this great enterprise was abandoned, after a stretch of 5000 toises[3] had already been cut underground and more than a million livres had been spent. The academics d'Alembert, Condorcet and Bossut then proposed to abandon this canal completely and to dig another one, which should connect the Sambre with the Sheldt through the forest of Mormal and Valenciennes.[4] However, this proposal was not taken into consideration and it was not until the reign of Louis XVI that the construction of the canal begun by Laurent was considered. Louis XVI allowed Laurent de Lionne, a nephew of the late Laurent, to continue the work on this canal and gave him several privileges to encourage him to continue. Through these privileges, however, the Parliament of Flanders found itself disadvantaged and the canal remained in the same condition as it had been left in 1775. The revolution that broke out afterwards made all such undertakings completely forgotten, until finally the stormy times calmed down again and Bonaparte became Consul. He was the first Consul to go to St. Quentin in the year 1800 to inspect the situation of the canal on the spot. He then gave the order that all designs for its direction should be examined anew by the engineers of water and road construction. The commission set up for this purpose, which consisted of Messrs Gauthey and Ducros (General Inspectors), Mr von Prony (Director of the School of Hydraulic and Road Engineering), Mr Recicourt (Director of the School of Fortifications) and the Engineer in Chef Mr Becquey (Director of all Hydraulic, Road and Bridge Engineering), first considered whether a connection of the Sambre with the Oise or a connection of the Somme with the Scheldt was preferable. It was soon agreed that the latter would be more advantageous and the only question now was whether the design by de Vicqu or Laurent should be carried out. The Commission voted in favour of de Vicqu's design, even though the total length of the canal would be greater than with Laurent's design, because the underground route of the canal would be shortened by almost half and more than one million francs would be saved. The Assemblée des Ponts et Chausées, when questioned, also agreed with this opinion of the Examination Committee, but left it up to the First Consul to decide whether the costs of more than one million livres already used in Laurent's design should be completely disregarded, or whether he would not prefer to have the work already begun continued. The First Consul, not satisfied with this report, ordered the Assemblée to examine the matter again and then to declare itself definitely in favour of the execution of one or other of the designs. This order gave rise to a heated dispute between the various opinions in the Assemblée, and Mr. Becquey took this opportunity to present a new design, by which the total length of the canal, with an underground stretch of the same size, was less than that of the de Vicqu design, but where the same difficulties arose for its execution as in the de Vicqu design, which is why the design of Mr. Becquey was not taken into account and the design of Laurent was preferred to that of de

[2] Probably Bellenglise
[3] One Toise was 6 (French) feet, becoming 2 metres between 1812 and 1840.
[4] This would have run south-east from Valenciennes.

Vicqu. After this decision, which was submitted to the government for final approval, the engineers who had been outvoted in the Assembly issued a memo,[5] in which they showed how few valid reasons the majority of the members had for the decision they had taken and what reasons existed for the execution of de Vicqu's design. In it they state that the majority had decided in favour of Laurent's draft only for the following reasons:

1) That Laurent counted on ground water to feed the canal and that this was really possible on the chosen route, which had been selected with regard to the mountain streams,

2) The long underground canal route would always be a far bolder, more honourable enterprise and more worthy of a great nation.

To this the authors[6] of the Mémoire replied that, firstly, the ground water could be dispensed with altogether, since the Sheldt yielded sufficient water, and that, secondly, a wise government, in choosing a design, must not be determined by its brilliance, but by its expediency and true utility. Moreover, they showed in this paper that the execution of de Vicqu's design had the following advantages over that of Laurent's design:

I ) Easier execution of the work

2 ) Lower costs of the work.

3 ) Shorter duration of the work

4 ) Rarer and less costly repairs, which in the case of an underground canal interrupt navigation each time.

5 ) Much easier passage for the boats, because of the greater width that the open canal can have.

6 ) The open canal would not be subject to such a multitude of completely unforeseeable and unavoidable accidents as the underground one.

7) Since Laurent's underground canal is to be 13,772 metres long, this makes the construction of an underground harbour necessary, because the vehicles cannot pass each other and yet spend a very long time in the underground canal. Laurent had also recognised this necessity, but the construction of the harbour was linked with endless difficulties. In de Vicqu's design, on the other hand, such a harbour would be unnecessary, as the boats could pass in places in a very short time.

Moreover, Mr. Gauthey had tried to show, against the cost estimate of the engineer Laurent (son of the late Laurent de Lionne), in which it was claimed that Laurent's design cost 1,222,504 francs less than de Vicqu's, that the construction of the underground canal section according to de Vicqu with a width of 24 feet would only cost 4,853,974 francs, and that the completion of the underground canal section according to Laurent, on the other hand, would cost 8,306,245 francs.

The First Consul, who might well have realised that a great deal of partiality may have prevailed when the last decision was taken, did not want to confirm this decision until he had received the opinion of the Academy of Sciences (Institut de France). This was immediately commissioned and it declared itself in favour of de Vicqu's draft, which was now approved by the government with an order for 3 million francs.

The work began in the summer of 1803 and the government immediately stipulated that it should be completed within three years. The canal, which was now led via Omissy, le Tronquoy (Lesdins), Bellinglise and Maquincourt (north end of the tunnel), could not be opened until 1810, however, and in 1821, when I saw it, the necessary vaults and the drawing way in the large underground section of the canal had not yet been completed. After the opening of the shipping,[7] the entrances to the underground parts of this canal received the following inscriptions, which I am reporting here, since they have now been removed and nevertheless belong to the history of the canal.

Above the entrance on the side to St. Quentin, one read on black stone tablets with golden writing:

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[5] Opinion des Ingenieurs composant la miniorité de l'Assemblée des Ponts et Chaussees dans la décision prise par elle le 15 Ventose an X sur la canal de jonction de la Somme à l 'Escaut.

[6] Among these are Messrs. Gauthey, Montrocher, Prony, Sganzin, Lesage, Girard, Houbouard, and Panay.

[7] The first six vessels arrived in Paris from Cambrai with loads of coal on November 9, 1810

NEAPOLIO IMPERATOR REX CANALEM NAVIGUS PERVIUM PARTIM EXCISIS. PONTIUS PARTIM EFFOSSIS AB ISARA AD SCADIM PERDUXIT

ANNO MDCCCIX

CURATORE VIARUM MONTALIVET

Over the Cambrai entrance:

NAPOLEON EMPEREUR ET ROI A TERMINE L'AN 1809, LE CANAL QUI REUNIT LA SEINE A L'ESCAUT; OUVRAGE COMMENCE, REPRIS ET DEUX FOIS INTERROMPU SOUS LES REGNES PRECEDENTS

Above the opposing exits of the two underground canal sections, one read:

SPECU PERFORATO MONTE PER SEX ET AMPLIUS METRORUM MILLIA NAIGORUM A SCALDI AD ISARAM COMMEATIBUS JUSSU NEAPOLIONIS IMPERTORIS ABSOLUTUS

ANNO MDCCCIX

CURATORE VIARUM MONTALIVET.

and over the other:

NAPOLEON EMPEREUR ET ROI POUR RENDRE PLUS COMMODE ET PLUS SALUBRE LA NAVIGATION DU CANAL DE S. QUENTIN EN A REDUIT A MILLE HUITCENT METRES LES EXCAVATIONS SOUTERRAINES PORTEES A TREIZE MILLE DANS LES PLANS DE SES PREDECESSEURS.

This is the most essential part of the history of the canal, of which, apart from a very brief general description, I will only give as much detail as is necessary for those who, like me, can only view it in passing, in order to focus their attention on the most important objects.

The whole canal is nearly 6 geographical miles long, and consists partly of the 2½ mile[8] long horizontal section A B, in which the underground parts of the canal are also located, partly from the sections descending to St. Quentin and Cambrai.

To St. Quentin one descends through 6 locks 13 mètres and to Cambrai through 18 locks 37.30 Mètres,[9] as we can also see from the general profile. The long horizontal stretch of canal is the actual point of distribution. This stretch of canal is therefore fed with the necessary water by intercepting and collecting several streams. For this purpose, the water of the Scheldt and Somme is collected in basins, from which the water that these basins cannot hold is diverted back into the old riverbed. But very wisely, they have avoided letting any of these rivers enter the canal directly. The ground water, which is found in abundance in the long underground stretch of canal, also serves to feed the canal. A circumstance which speaks for the acceptance of de Vicqu's design, insofar as it was modified by the Assemblée to the effect that the canal bed was laid 18 feet deeper than de Vicqu had proposed.

The open stretches of canal, which in some places had to be given significantly high banks, as is already suggested by the lowering of the canal, have been given a width of about 40 feet with a water depth of 5 feet. The slope of the canal banks under water is 2 feet. In this way, the canal has obtained a sufficient width for two boats to avoid each other. The soil here is generally very good and, with the exception of a few peaty areas, consists of beautiful rich reddish clay or marl. Here, as in several canals in France, parallel ditches have been constructed to keep rainwater flowing down from nearby heights away from it, as it can easily cause a canal to silt up. This water, which is kept separate from the canal in the parallel ditches, as well as the brooks which the canal cuts through, are led under the canal through several massive culverts, which was all the easier to accomplish

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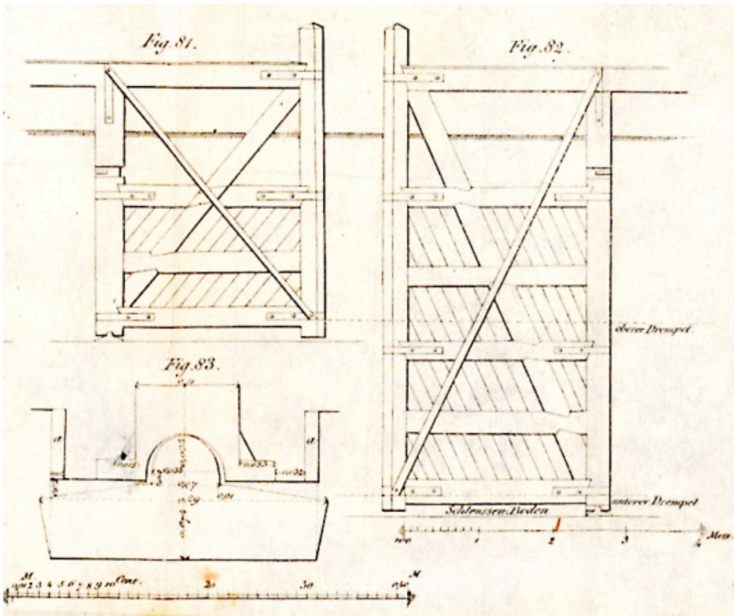
[8] According to the general profile (Fig. 71. Taf. VI.): 18,027 Mètres and according to Courtin, ***Travaux des Ponts-et-Chausees depuis 1800***, 1812, 20,177 Mètres.

[9] Courtin gives 37,61 mètres and Schulz 40 mètres. The latter figure might be the correct one, since Courtin's figures are not always to be trusted, and the general profile given does not quite correspond to the execution. Since, as far as I know, we have not yet received a detailed description of this canal after its completion by the French, I will share the information I found with Courtin and Schulz here. The information that Mr. Schulz gives in his travel notes was obtained on the spot from the engineers engaged in the construction at the time

because the bed of the canal is in part higher than the river bed of the Somme and Scheldt; however, where the bed of the canal is not high enough for these waters to pass straight under it, so-called siphon-like culverts (épanchoirs à syphon) were constructed, as for example close to St. Quentin.

The construction of aqueducts was avoided as much as possible by directing the canal mostly along the right side of the Somme and the left side of the Scheldt. Only at Honnecourt and Noyelles was the construction of aqueducts unavoidable. Construction Director Schulz mentions only two aqueducts near Honnecourt and does not mention the one near Noyelles, to which my attention was drawn in St. Quentin because of its beautifully constructed stonework. Unfortunately, heavy rain prevented me from visiting the aqueducts at Honnecourt and Noyelles, and in order to get to Cambrai more quickly, I followed footpaths which often took me away from the canal, and finally, as I have already mentioned, I completely abandoned following it to Cambrai, because I had already sent my clothes there from Riqueval, and could not spend the night with soaked clothes in the village of Manières.[10]

The fall of the canal is overcome by 24 locks, of which it is remarkable that they are all constructed without ground piles or sheet pile walls, and are built directly on the ground, which admittedly mostly consists of good clay (Letten). To secure the lock floor, deeper walls (murs de batardeaux) were built under the lock gates, and the rest was reinforced by a double layer of cross beams so that there was no fear of it pushing upwards due to the disproportionately stronger pressure of the side walls against the brick-built, 4-foot thick lock invert floor. Even if the precautions taken here against the pushing up of the lock bottom might not be sufficient for locks of greater width, they are, according to the experience obtained here, for locks of 16 feet width between the gates. As far as the length of the locks on the St. Quentin canal is concerned, the information on this is not consistent and a stranger does not always have the opportunity to find out exactly what the dimensions of a structure are. I can therefore only tell you how I found the length of the locks in Courtin and Schutz, compared with a table on a ground plan of the canal, which I had the opportunity to see and hastily copy at St. Quentin. According to this ground plan, the length of the lock chambers is 120 feet, while Courtin gives it as a little over 114 feet, or 37 metres; whereas according to the information that Mr. Schutz received from the local engineers in 1803, the length is 130 feet. He remarks here that, according to an earlier draft, the locks were to be built shorter and to have culverts for filling the chambers as those on the locks of the Canal du Centre, but that this was later abandoned. From all that he tells us about this, it seems to me that at the time the engineers did not quite agree on the determination of the length, and the reason given for the lengthening seems even less appropriate to me, since with the culverts a boat can get as close to the forebay as with the culverts on the locks of the Canal du Centre, which will become even clearer by a comparison that will be made further on, where I will describe these culverts and their method of closure.




The side walls only have buttresses behind the gates, but they are heavily stepped and the sills consist entirely of ashlar blocks, without a wooden threshold like those on the canal of St. Denis and the locks at Havre. Perhaps it was found unnecessary here, because the water in the upper canal is still, does not cause the gates to slam together as violently as when the water has a slight gradient

[10] Manières is the only village on the St. Quentin Canal where one can get a decent night's sleep.

and thus more current.

As far as the construction of the gates is concerned, it is the same for most locks, as Figs. 81 and 82 in Plate VI show. One can see from this drawing, which I received in Paris from Construction Director Schulz,[11] that the French are now quite consistent in the construction of their lock gates, if one compares them with Figs. 40-45, Plate III, and with the illustrations which Cessart has given in his work: ***Travaux hydrauliques etc***. The gates on the St. Quentin Canal, however, are distinguished by the spigots and sockets which have been applied to the quoin posts. You can compare (Fig. 46-52. Plate. III, on next page), which the lock at Louviers[12] and those at the St. Denis Canal are said to have received, with (Fig.83 Plate IV) and a quick view will show that these are even more purposefully constructed than the former. I also received a drawing of them in Paris on a considerably larger scale, together with the dimensions noted. It differs in some respects from the one we find in the book by Construction Director Schulz, but not to any extent. The usefulness of this device consists in the fact that the socket attached to the quoin post moves on a fixed pivot, instead of the pivot moving in the fixed socket, as is usually the case. This modification prevents the socket from silting up, which is often not only a hindrance to movement, but also leads to the earlier destruction of the pivot and socket. According to the description and illustration in the above-mentioned book, the pivot and socket are not completely of cast iron, as here, but of a plate of cast iron in which a steel pivot is embedded. The pivot there is cylindrical with a segment-shaped sides, whereas here it is only slightly cylindrical with a semicircular surface. On both, the socket has been shaped like the pivot, only with a larger radius. On the drawing I copied and included here, it was noted that both pieces, the spigot and the socket, are made of cast iron; here, however, the latter is made of metal,[13] which is much more practical, since one never makes parts that rub against each other out of the same material without reason. On the outside, the pan has a regular 6-cornered shape (not 8-cornered, as described but not drawn) to prevent the pan from turning on the stand. The ring **a** is made of wrought iron. As far as the dimensions are concerned, I cannot make a comparison because I have not found a scale on the drawing supplied by Construction Director Schulz.[14] It is very noteworthy that the socket is set into the pivot post in such a way that the centre of the pivot is at a distance from that of the quoin post, namely on the side facing away from the sill. This has the effect that when the gate is closed, the quoin post fits exactly into the quoin stones, which are rounded to exactly the same radius, but when the gate is opened, it immediately moves away from it, thus completely preventing the very disadvantageous and difficult-to-overcome friction on the quoin.

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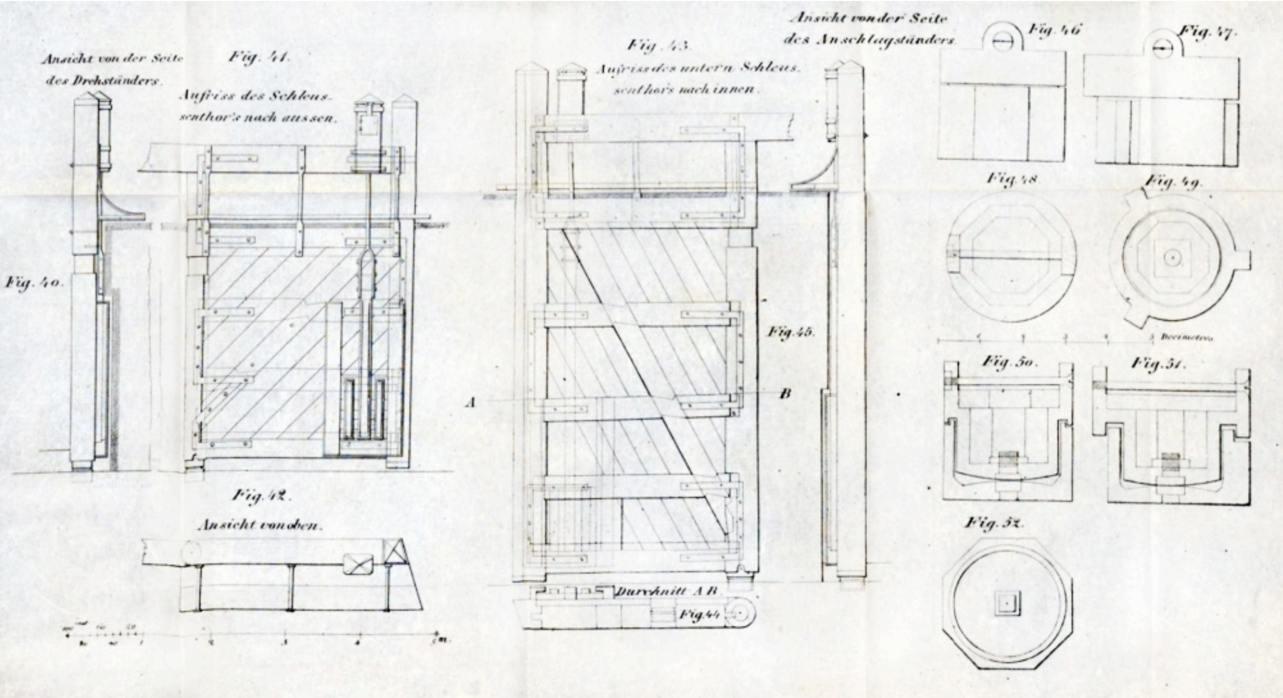
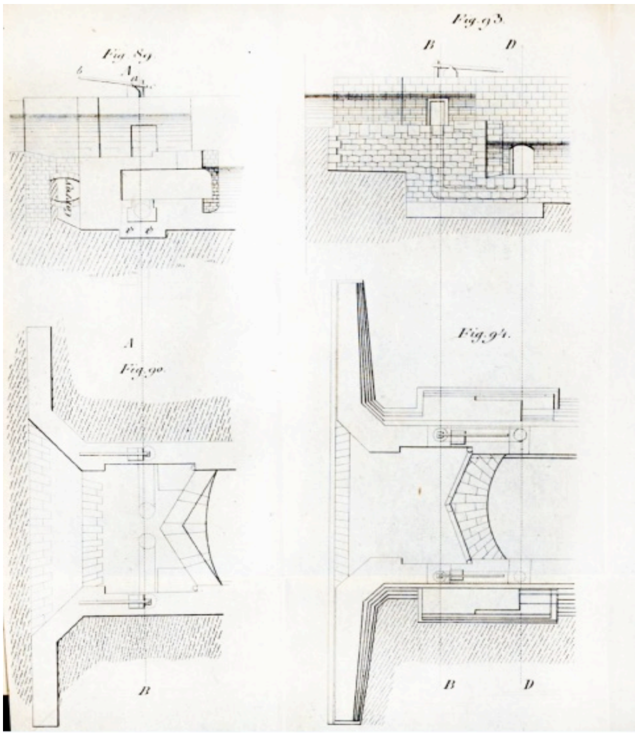
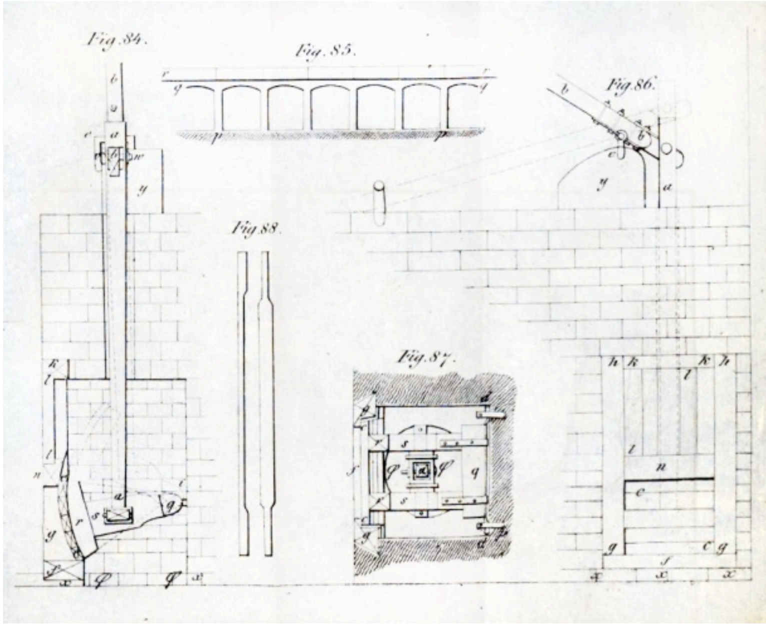
[11] Schulz, Friedrich Johann Ernst: ***Versuch einiger Beyträge zur hydraulischen Architektur***, 1808.
[12] River Eure.
[13] Probably bronze or brass.
[14] In the 4th booklet of the ***Pract. Anweisung zur Wasserbaukunst*** (p. 71) by Mr Eytelwein, you will also find a description and very instructive illustration of this type of spigot and socket for lock gates. In essence, it corresponds completely with Schulz's drawing; only the dimensions of the socket and the trunnion, as well as the shape of the trunnion bearing, are somewhat different




The previously-mentioned  device for filling and emptying the chamber is now to be described in more detail, as follows. Cylindrical culverts of 2 feet in diameter have been built around the upper and lower gates, as Fig. 93-96, Plate VII, show more clearly.

The culverts themselves consist partly of large stones in which the entire cylinder-shaped opening is cut out, or of semi-circular pieces which, together with 2 or 3 smaller arched pieces, form the cylinder. This refers mainly to the horizontal part of the culverts. The inlet and outlet of these culverts consist of square chambers, of which, however, at the upper lock head the outlet chamber with its bottom is always higher than the horizontal part of the culvert, so that the water first enters the outlet chamber from below before it is released into the lock chamber. This arrangement, which seems to me to be even more suitable for maintaining the water within the lock chamber as calm as possible than the arrangement chosen on the Canal du Centre, which I will describe for the sake of comparison as soon as I have adequately explained the one installed here. These inlet culverts are closed by a device which is certainly worthy of imitation and seems to me to be a much improved imitation of the device installed for the same purpose on the locks of the Canal du Centre. Fig. 84, Plate IV. shows the device installed on the St. Quentin canal in a vertical cross-section, and Fig. 87. shows it in a horizontal cross-section. The view of the closed paddle is shown in Fig. 86. From these figures we see that the frame, which fits tightly into the opening of the culvert, is more than half sealed by a surrounding bead. The opening still left in the frame is closed by an arch-shaped protection board **c c**. This protective board consists of two crooked strips **r r**, the crooked sides of which are shod with 2 inch planks. An arm **s s** is screwed into each strip and both arms into the cross-piece **q**, to which



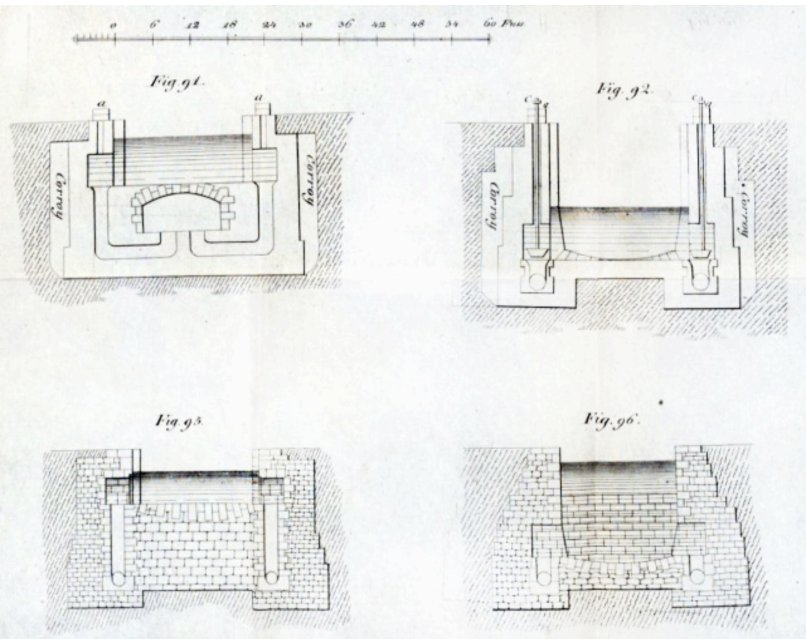



they are also connected by the stirrup placed around **q**. The stirrups also hold the iron axle **d d**, which we find illustrated in Fig. 88, Plate VI. The ends of this axle rest in the brackets **p p**, which are inserted and cast into the wall. In order to be able to move the paddle board **c c**, the two arms are connected by a half timber with round ends, but with a square opening in the middle. The rod is inserted through this opening and fastened with a screw bolt. For the movement of this rod, a 7 inch long and 4 inch wide clearance is left in the lock wall and the rod itself has a square hole at the upper, stronger end, through which the lever **b b** is inserted and fastened with the bolt **v w**. The lever **b b** rests on a large bearing block **y**, which is provided with an inserted and cast-in clamp **e e**, around which the lever moves as if on its resting point by means of iron rails. From the description and illustration given here, it is easy to see how a pressure on **b b** is sufficient to lift the paddle board **c c** and open the chamber, or, on the contrary, to close it after it has been opened by lifting the lever. In order to raise the board or open the chamber, one end of the lever **b b** is pressed under the iron cramp **u**.

It should be noted, however, that the curved paddle **c c** is not rotated on **d**, but from point **i**, whereby **c c** moves away from the frame **i g f** from the moment of lifting and in this way the friction of the paddle planks **c c,** which were previously firmly attached to **i f g**, is reduced.

This idea for closing off the inlet culverts seems to me to be an imitation, and I would also like to say a perfection, of the idea according to which the inlets of the culverts on the locks of the Canal du Centre are closed and opened. A brief description of the device used on that canal will show at best how far the device installed on the St. Quentin Canal is to be regarded as more appropriate.

The locks on the Canal du Centre have also been fitted with bypasses for filling and emptying their chambers. Strictly speaking, however, only the circular culverts installed for the purpose of emptying the lower heads can be so called, because only these guide the water around the gates, while the upper guide culverts lead the water out of the upper channel into a curved chamber under the forebay, in the same way as the outlet chambers at the locks of the St. Quentin canal, i.e. in such a way that the water first enters the chamber from below and only fills that gradually before it emerges into the lock chamber. Accordingly, and as I can see from Figures 89 to 92, Plate VII, the arch under the forebay forms the common outlet for the inlet culverts on both sides at the head, and the water leading from the upper culvert into the lock



chamber does not run around the gates, but under the gates. However, the water is not let in and out by closing and opening the inlet culverts, as is the case with the locks on the St. Quentin Canal, but by directly blocking the guide culverts themselves. For this purpose, a wooden plug is used, which fits exactly into the upper mouth of the culverts and is lifted by means of a lever in the same way as the arched paddles on the St. Quentin Canal.[15]

However sensible to construct the arch under the forebay, however simple the device for closing and opening the culverts may be, and however much praise the inventor of this device may deserve, it cannot be denied that this device is not only happily imitated on the St. Quentin Canal, but is even greatly improved. The water enters the lock chambers just as calmly as on the Canal du Centre through the arch under the forebay, and the boats can lie just as close to it as there. The weakening of the forebay caused by the arch is avoided and the device for letting the water into the culverts, although not as simple, is much more practical. Either the plug fits exactly into the upper opening of the culverts or it does not. In the former case, it would be impossible to prevent the plug from becoming swollen and it would then be very difficult to pull it up. In the latter case, it would probably let through more water than is good, since almost all lock gates let through more water than is desirable after prolonged use. In addition, such a plug must wear out very soon if it is frequently pulled up and down. The arched paddle has neither the disadvantage of swelling nor does it have to overcome the pressure of the water, which is necessarily the case with the plug when it is to be lifted. With the arched paddle it can also control the water to be let in so it does not rush too quickly into the culverts and enter the lock chamber too quickly, which usually affects the boat the most, because the inflow culvert can be opened gradually. Since this device is mostly made of wood, I would think it would be more effective than lifting paddles with gearing or the expensive iron screws found on some locks.

I now come to that part of the canal which distinguishes it from all other existing and known canals in a most noticeable way, namely to its subterranean stretches,[16] which, especially the longer one, must excite the admiration of both people today and posterity. Those who are not familiar with this canal might reply that we already have several navigable underground canals in France and England, and that even a stretch of the Canal du Midi had been built underground. However, if one compares the underground navigable canals already mentioned with those of the St. Quentin Canal, one must admit that in terms of width, height and length they cannot be compared with it. When one considers, finally, in how short a time it took to complete this work to such an extent that navigation could be opened, admiration is surely joined to astonishment by everyone who knows a little of the difficulties connected with the execution of such a work. A monument of national power, equal to those created by the Romans when the strength of the Roman Empire had not yet been broken, this canal can be placed alongside the most daring undertakings of the kind of past and present times.

Of these two canal tunnels, the smaller is at Tronquoie, and the larger between Riqueval and Macquincourt. The excavation of the former was less difficult than that of the latter, because the upper soil as well as the other layers were loose and only contained a little ground water, which was a particular hindrance to the rapid excavation of the larger tunnel. The method used to excavate these tunnels is remarkable. In order to complete the work as quickly as possible, they started by digging shafts. These were dug at both ends as well as to the middle of the tunnel. Also, the shafts to be dug deeper were not placed at a greater distance from each other than the less deep ones, as

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[15] According to what Herr v. Wiebeking says in his ***Wasserbaukunst*** III. p. 138. about the locks on the Canal du Centre, there are just such arched gates on them as on the Canal of St. Quentin. As I did not see the Canal du Centre, I must leave it open to question whether the locks mentioned by Construction Director Schulz in his notes on his travels and partly borrowed from here is incorrect or whether the arched gates were perhaps introduced at a later date instead of the stoppers. Mr. v. Wiebeking, op. cit. II - p. 713. also mentions this channel of the device with plugs. The notes in the third part, p. 138, on the other hand, are by his son, the Royal Bavarian Councillor, Mr. Karl Wiebeking. Karl von Wiebeking, who visited the Canal du Centre in 1813. However, the extent to which the travel notes of Mr. von Wiebeking are to be trusted can be seen from what I saw during my way to Amsterdam on the occasion of my visit to the drainage lock at Katwijk on Rhin.

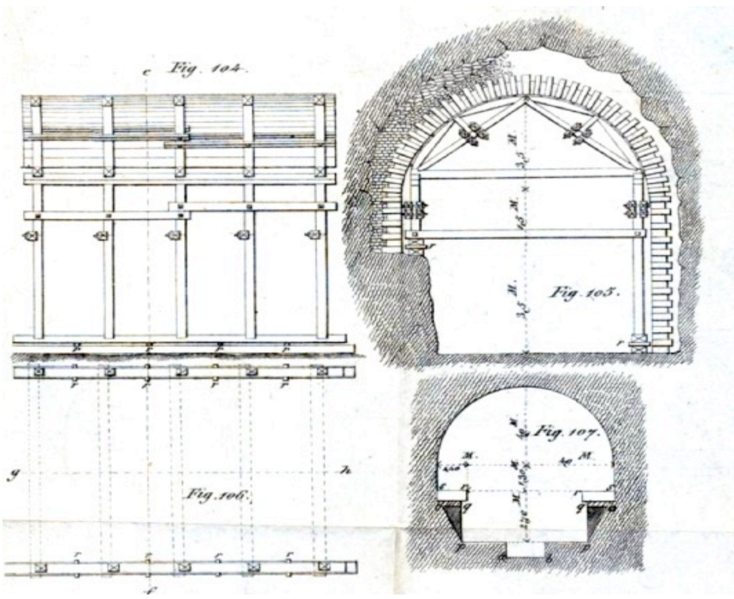
[16] The word 'tunnel' or an equivalent is noticeable by its absence in French and German books on canal building at this time, suggesting that the idea of an underground navigation, despite the one at Malpas on the Canal du Midi, was new.

one is usual in such work if one wants to build with the greatest possible saving of costs, but on the contrary, they were placed even closer together, because this undertaking was more concerned with speed than with keeping costs low. If one had contented oneself with digging from both ends of the tunnel towards the middle, it would have been easy to remove the ground water and it would not have been necessary, as it had to be done here, to pump them out using steam engines, and finally a small drainage canal would have had to be built over the actual navigation canal in order to lead the upper ground water to where it could find a natural outlet through the rock or could also be drained through the end of the tunnel. The tunnel keeper there showed me traces of these drains on the walls, where they had been removed, running from the higher working sites downwards to the sides of the actual canal. Reducing the distance between the shafts at the deeper places, which would have been against all the rules normally, was done in order to be able to raise the rock to the surface more quickly, since the number of the shafts had to be balanced against the loss of time, which increased for the extraction of the rock with the depth of each shaft, since it could be brought out by no other way than through the shaft itself.

The shafts in the small tunnel were infilled after the canal had been completely excavated and arched. In the large tunnel, however, some have been preserved open to give it the necessary air circulation.

When I saw this canal, the brick arching of the smaller tunnel had been completed, but not that of the larger tunnel, which, if not throughout, is nevertheless arched with brickwork in places where the rock is not firm enough. This work, which can only be done during the time the canal is drained, was being carried out in the months of July, August and September, which is when this takes place on most of the canals in France. The centring necessary for the lining of the arch was only 6 to 8 feet long, and was so arranged that it could easily be taken apart and put back together again. It does not seem, therefore, that the mobile centring, which was used for an underground stretch of 250 metres on the Moustiers canal,[17] and of which Figs. 104-106, Plate VIII, give an illustration, would have met with great approval. I have nothing further to add to the explanation of the figures given here, except that **r r** are the rollers on which the centring can be moved under the vault.

The insertion of the keystone was somewhat laborious because there was hardly enough space between the arch, which is about as thick as 1½ bricks, and the hewn stone for a man to move around, even if he was kneeling. After setting the keystones, this space was filled with bricks. Incidentally, in some places it would not be possible to place the keystone in such a way that a man is above the arch; it would be necessary to limit the length of the centring to only 3 feet, so that a man standing in front of it can still reach over with his arm. The arch is semi-circular, and Fig. 107, Plate VIII, shows the average section of the tunnel according to information I received in St. Quentin. At the same time, it can be seen that the canal has two towpaths, each 1m 40 centimetres wide, i.e. a little over 4 feet wide. Its total width is a little over 24 feet and the canal bed still has a drainage channel (**ab**). At the beginning, there was no agreement on the layout of the towpaths. In order to reduce the resistance that the water makes to a canal barge when it is navigating, some engineers suggested that the towpaths should be made of overhanging stone slabs set into the rock, so that the water could pass underneath. Gayant (Engineer en chef and director of the works on this canal) heard that this was too risky




[17] Possibly the Thoraise tunnel on the Canal de Monsieur (Canal de Rhône au Rhin).

because of the low hardness of the rock, and therefore proposed to let the towpath sit on horizontal iron rods, which would be embedded in the rock at one end and supported by vertical iron rods at the other end. These horizontal bars, however, were to be laid out on their edge and then a flat brick arch was to be built from one bar to the other. Instead of these arches, Mr. Gayant was not in favour of using a plank covering, because this would not be durable enough. There was also disagreement for a long time as to whether two 3 foot wide towpaths should be built or only one 4 foot wide. As we can see from the profile given, in the end it was decided to have two towpaths and to give each one a little over 4 feet width. However, neither the one nor the other proposal was accepted with regard to its construction, but the rock along the canal was left about 1 metre wide and 2 metres 20 high, so that the width of the canal was only 6 metres. These stone benches, however, were cut in certain places from their base towards their surface, as we see in Fig. 107, but in such a way that the remaining pillars (**q p** Fig 85 Plate VI) still remain connected to each other towards the top and the pieces **o q** connecting them are curved underneath. Stone slabs **s r**, 1 metre 40 centimetres in width, have now been laid on top of them and these now form the towpath. Since in this way there is not as much room for the escaping water as in the previous proposals, one has probably tried to remedy this deficiency by deepening **a b** Fig. 107. In the large tunnel, however, these towpaths had not yet been completed.

In order to reduce the strong draught that often occurs in long tunnels and the resulting increase in cold during the winter, a device was installed by means of which it can be closed at both ends if necessary. This device consists of a sliding gate at each exit, which is hidden in a groove cut into the rock, and which it rests on wheels, and can be pushed out. Once it has been pushed in front of the entrance, it can be lowered to the canal bed by means of screws.

Since this 2½ lieues[18] long tunnel is not wide enough for two boats to pass each other, the open canal at the entrances has been kept clear for a considerable length of 40 metres, so that the boats can gather in front of the entrances until the time appointed for passage.

As soon as you have passed through the large tunnel from St. Quentin, you first encounter two locks which are unusual in the design of their gates. They are an attempt to make the frame of the gates out of iron bars. When my attention was drawn to these gates in St. Quentin, I was eager to get to know their construction on the spot, but unfortunately I was unable to do so because they were covered with boards on both sides. Whether this attempt yields a result that invites imitation remains unknown to me.

The St. Quentin Canal, which connects the Somme with the Scheldt, and thus also the Rhône with the Scheldt, and Antwerp with Marseilles, having Paris as its centre, cost 11 million francs. As proof of its usefulness, 756 boats carrying coal and 231 boats carrying grain passed along the canal in the first eight months of 1812.

This canal opens out into a basin at Cambrai, which has the shape of two elongated hexagons, between which there is a swing bridge. This swing bridge is set in motion by means of a vertical gear attached to its landward end, which engages in a toothed circular rack fixed below. It was in poor condition, as was the lock into the lower basin, the construction of which was unknown to me at the time, as I was not yet familiar with the hydro-technical travel notes by Construction Director Schulz, who gives a fairly detailed description of this type of lock. Since I still have a few things to add to this description, and since this device for narrow-width navigation locks seems to me to be practical and much more efficient than other types, I will share it here.

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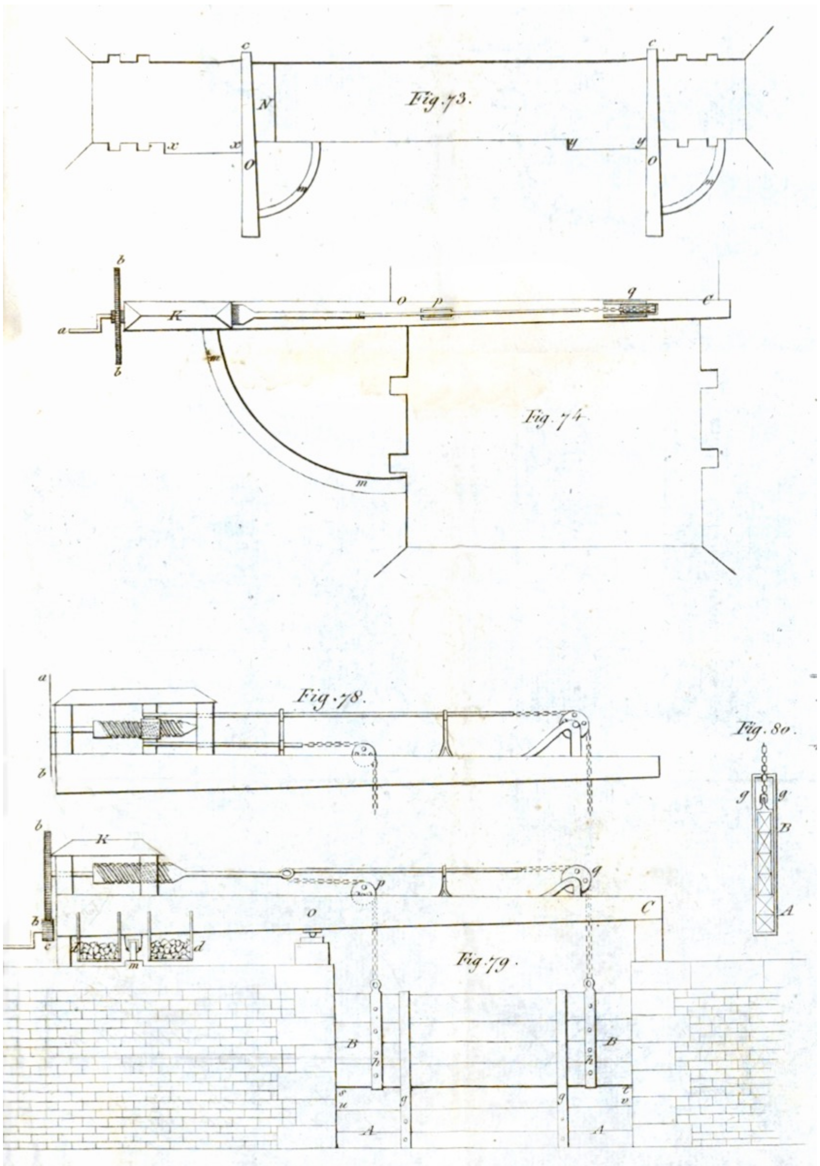
[18] The tunnel is 5.67 km in length; the 2½ lieues are probably 17th century dimensions, which are shorter than post-Revolutionary ones.

The walls of the lock chamber are made of bricks and the corners are fitted with ashlar. The width of the lock is about 16 feet and the forebay is vertical. The chamber is not closed by mitre gates, but by a device that is perhaps only found on the locks between Cambrai and Valenciennes. Six to ten transverse beams **A B** (Fig. 78-80, Plate VI), which lie between two iron frames (**gg**), close the entrance and exit of the lock. Four of these beams **B B** are connected by iron bands (**hh**) to form a whole, so that they can be moved up and down within the iron frames. The other crossbeams are attached to the iron frames themselves. The iron frames (**gg**) are one beam higher than the bars between them and the iron bands (**hh**) of the upper four bars have rings into which chains are hooked by means of which they are pulled upwards when the crank **a b** (Figs. 78 and 79) is turned. From these figures we see how these chains are connected to the wheels **ab** and **bc** and can be pulled over the rollers **p** and **cg**. If a boat is to move from the upper canal to the lower one, the four upper crossbeams at the entrance to the lock are first pulled up so far that they touch the frames at the top. Through the now created opening **stuv** the water enters the lock chamber up to the necessary height, and as soon as this has happened, the iron frames with the lower crossbeams are also lifted up from the lock floor by turning the crank further and the whole beam gate, which is suspended from the boom **OC**, is turned around with it, so that it fits into the gate recess **xx** (**f**. Fig. 73 Plate VI) built into the side wall of the chamber. The turning beam **OC** rotates around the pivot at **O** and also rests on a metal roller which moves around **mm** when turning. As soon as the boat is in the lock chamber, the same procedure is followed with the lower ‘beam gate’. It is obvious that it is still necessary to keep the turning beam **OC** in balance with the attached weights. For this reason, not only was a thicker end given to the beam on the land side, but also, because the wheels and screws on the beam are not sufficient, the beam was weighted down as much as necessary with attached stones (**dd**).




The drawing given here differs in some individual parts from the one given by Construction Director Schulz, but it is faithful to a draft I made on the spot. Figs. 78 and 79 show that two different methods have been used to wind up the gate, one with a fixed nut and the other with a movable nut. The screws are not only protected from the weather by a roof (**K**), but also by a casing surrounding them, which is not mentioned here. In Schulz's description and drawing, the bolts are not noted and thus it is not clear in which way the beams were raised. The stone weighting is also attached differently; perhaps it is found in this way on the locks between Cambrai and

Valenciennes, which I did not see.[19]

I must also note that the gates, when they close the chamber, do not lie directly against the stone recesses in the side walls, but against wooden posts fitted in the corners. In the side walls themselves, channels were built along their entire length, which are opened when the lock is to be drained in order to be able to make the necessary repairs.

The entry and exit of the boats took place as quickly as in any other lock facility. If there were two men, they did not even use the crank, but grasped the spokes of the large cast-iron wheel to lift the drop gate, and as soon as this was done, one leaned with his back against the shore end of the main beam to turn the gate into the side recess. Although the individual parts of this device were not in the best condition, the filling and emptying of the lock chamber, as well as the opening and closing of it, took place with great ease. While I was watching this operation, I could at least not convince myself that this device was a parody on the construction of locks, as Mr. v. Wiebeking thinks in his ***Wasserbaukunst II,*** p. 652, where he expresses himself as follows: '*In earlier times, the two gates were equipped with pull-up paddles, which, however, could only be used for a small fall of about 4 feet. At the present time, their use in chamber locks, after we had made the mitre gates easy to open and close, would betray a great ignorance, and locks with such gates would be a true parody on lock construction in that country.*'

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[19] In Kraft's work: " Plans, coupes et élévations de diverses productions de l'art de la charpente etc.. Paris, 1805. 4me partie, No. 15. there is an illustration of such a lock near Valenciennes; but this one has no stone weighting at all. This drawing also differs in some details both from the drawing here and from the drawing provided by Schulz.