

RIJKSWATERSTAAT COMMUNICATIONS



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MODERN CONSTRUCTION OF WING - GATES

by

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Chief Engineer Rijkswaterstaat - Board of Zuyder Zee Works



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1964

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BOORLAAN 2 — THE HAGUE — NETHERLANDS

The views in this report are the author's own

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Modern construction of wing-gates

Para. 1. Introduction

It was round about the year 1800 when people began to endeavour to make the management of our polders more efficient and there was a demand for discharge-sluices that would satisfy more exacting requirements than did the existing types. One of the main requirements was that the sluices should also be capable of being opened or closed quickly and easily when the water-levels on either side of the door, slide, or flap, differed. That was when wing-gates, which satisfy this requirement, were invented in the Netherlands. It is not known who invented this ingenious device. Both Blanken and Goudriaan (water-control engineers) claimed the invention, but according to Dr. A. Tutein Nolthenius it was the "Town Architect and Factory Master" of Ouderkerk aan de IJssel, Jan ten Holt, a native of Kampen, who in 1777 first devised a wing-sluice, the Staphorst-sluice near Zwartsluis. But his plans were not put into effect because people were loth to try the "hydraulic novelty", and probably also because Jan ten Holt was not credited with sufficient authority.

It was Inspector Blanken who actually carried off the honours, because he managed to obtain a patent on Jan ten Holt's invention by using the latter's wing-gates in the Benschop-sluice near IJsselstein. In fact the patent was granted by Louis Napoleon, who then occupied the Netherlands and with whom Blanken had found such favour that the former was actually present when the sluice was tried out.

This sluice demonstrated "the usefulness of hydraulic action"; it made it possible to open and close sluices when the water-levels differed considerably. During the first decades of the 19th century ten units (sluices, flood gates and locks) were fitted with wooden wing-gates, and a few more were constructed in the second half of that century and at the beginning of the 20th century, the last having been built in the entrance to Zevenbergen harbour in 1908 (exactly 100 years after the first wing-sluice).

The effective width of the wing-sluices was generally small, ranging from a mere 10 feet to about 27 feet owing to the limitations of wooden door structures. There is one exception: the sluice built near Andel, at the junction of the rivers the Maas and the Waal in 1898, which is 43 feet wide and has steel sector gates.

The reason why wing-sluices, with all their great advantages, were not more generally used in the days when sluice gates were seldom if ever made of steel, is doubtless that the scope of wood as a construction material is limited. At first there was no tropical wood on the Dutch market (tropical wood is more resistant and is available in larger dimensions). Besides, it was difficult to make wing-gates, especially large ones, of wood, the problem being how to connect the wing-leaf and the gate-leaf to the heel post. The fact that wing-gates were little used later is due to the development of electro-mechanical operation for sluice gates of other types, offering more or less the same advantages as wing-gates operated by water pressure.

Electro-mechanical operation made it possible to move large sluice gates when the water-levels were different, so that larger locks, safety gates, sluices and adjustable weirs were built in many places.

Useful as these large motor-driven constructions are, they have one disadvantage, viz. that when the power supply (usually electricity) fails, or when the installation is out of order, they have to be worked manually, a time-consuming operation. However, there is little likelihood of technical trouble occurring nowadays because modern electrical apparatus is so efficient and the system of linked mains so reliable. Although slow, manual operation of the sluice is not always directly harmful, there are some by no means hypothetical contin-

gencies in which material or economic damage might certainly occur – for example, if a ship were to collide with the gates of a lock equipped with mitreing doors opening on to a low-lying polder, breaking a collar-strap and causing the gate to fall down. The second pair of mitreing doors, through which a strong current would then flow, would be incapable of controlling or stopping the water and thus to close; if wing-gates had been used instead the situation would have been saved. Wing-gates are also far better than mitreing gates for locks that can be left open in normal circumstances but which must be capable of being closed if the water-level rises on both sides of the sluice, because of strong winds for example.

Therefore, since there are cases in which wing-gates are most effective, it is very regrettable that they have gone out of fashion and that their design has consequently not moved with the times. It would be well worth considering the reintroduction of wing-gates of modern design in many places.

In fact, they have already started coming into their own again, having been adopted here and there for the Zuyder Zee Works; various sluices have been fitted with wing-gates and they are completely satisfactory.

Therefore the aim of this publication is to bring wing-gates to the attention of engineers again after a long period of disuse.

Para. 2. The principle of wing-gates

Although it may be assumed that the principle on which wing-gates work is well known, it is briefly outlined below for the sake of completeness.

Figure 1 shows a diagram of wing-gates in the closed position; the position of the wing-leaf when the door is open is indicated in the bottom gate-recess by a dotted line. Each gate consists of a gate-leaf and a wing-leaf, which are linked to provide the necessary stiffness and which have a common heel post. When closed, the gate-leaves of a pair of gates form a set of mitreing gates (slope 1 : 3), the highest water-level being either to the right or to the left of the gate (see figure 1). The gates are not free to rotate and there is no play in the pivots as there is with mitreing gates, owing to the desirability of keeping the leakage crack between the gate and the lock building as small as possible (see para. 4). This means that when static the heel post does not transfer the water pressure to the gate recess either distributed over the whole height or in local points of support; the forces are transferred to the lock building only via the bottom and top centres of rotation. The heel post consequently has to carry a far heavier load than it does in a lock with mitreing gates. The result is that in a certain sense the heel post determines whether, given the width of the lock and the difference in water-level, wing-gates are practicable.

In the closed position, the wing-leaf seals off the fan box in front. As explained in para. 4, the leakage crack must be as narrow as possible at all positions of the gate; consequently, the mitre post of the wing-leaf must move along a curved wall with the minimum amount of play. For the same reason, the leaf must also move along the floor with the minimum amount of play.

When the door is in the closed position, the wing-leaf needs no "escape bar" against a mitre sill or vertical girder, provided the inflow through the culverts keeps pace with the leakage through these cracks (see para. 4). From the construction aspect it is undesirable to have such "escape bars", because when they are used the interplay of forces in the whole construction is uncertain.

If the gate is to work well, the wing-leaf must be longer than the gate-leaf, but from the construction angle there are limits to this, and so the ratio of 6 : 5 is usually taken.

The gates work as follows.

The part of the fan box behind the wing-leaf is connected by culverts with the water on either side of the lock. By connecting the box with one of the two water-levels it is possible to bring about a difference in water pressure on the wing-leaf and the gate-leaf, which, owing partly to the relative lengths of the two leaves, gives a water-pressure moment that causes the gate to move or, if desired, holds it still (see further para. 4). It is possible by this procedure to open and close the gates, or to keep them open or closed, no matter on which side of the

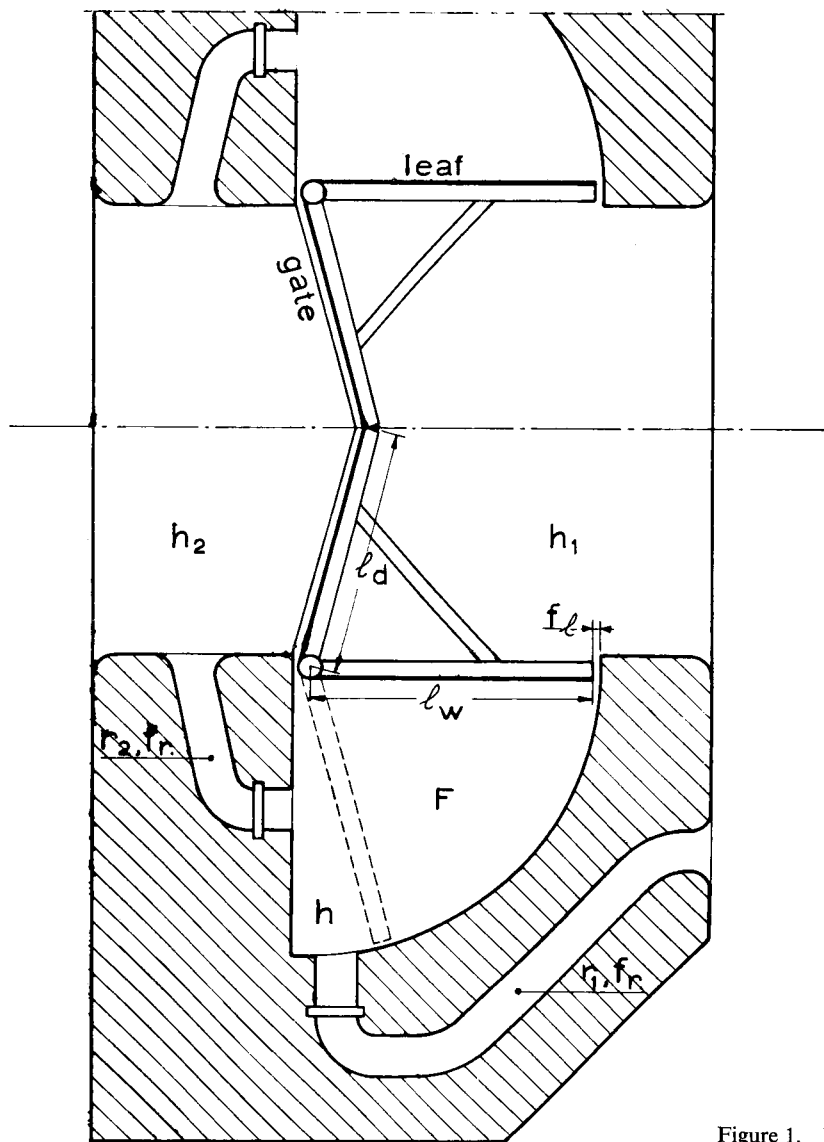


Figure 1. Diagram of wing-gates.

gate-leaf the high water lies. It is also possible to regulate the speed of movement of the gates by changing the water pressure, and to keep the gate in any desired position when there is a certain difference in water-level. (This latter fact makes it possible for a lock chamber to be filled and emptied by means of the gates, the movement of the water in the chamber being restricted as necessary, so as not to disturb the ships lying there.) When the water-levels are equal, and there is consequently no water pressure to harness, but the gates still have to be moved for some reason or other, the wing-leaf is made to describe a sort of sucking movement in the fan box; owing to the narrow cracks between the wing-leaf and the fan box, which facilitate a satisfactory operation when there is a difference in pressure, moving the gate in level water is rather difficult because the change in water-level (a rise when closing, a fall when opening) cannot be coped with quickly enough by the culverts. It is therefore useful to construct a paddle in the wing-leaf, so as to accelerate the inflow or discharge of water in the fan box when moving the wing-leaf in level water; this is particularly useful during manual operation, which is dependent upon a man's physical capacity; it is less important in the case of electrical operation, because the power can be adapted to the extent of the accumulation or sucking away of water in the fan box.

In para. 4 further consideration will be given to the way in which the various operations mentioned above can be carried out, and particularly to the dimensions of the culverts required for gates of given sizes.

Para. 3. Advantages and disadvantages of wing-gates

Further to what has been stated in para. 2 about certain special characteristics of wing-gates, a survey can now be given of their advantages and disadvantages.

Advantages:

1. retaining-wall in both directions;
2. opening and closing possible when water-levels vary;
3. filling and emptying of the lock-chamber possible by means of the gates;
4. unlimited headroom;
5. no vital (moving) parts permanently under water;
6. as a rule, a simple manual operation is sufficient to turn the gate slightly out of the recess, if the difference in the water-level in the lock does not adjust itself;
7. simplicity of operation;
8. it is possible to construct wing-gates in steel for a lock 12 to 18 m. wide;
9. can be employed in principle for any difference in water-level.

Disadvantages

1. the form of the lock head is less simple because of the curved inner side of the fan box, which has to be finished with great care;
2. they are less easily removed and reinstalled;
3. they move rather slowly, which is a disadvantage in a lock for ships, where the gates are used as mitreing gates (in level water). When the gate is operated by hand it takes rather a long time, because accumulation or sucking away of water in the fan box has to be overcome. In that case electrically operated gates are to be recommended, the capacity of which can be adapted, as required, to the water resistance that has to be overcome. The water resistance is highest at the beginning of the closing operation and at the end of the

opening operation, because the surface of the fan box is then at its smallest and the sucking away or accumulation of water is consequently at its greatest. If, in the open position, the angle of the fan box left behind the wing-leaf $= 0$ (wing-leaf against the wall of the box), even the accumulation of water would become ∞ great; it is therefore recommended that the box be here given considerably more scope than corresponds with the turning-angle of the gate.

For the rest, this great accumulation of water near to the final position need not cause much anxiety, for at the moment when the gate encounters great resistance the number of revolutions of the propelling motor will diminish, reducing the angle-speed of the gate, and the accumulation will be lessened.

Para. 4. Calculation of the culverts

The culverts must satisfy the following requirements:

1. they must be able to retain in the fan box the water-levels required under all working conditions for doors of given dimensions;
2. they must be able to effect rapid changes in the water-level;
3. they must not be unnecessarily wide.

re 1: Whether a wing-gate can be kept in any desired position when the water-levels fluctuate, or whether it can be moved in both directions, depends upon the water-level in the fan box; for that level must be such that the moment resulting from the difference in pressure on the wing-leaf gives the required restraining or operating moment.

The following notations apply in the various possible cases (see figure 1):

length of gate-leaf	l_d ;
length of wing-leaf	l_w ;
ratio $\frac{l_w}{l_d}$	λ ;
water-levels	h_1 and h_2 ;
ratio $\frac{h_2}{h_1}$	ϵ ;
water-level in box	h ;
culverts.	r_1 and r_2 .

Case I – where the gate is kept closed

The fan box is connected with the water outside by r_1 if $h_1 > h_2$ and by r_2 if $h_1 < h_2$. Level h must then be such that (in both cases)

$$l_d^2 (h_1^2 - h_2^2) \geq l_w^2 (h_1^2 - h^2)$$

or else

$$h \geq \frac{h_1}{\lambda} (\epsilon^2 + \lambda^2 - 1)^{1/2} \dots \dots \dots (1).$$

This is always true (even when $\lambda = 1$) if $h_1 \geq h_2$, because, by inflow of water through r_1 and discharge of water through the leakage crack near the heel post, $h_2 < h < h_1$ always applies. If $h_1 < h_2$, formula (1) can only be satisfied if $\lambda^2 - 1 > 0$ or $\lambda > 1$, showing the necessity that $l_w > l_d$; in the case of $\lambda = 1$ there is equilibrium, so that if there is even the slightest additional factor (waves or wind) the gate will begin to open.

Case II – where the gate is opened

It follows, therefore, that the gate can be opened if

$$h < \frac{h_1}{\lambda} (\varepsilon^2 + \lambda^2 - 1)^{1/2} \dots \dots \dots (2).$$

This situation can be brought about by connecting the fan box with the outside water through r_2 if $h_1 > h_2$ and through r_1 if $h_1 < h_2$.

For $\lambda = 1$, formula (2) changes into:

$$h < h_2 \dots \dots \dots (2a),$$

which shows that the gate can only be moved if:

$$\lambda > 1, \text{ or } l_w > l_d.$$

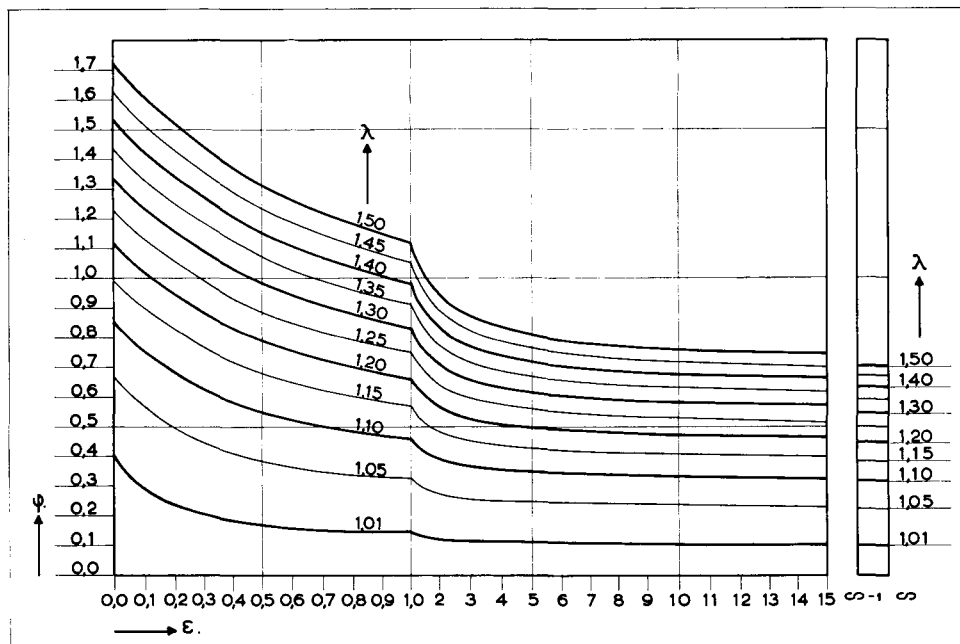
Case III – where the gate is kept open

This is the final position of Case II, so that the formula applies:

$$h = \frac{h_1}{\lambda} (\varepsilon^2 + \lambda^2 - 1)^{1/2} \dots \dots \dots (3).$$

Here, however, the values of h_1 and h_2 are different outside the lock, because the difference in water-level is taken up over the whole length of the lock (largely when the water flows in). At the site of the drop is small and h will approach the value of h_1 close to the gate. Practically speaking, therefore, the gate and the leaf are in the same level of water, so that the gate will remain open with a very slight effective pressure.

Figure 2. Relation between λ , ε and ϕ .



Case IV - where the gate is closed

When r_1 is opened if $h_1 > h_2$, and when r_2 is opened if $h_1 < h_2$, h becomes greater and the gate begins to move; when

$$h > \frac{h_1}{\lambda} (\epsilon^2 + \lambda^2 - 1)^{1/2} \quad (4).$$

Here, as in Case III, the useful difference in the water-level will be small; it may even drop to zero, and then the gate has to be helped out of the box (manual operation). Once the gate is a short distance out of the box, the somewhat narrowed lock opening brings about a difference in water-level near the gate, and the movement then continues under pressure of the water. In this case also, it is essential that $\lambda > 1$.

All the foregoing cases give "final" positions. It may also be necessary to keep a gate in an intermediate position (for example, for "jammed" sluicing or for filling or emptying the chamber), or to slow it up towards the end of its movement. When this happens, part of the total difference in level comes into action against the gate, and it will be necessary to experiment to find out how far the culvert in question must be opened in order to establish the desired h .

Whether the required water-level h can be attained depends upon the section of the culvert and the size of the leakage cracks along the wing-leaf. If we call the effective section of the culvert f_r , of the leakage cracks f_l , with $\phi = \frac{f_l}{f_r}$, and the surface of the sector-recess F , then the water-level h rises in the recess when $h_1 > h_2$ (beginning at $h = h_2$) in accordance with the following differential equation:

$$\frac{dh}{\phi \sqrt{h_1 - h} - \sqrt{h - h_1}} = \frac{f_l \sqrt{2g}}{F} dt \quad (5).$$

The solution of this equation reads (symbolically):

$$\ln f(h) = ct \quad (6).$$

From (5) it follows that h is maximum for $\frac{dh}{dt} = 0$ (inflow through culvert - discharge through leakage crack), or:

$$h = \frac{\phi^2 + \epsilon}{\phi^2 + 1} h_1 \quad (7).$$

In this case $t = \infty$, as follows from the complete solution of (6).

All this means that with a given ϕ the highest value of h can be obtained when $t = \infty$ and, vice versa, that with the required h for $t = \infty$ the smallest section of the culvert is obtained.

Yet for all practical purposes this is not acceptable, because the desired manipulation of the gate could only take place after $t = \infty$. This means that a larger ϕ must be taken, large enough, in fact, to ensure that h is reached after the feasible time t_p .

So in (6), after calculating h according to (1) to (4) inclusive, t_p must be filled in, after which ϕ_p is obtained.

Owing to the complicated nature of (6), this can best be tackled in the following way: ϕ min. are taken as a basis according to:

$$\frac{\phi^2 + \epsilon}{\phi^2 + 1} h_1 (7) = \frac{h_1}{\lambda} (\epsilon^2 + \lambda^2 - 1)^{1/2} (4)$$

which, when worked out, gives:

$$(1 + \epsilon) \phi^4 - 2(\lambda^2 - \epsilon - 1)\phi^2 - (1 + \epsilon)(\lambda^2 - 1) = 0 \quad (8).$$

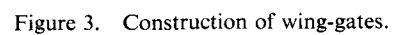


Figure 3. Construction of wing-gates.

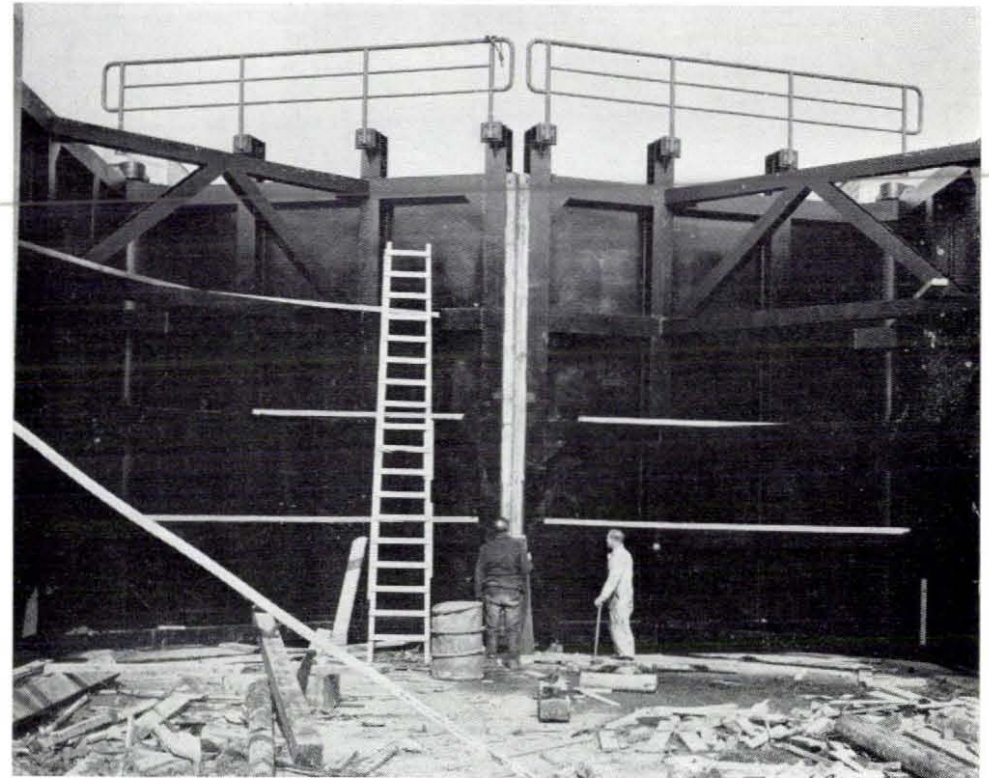


Figure 4. Putting a wing-gate into position in the Roggebot lock.

This equation, which is easy to solve, (quadratic equation in ϕ^2), shows that ϕ at given water-levels depends only on $\lambda = \frac{l_w}{l_d}$; so this formula gives, as a guide, the value that ϕ must have in each case (ϕ min.).

Figure 2 shows a graph of equation (8). With a given ϵ and λ , ϕ min. can be obtained. This graph also shows that when λ is greater than 1.20 to 1.30 the effect on the value of ϕ is no longer great, so that $\lambda = 1.20$ is indeed a reasonable measurement to take for practical purposes.

In the worked-out form of (6), with given ϵ , values are now filled in successively for $\phi = 1, 1 \phi$ min. etc., and for each of these values t is calculated. From a graph plotted from these, or by interpolation, ϕ is then, with the desired t_p , read or determined.

Since, in (6), the surface F of the fan box occurs, so that t is dependent on F ($F \propto t^*$), when the gate is open (F small) t will be considerably smaller then when the gate is closed (F large), so that for the open position ϕ is determinant.

*) $\propto$ means: "proportionate to"

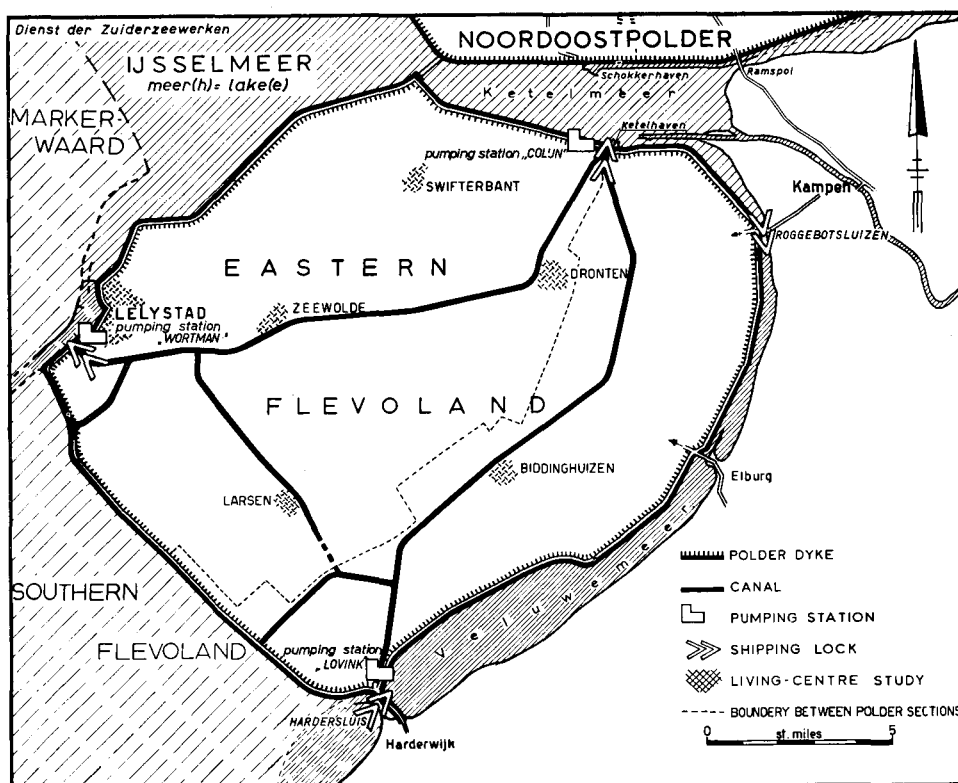


Figure 5. Eastern Flevoland with its various locks.

Likewise, f_1 is not a constant value; it declines as the water-level drops. But its greatest value must be taken into account when determining ϕ .

re 2: From the above it follows that it will be possible to make changes in the water-level h , the larger ϕ one takes.

re 3: Unnecessarily large culverts cannot be operated so quickly, at least when the valves are worked by hand. Since one of the reasons why wing-gates are preferable to other types of gates is that they can be operated by hand, it is important that culverts that are too large should not be chosen, for then the manual operation of the valves takes too long and object of large culverts is defeated. In this matter, experience will have to decide.

Para. 5. Construction

When it comes to constructing wing-gates the heel post is the part that gives most difficulty. This serves as a beam on which to rest the transoms of the two leaves, which meet

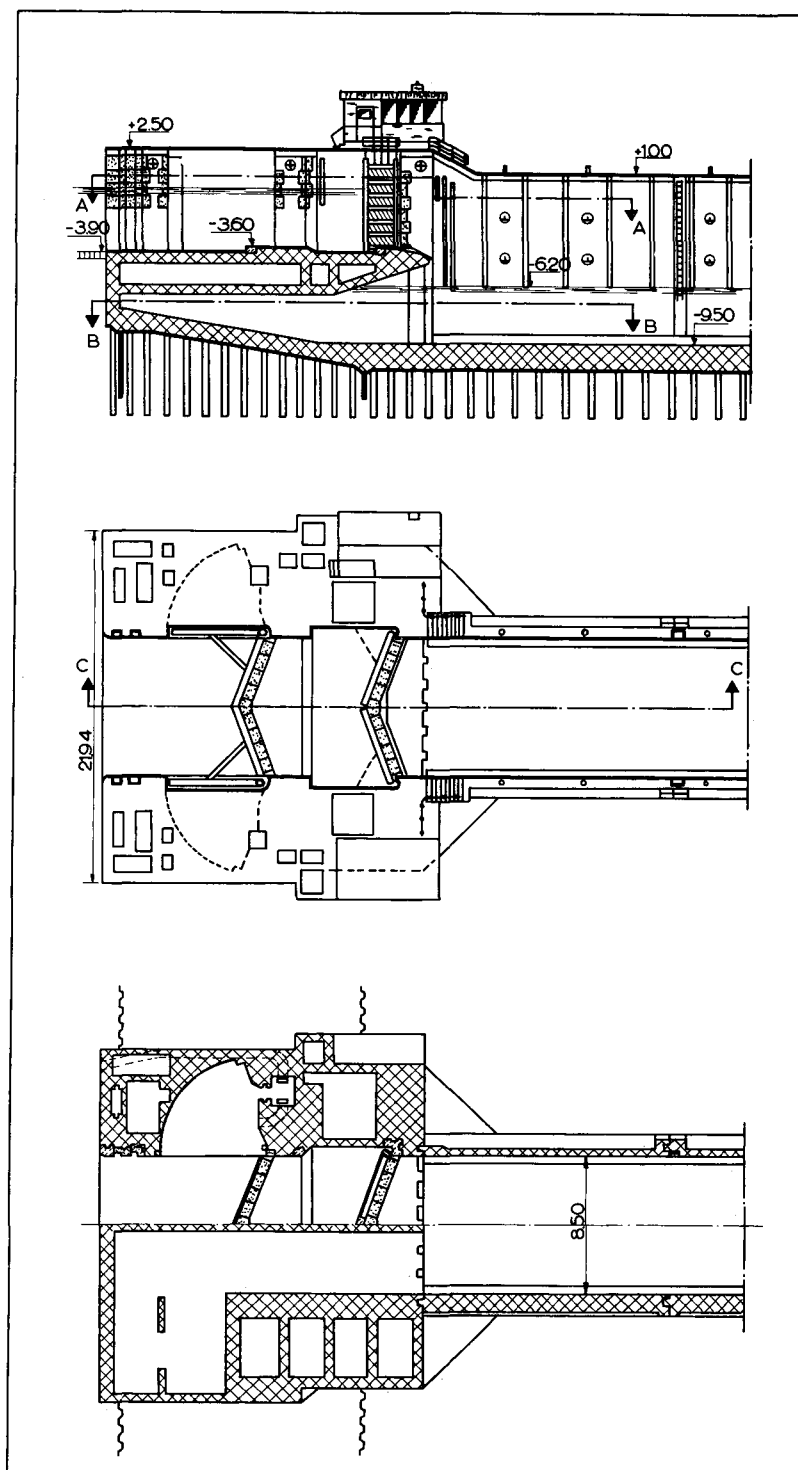


Figure 6.
Lock head of
the access lock
at Lelystad.

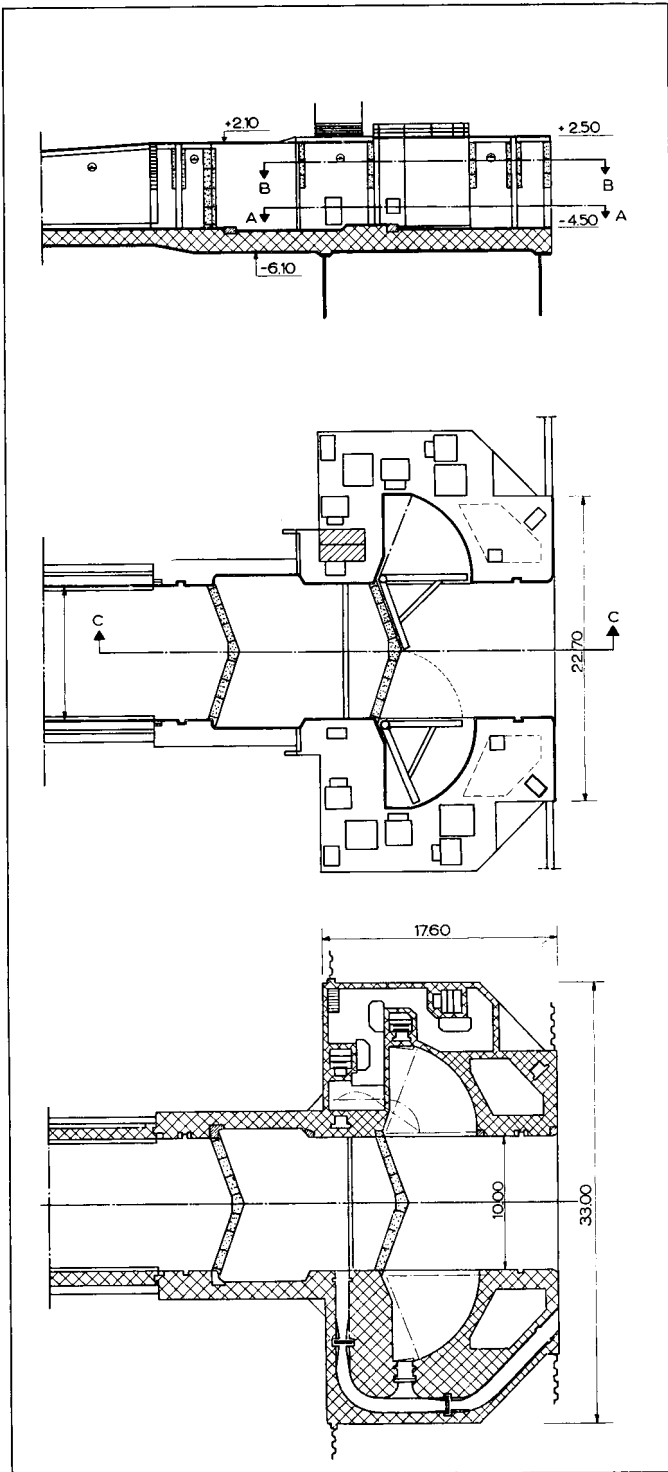


Figure 7. Lock head of the Roggebot lock.

at an acute angle at the post; the heel post itself rests on the two centres of rotation. In the case of a long wooden gate, the size of the transoms is such that the two sets of transoms meeting in a post of normal dimensions weaken the construction too much. Since there are limits to the weight of wood that can be used for the post, the transoms must not be too heavy. Consequently, the size of the gates must be kept within strict limits.

If steel is used, this difficulty only arises when the dimensions are much larger, especially when the construction is welded and there is no difficulty whatever in connecting the transoms to the post.

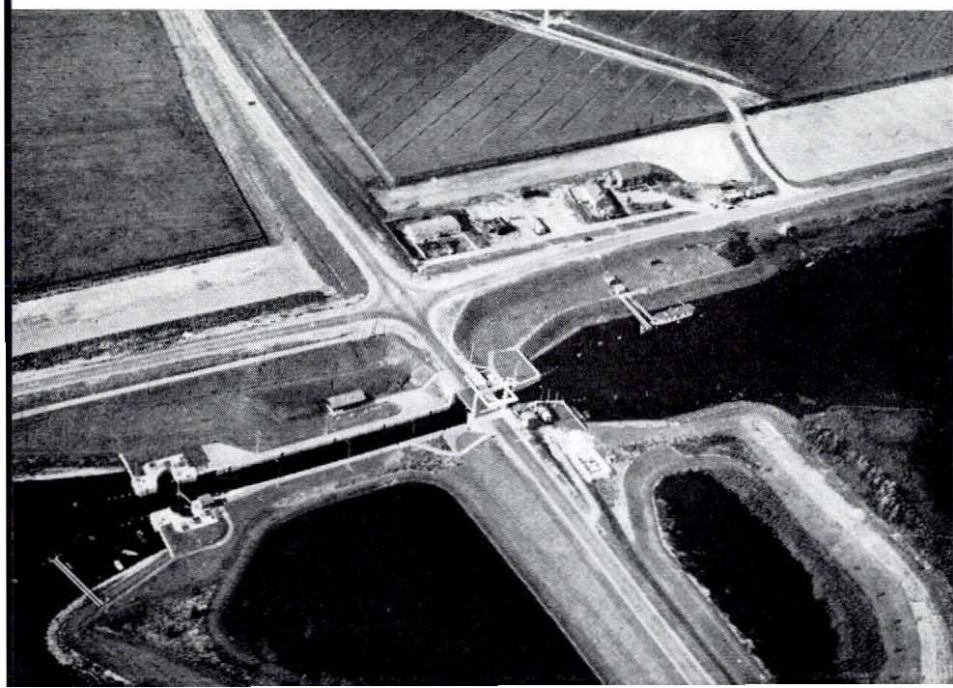
Figure 3 shows the construction drawing of a welded wing-gate. Both the gate-leaf and the fan-leaf consist of a framework of Din beams, covered with plating. This kind of construction, which needs little welding, is economical to build. The leaves are linked by a diagonal strut, also of Din beams. The heel post consists of a seamless tube, with thick walls that will not be weakened by the effect of the heat when the seams of the transoms are welded. The gate-leaf is closed off at the bottom by a wooden strip, and the front supporting beam is also of wood. The mitre post of the fan-leaf is fitted with a wooden staunching strip, made to fit as closely as possible against the curved wall of the box. This leaf is edged at the bottom with a steel staunching strip, fixed to the lower transom. The strip is placed at such a height that it can just slide over the highest point of the floor of the fan box (for a concrete floor always shows slight irregularities, however carefully it is finished).

Along the post, rubber is used for staunching purposes; when the gate is open, a strip of rubber between a strap placed at right angles presses against the side of a cast-iron staunching strip. The strip is given a concave form, causing a fairly long, narrow leakage crack along the post, which offers great resistance to the water flowing through, so that the leakage can only be slight.

As the above description and the drawing testify, the whole gate is of very simple construction and has no frail parts likely to wear out quickly and need replacement.

Figure 4 shows a photo of a wing-gate (width of lock 10 metres), being put into place.

Figure 8. Aerial photo of the Roggebot lock.



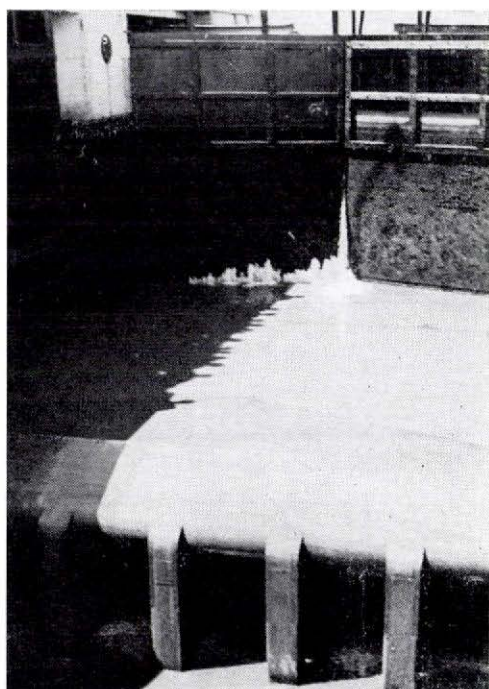


Figure 9. Access lock at Lelystad: the wing-gates have just begun to open.

Para. 6. Uses

In the Zuyder Zee Works, wing-gates have been used for two kinds of locks, namely the locks giving access to the polder Eastern Flevoland, and the locks in the dyke enclosing Lake Veluwe (see figure 5 for the position).

In the entry locks, wing-gates have been used as emergency gates; these locks have to be very reliable because a polder of about 50,000 hectares lies below them, the level of which is some 6 m. below the water-level of the adjacent Lake IJssel.

Figure 6 shows the head and the wing-gate of these locks. For normal use wooden mitreing gates are employed, one set in each head. If the water in the chamber were high (upper gates open) and a large ship entered the lock while the movable bridge near the lower head was open, and by a faulty manoeuvre collided with the gates of the lower head in such a way as to break the collar strap, it would not be possible, without damage, to close the mitreing gates against the strong current that would result from the difference of 3.2 m. in the water-levels. If the current continued to flow for any length of time, there would be real danger of the bed downstream from the lock being hollowed out, and even of the lock itself subsiding, not to mention the damage that would be caused by the gradual inundation of the polder. To provide against such an eventuality, wing-gates have been placed in the upper head as an emergency measure. Damage to the lower gates from the polder side would not normally be serious, because the destructive impact goes counter to the waterpressure and is thus absorbed by the mass of water behind the gates.

Another possibility is that the gates of the upper head may be struck from outside while the water in the chamber is low and the lower gates are open. It is even possible for a gate to be so badly damaged that the ship is drawn into the lock by the current. In such a case the wing-gates can simply be closed. If the damage to the gates is less serious and the ship gets jammed somehow in the lock head, there is a strong likelihood that the ship will obstruct the closing of the wing-gates. But they can be closed as far as the ship's position allows; the opening will then be blocked, partly by the wing-gates, partly by the ship, and perhaps partly by the mitreing gates themselves, so that with a certain amount of care the gates of the lower head can be closed, though the currents will cause them to close far from gently.

Figure 10. Idem; the wing-gates half open.

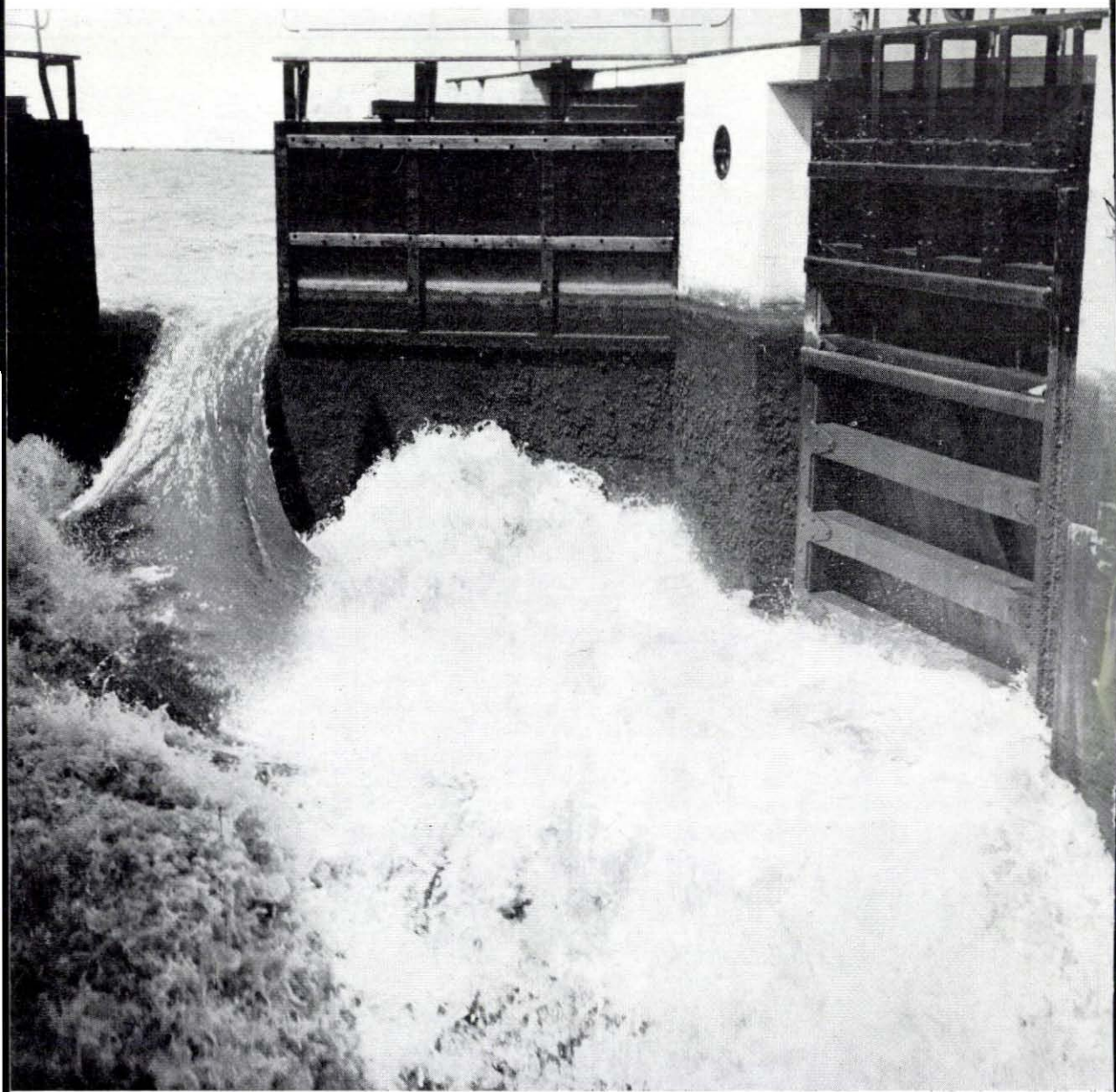




Figure 11. Idem: the wing-gates almost completely open.

It should be mentioned here that the corresponding locks at the North East Polder are not provided with wing-gates but have an emergency guard consisting of pipes which are lowered into grooves on the upper head after being brought above the opening by means of a rolling bridge. This arrangement has not proved very satisfactory in practice; it takes a long time to get the pipes into place, and the whole manoeuvre is overmuch dependent upon the proper functioning of the rolling bridge, the cables, etc.

The culverts are sealed off by hand-operated sliding stop-valves, the operating wheel being situated on a column in the head of the lock.

The locks of Lake Veluwe (Hardersluis and Roggebotsluis, see figure 5), are fitted with wing-gates. In winter, when the waters of Lake Veluwe and Lake IJssel are equally high, the locks are left open, but in the event of a rise or drop in water-level due to high winds, it must be possible to close them if the resultant current is so rapid that it proves troublesome to ships passing through the lock, and of course it must also be possible to open them again when the difference in water-levels is no longer of consequence.

Further, these two locks serve as discharging sluices. In the summer months Lake Veluwe rises to a higher level than Lake IJssel. If too much water flows into Lake Veluwe during this period, the excess has to be discharged; the difference is then 35 to 45 cm. When enough has been drained off and the most suitable water-level arrived at, the lock must be capable of being closed when the difference in levels is such or less.

For these two purposes the locks are fitted with one set of wing-gates in the inner head; these wing-gates, which are electrically operated (see figures 6 and 7), are to allow for ships to pass through, for which purpose it must be possible to close them at level water. The culverts are fitted with electrically driven slides, for these fan-culverts are also used for filling and emptying the chamber, which must of course be done with speed. For this purpose it must be possible to close the fan box while the two slides in the culverts are open during the levelling operation, for the wing-gates would be opened if there were a connection with the high water.

Naturally, the electric motor need not be used for opening and closing the lock when the water-levels are unequal; this can be done simply by means of the slides in the culverts. Figure 8 shows an aerial photo of this lock.

Para. 7. Experience acquired

In one of the access locks referred to earlier a test was carried out in circumstances as similar as possible to those in which the wing-gates would have to serve. For this purpose the water in the chamber was brought down to a low level, the culverts in the lower head were opened, but the lower gates were closed and the upper gates, of course, opened. Outside the wing-gates the difference in the water-level, from the upper-level down to the sill, was 3.20 m. The appropriate culverts were then opened and the gates began to open slowly and gently, against the water-pressure. During the opening, which only took a few minutes, the lower water did not remain below the sill right until the end, because the culverts of the lower head were unable to drain off the inflow of water rapidly enough. Therefore, the closing took place afterwards, when the difference in level was slighter; but the trial was repeated with the gates being opened until the level in the chamber approached the sill, at which juncture (with the whole difference in level) the gates were again closed. The closing operation went off smoothly and there was only a slight impact when the gates met. During the interval between opening and shutting, the gates were stationary and could be kept so by means of the valves. It would be possible to close the gates without any impact at all if the slides could be adjusted a little faster, for the manual operation of the valve takes some time. For quicker adjustment either smaller valves would be needed, which again would not be very satisfactory, or greater motive force for opening and closing the slides more rapidly. However, the impact was within reasonable limits, and could have been several times harder without causing the slightest damage to the gates. However, the more quickly the valves can be opened and closed, the more accurately the movement of the gates can be regulated. Some photos (figures 9, 10 and 11) show the tests being carried out.

No special trials were made with the locks of Lake Veluwe, because the normal use provides ample opportunities for studying their performance under various conditions. Here, also, the results were satisfactory; it was again demonstrated that by a quick manipulation of the valves all movements can be regulated with complete accuracy. Rapid movement of the valves was possible, thanks to the electrical operation of the slides, which for another reason was considered desirable. This lock is hard to work with the reserve manual gear, because the dimensions of the whole wing-gate installation have been worked out with a view to electrical operation, the lock having to function as a single lock. This difficulty is accepted because here, in contrast with the access locks described earlier, whose gates serve as *emergency gates*, nothing of vital importance would be imperilled if the lock should be operated slowly when electric power failed.

As the Zuyder Zee locks with their wing-gates function very satisfactorily and in every way serve their purpose, there is good reason to draw attention once again to this ingenious device.

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