with the upper part of the anchoring-rod is effected by means of a bolt 16 inches long passing through the eye formed in one part of the tie and the fork with eyes on the other part.

The anchoring-rod also goes through the wooden hurter or sill, and by means of a countersunk nut holds it fast in a rabbet in the masonry.

The hurter or sill intended to act as a support for the feet of the needles, and to hold the journal-boxes of the trestles, is made of oak; it squares 20 inches by 16; it is held in the rabbet in the cut stone by oak wedges, by the anchoring-bolts just named, and by stirrups imbedded in the stone, to which are attached horizontal bolts which pass through the sill.

At the end of the navigable pass is a rectangular mass of masonry 13½ feet above the sill. This abutment is 16½ feet wide and 25½ feet long in the direction of the current; it rests upon a foundation like that of the navigable pass.

APPARATUS FOR CLOSING THE NAVIGABLE PASS.

Trestles.—The closing of the navigable pass is done by means of trestles, movable around a lower axle parallel to the current and spaced 3 feet 8 inches from the face of the abutment, and at 4 feet 11 inches from the face of the pier.

These trestles secure a pool 10 feet 2 inches vertical above the sill; they are 11 feet 6 inches high from the floor to the under side of the collar of the movable bar; their width is 8 feet 4 inches at the base, and 4 feet 9 inches at the top; the quadrangular frame thus formed is made of wrought-iron bars; it is made rigid by a double brace of the same kind of iron, held in the frame by horizontal binding-pieces placed at mid-height of the trestle, by a piece of sheet-iron bent and bolted around the foot of the brace and the lower axle, and by two recessed and swelled connections, firmly joined by means of a quoin placed between the cap of the trestle and the head of the brace and fastened by a bolt.

The trestle-frame proper is surmounted on the up-stream side by a hollow tube, and on the down-stream side by an upright, both of which are 20 inches high and support on their upper ends the axle of the floor of the foot-bridge. When the trestles are raised this floor is thus placed at a height of 13 feet 2 inches above the water-line on the upper side of the dam.

Trestle journal-boxes.—The trestles can turn around their lower axles, which lie in the direction of the current, and are terminated by two journals, which engage in cast-iron journal-boxes.

The upper journal-box is imbedded in the oak sill of which mention has already been made; it is firmly held there by means of screws and iron bands.

The lower journal-box is imbedded in the stone floor; it is solidly fastened to it by three rag-bolts sealed with lead. This journal-box has the appearance of a horizontal semi-cylinder, open and flared upwards to permit the introduction of the journals, and closed on the down-stream side by a vertical back which is part of the same casting as the journal-box; it is this back which receives the horizontal thrust of the trestle and prevents the latter from yielding to the force of the water-pressure.

When the journal of the trestle is introduced into the down-stream journal-box, it is prevented from coming out by means of a wrought-iron key with broad head which slips over the journal through transversal openings left for this purpose in the cheeks of the journal-box. This

maneuver is easily performed by means of a fork which is handled from the surface of the water, and the services of a diver are not required.

Flooring of the trestles.—When the trestles are raised, they are held vertical and kept firm by means of a sheet-iron floor with which each one is provided; this floor is fastened to the cap of each trestle around which it is free to move; it is provided at its outer end with two double claws, flared in the shape of a deer's foot, which grasp the cap of the adjoining trestle; two little keys passed under the sill and through the claws prevent the floor from being displaced, and make the two trestles rigid. The floors of the trestles are 3 feet 7 inches wide, and they form, when the dam is up, a foot-bridge on which one can circulate in perfect security.

A fixed bar, similar to the cap of a trestle, is fastened in the abutment and serves to connect the floor of the first trestle with this abutment.

A floor 5 feet 3 inches long, movable around a horizontal bar fixed under the plate that covers the recess in the pier, serves to connect the last trestle to this pier.

Maneuver of the trestles.—When it is desired to lay down the trestles it is sufficient, after having taken the keys out of the claws, to gently lift the flooring and push it away from the pier; the trestle drops spontaneously and falls gently upon the foundation, its motion being retarded by the action of the water upon the sheet-iron floor. The maneuver of lowering the trestles ought to begin from the side of the pier, and to be ended on the side of the abutment.

The raising of the trestles is done by the help of a portable windlass; to facilitate this maneuver all the trestles are connected together by chains of suitable lengths, which are fastened at the ends of each piece of floor, and which may be attached by means of a ring and toggle to the middle of the cap of the preceding trestle. The operation of raising is begun at the abutment end; the portable windlass is fastened to this abutment in order to raise the first trestle; when this one is up the portable windlass is placed on it in order to raise the second trestle, whose chain has been brought to the surface along with the first trestle; the operation is continued in the same way for all the successive trestles. During this maneuver the foot of the portable windlass rests on the cap of the trestle last raised and its head is fastened to the cap of the trestle that precedes it.

Kummer escapement.—At the upper end of the frame of each trestle, and only a few inches above the normal level of the pool, there is an iron bar, movable around a vertical axis formed by a cylindrical tube welded on the trestle very nearly in the prolongation of its upper leg; the other end of this bar rests against a vertical jack-post placed inside of the tube of the preceding trestle; when in this position the movable bar is the upper support of needles whose lower support is obtained from the projection of the sill above the floor.

The jack-post, against which the free end of the movable bar is supported, is cylindrical for the whole height of the tube in which it is inclosed, except in the part that corresponds to the end of the movable bar; this part is notched and has the form of a half cylinder. The tube also is notched so as to leave a free passage for the end of the movable bar of the preceding trestle, and the same thing, and for the same reason, is true of the rear end of the collar of each movable bar.

The head of the jack-post, which projects above the tube, is square so that it may be turned by means of a wrench when it is desired to allow the movable bar to escape. The movement in azimuth of the jack-post is limited to 90° by means of a set-screw, which freely travels in a slot of the same size cut in the tube. This screw also prevents the jack-post from getting out of the tube when the trestle is down.

As has just been stated, the movable bar of each trestle is connected with the tube of this trestle by means of a collar, which permits it to turn freely around this tube; there are therefore at this point three concentric cylinders; namely, the jack-post, the tube, and the collar of the movable bar.

Practical test of the strength of the trestles.—The use of iron of rectangular cross-section for the construction of the trestles of the navigable pass was ordered after comparative tests of strength not only of trestles of the type described, but also of four other types made up of T and U irons put together in different ways. Trestles of special shapes of iron, although almost as heavy as trestles of rectangular iron, developed much less strength than the latter, especially in the direction at right angles to the plane of the trestle. A trestle of the type selected, having been fastened by its two journals in a wooden frame, supported without permanent change of form a force of 17,638 pounds applied at the base of the tube. The pressure which the trestles have to sustain at this point, when they are used in dams of the maximum lift, is only 4,409 pounds.

Needles.—The needles are of red Riga fir; they are 12.3 feet long, with a constant width of $3\frac{7}{8}$ inches and a variable depth, so as to give them a form of equal resistance; the thickness at the point of maximum pressure is $4\frac{3}{4}$ inches, and it is constant for a length of 10 inches on each side of this point; it is reduced to $3\frac{7}{8}$ inches towards the foot, and to $3\frac{1}{2}$ towards the head of the needle; the head itself is 9 inches long; it terminates in the shape of a ball or handle, which can easily be grasped by one hand. The needles are provided at their head with a wrought-iron eye riveted to two little iron plates nailed on the two opposite sides of the needle. This eye is designed to receive the maneuvering rope. One rope is passed through the eyes of all of the eleven needles in each bay between two consecutive trestles, forming what is called a set or series of needles; one end of this rope is terminated by a large knot by which it is held in the eye of the first needle, the other end is passed through the space between the two trestles, and is temporarily fastened to the top of the downstream leg of one of them.

When it is desired to remove some needles this rope is tied to a longer one which serves to hold either to the shore or to the pier the set of needles which the current has carried below the dam after the jack-post that supports the movable bar has been turned.

The putting in place of needles is done without any difficulty; the dam-tender, standing on the foot of the bridge, holds the needle by the head, and with only one hand slides it out on the edge of the floor to a proper distance and then quickly plunges it into the current which brings it against the sill and against the movable bar.

Tests of the needles.—The needles weigh about 55 pounds each; they were tested before being used, and they supported without permanent alteration or change of form stains three times greater than those which they have to withstand in dams of the maximum lift.

MODIFICATIONS AND IMPROVEMENTS MADE IN BELGIUM IN THE TRESTLES OF THE POIRÉE SYSTEM.

The most important improvement is undoubtedly the application to these trestles of the method of escapement of needles, invented about

1845 by Mr. Kummer, at that time chief engineer of the special service of the Meuse River in the province of Liège. This system of escapement, which has been applied to all the needle dams which have been built since that time on the Meuse between Visé and Namur, has always worked very satisfactorily.

It is by means of this system which has just been described, that it has become practicable to apply needle-dams to high lifts; thanks to the escapement there is no other limit to their use than the weight of each needle, which must not be too heavy for a man to carry; the putting in place of the needles in the dam is in fact rather a matter of skill easily acquired than a matter of strength. As for the opening of the dams, it will always be easy, whatever the lift or the length of the needles, since in the Kummer system it is the pressure of the water in the upper pool which makes the needles fall and carries them below the dam.

Although the new dams in actual use or in process of construction on the Meuse above the village of Rivière create pools, with depths of 11 feet 2 inches on the sills of the navigable passes, which is more than is obtained by any needle-dam in France, we are convinced that we have not reached the limit at which these dams will cease to work properly and easily, providing always that the trestles be supplied with the Kummer escapement.

Connections between the trestles.—Another advantage in the trestles of the type used in the dams above Namur consists in the method of connecting them by means of sheet-iron floors which serve as a footbridge. This method of connection, which neither complicates nor in any way retards the lowering of the trestles, removes all danger and particularly renders impossible any recurrence of accidents like those which used to be deplored, and which occurred some years ago at the Maizeret dam, and recently at the Canon Foundery dam at Liège, and in which several dam tenders were drowned because the trestles, which were not properly connected, fell down under the feet of the victims.

The perfect connection of the trestles by means of sheet-iron floors results in making the manœuver of opening the navigable pass much more rapid. In dams where this method of connection is not used the manœuver is as follows:

When a freshet is coming, the dam tender begins, successively and gradually as the rise increases, to remove half only of the set of needles, taking care to replace each time the movable bar which constitutes the only means of connecting the trestles of these dams, and to leave a closed bay by the side of each open one; without this last precaution, the trestles, which no longer support the pressure of the needles and of the upper pool, would vibrate violently under the action of the current; the jack-posts might turn of themselves, and the trestles, being no longer connected by the movable bars, might fall spontaneously and carry down with them the workmen who happen to be on the foot-bridge. A great deal of time is lost through the necessity of replacing the movable bar after each removal of needles, because the two trestles between which an opening has been made are often spread apart by the lateral pressure of the adjoining spans which are still shut; this spreading makes it difficult to introduce the end of the movable bar into the notch in the tube which is intended to receive it.

The escapement of the first half of the sets of needles of a dam-maneuvered under these conditions is always done quickly and without difficulty; the only loss of time being that resulting from the necessity of reclosing the movable bar after each escapement.

After the first half of the sets of needles has been removed, should the rise still continue, it will be necessary to commence to dismantle the dam, and the remaining sets of needles are removed as they are reached in lowering the trestles. This second part of the maneuver of lowering the dam is always more inconvenient than the first: as it is no longer practicable to alternate the openings, so as to direct the waters properly, the obliquity of the current sometimes causes sets of needles to get entangled in the trestles not yet lowered, thus embarrassing the maneuver.

The remedy for this inconvenience consists in connecting the trestles together in some other way than by movable bars, either by means of eye bars or by a special arrangement of the claws of the floor as we have done on the new dams of the Meuse above Namur. All fears of seeing the trestles fall down spontaneously having thus disappeared, all the sets of needles may be removed before commencing to lower the trestles, and as the maneuver may then be made by suitably alternating the openings so as to maintain a current normal to the direction of the dam, there need be no fear of seeing series of needles get entangled in the trestles. Where this new method of connecting trestles that have the Kummer escapement is used, in case of a very sudden rise or any other pressing danger, only a few minutes would be required to remove all the needles of a dam.

In maneuvering as above indicated it is not necessary that the trestles should be lowered as frequently as was done formerly, because the rise often stops before all the sets of needles have been removed.

Apparatus for closing the down-stream trestle journal-boxes.—Another improvement may be found in the method that we have adopted for fastening the down-stream journal-boxes of the trestles.

In the needle-dams built below Namur the down-stream journals, as has been stated, are plain semi-cylinders open at the top and flared upwards; therefore when the trestles of these dams are to be lowered the presence of a foreign body on the floor will suffice to make them jump out of their boxes, and a single trestle out of place usually causes the displacement of several others adjacent to it; these trestles that have gotten out of their journal-boxes sometimes get entangled and occasion considerable loss of material and great difficulties in raising the dam, which sometimes give rise to quite long delays. These inconveniences cannot occur when the trestles are firmly held in the two journal-boxes; but as these trestles may sustain damages requiring their immediate replacement, it was indispensable that the apparatus for closing the lower journal-boxes should be readily opened from the surface without requiring any one to go under water; this improvement is realized by the introduction in the boxes of transversal keys which may be put in place even when the water is muddy or cold, and the services of a diver cannot be obtained.

WEIR.

The pier which separates the navigable pass and the weir is composed of a rectangular mass 41 feet long and 10 feet wide, terminated upstream by a cut-water of ogival shape 8 feet 6 inches long. It rests on a foundation similar to that of the floor of the navigable pass.

In elevation, the pier has a recess, intended to receive the first trestle of the navigable pass, a well for gearing used in maneuvering the tripping-bar of the weir, and a recess to receive the first trestle of the weir. The recesses are covered by cast-iron plates, to which are attached the false trestles and their floors. Movable cast-iron covers protect the chamber that contains the gearing for maneuvering the tripping-bar.

A platform 3 feet 6 inches in width is constructed at the lower end of the pier at a height about 3 feet above the level of the lower pool. This platform communicates with the top of the pier by a stairway of about 10 steps, having the same width as the pier. It is on this platform that the lock-keeper usually stands to pick up the needles after their escapement.

The immovable parts of the weir starting from the pier consist of a floor made flush with the low-water level of the river and an abutment built into the river bank.

The floor is entirely of masonry; it is 179 feet in the clear between the pier and the abutment, and its width is 23 feet, measured between the inside faces of the sheet piling. This floor is founded on a bed of concrete 16 inches thick; it is confined above and below by two rows of oaken piles and sheet piling cut off and capped at the low-water line. The foundation course of concrete supports a mass of rubble masonry, on which rests the floor proper, which is composed of two chains of cut stone and a quarry-faced paving; these two portions of the floor have together a thickness of 5 feet 3 inches.

The sill designed to receive the twin journal boxes of the wickets, and to serve as a point of support to those wickets, is of oak; it squares 16 by 13 inches and is sunk in a rabbet prepared in the cut stone and held in it by means of anchor-bolts and forked bolts imbedded in the masonry. A piece of sheet-iron, fastened down with screws, protects the edge of the sill that supports the bottoms of the wickets.

An oak stringer, on which the tripping-bar rests, is sunk in a channel cut in the stones of the lower chain of the floor.

An oak sill, squaring 10 by 10, intended to receive the journal-boxes of the bridge trestles, is fastened by means of angle-irons and plates directly to the cap-pieces of the upstream row of piles and sheet piles.

The abutment of the weir consists of a solid rectangular mass of masonry, 11 feet 6 inches high, and of a stairway adjoining its upper face; both are founded just like the floor of the weir; the abutment is 13 feet 9 inches wide and 16 feet 6 inches long in the direction of the current. Provision has been made for a well which is to receive the gearing for maneuvering the tripping-bar.

CLOSING THE WEIR.

The closing of the weir is done by means of movable wickets, on the system of Mr. Chanoine, formerly chief engineer in the French corps of *Ponts-et-Chaussées*. A foot-bridge supported by trestles, intended to facilitate the raising of the wickets and to permit the regulation of the level of the upper pool, is placed above the wickets.

The wickets of the weir (39 for each weir) are formed of an oak frame suitably strengthened by irons; they are 7 feet 4 inches high and 4 feet 3 inches wide; the interval between two consecutive wickets is 4 inches; in low-water this space may be completely closed by a board placed over it and resting on the sides of the wickets.

When the wickets are raised their tops are at the normal level of the upper pool, which corresponds to a height of 7 feet 4 inches above the sill of the weir.

Each wicket is supported by a quadrangular iron horse, the upper and lower cross-pieces of which are prolonged beyond the uprights by journals; the two lower journals of the horse work in twin journal-boxes fastened to the sill of the floor; the two upper ones work in wrought-iron journal-boxes, which are bolted to the uprights of the wicket.

The cap of the horse has at its middle two wrought-iron flanges traversed by a large bolt, by means of which a wrought-iron prop is loosely fastened to the horse.

When the horse is raised, the foot of the prop rests against a cast-iron hurter firmly fastened to the floor; in this position, the horse and the prop form together a tripod of invariable shape, whose summit supports the wicket.

Thus, each wicket has two horizontal axes of rotation, one at the bottom of the horse and the other at the top; the latter is attached to the wicket by collars placed a few inches above one-third of the height of the wicket.

When the prop of a wicket is removed from its point of support against the hurter it is pushed by the pressure of the upper pool and it falls down on the floor, turning around both axes of the horse. By means of a combination of projections in the stones of the floor of the shapes given to the props, and of the journal-boxes of the wicket, the wicket when down lies a few inches above the floor, so as to give a free passage to the tripping-bar which is about to be described.

To lower the wickets of the weir on the floor the prop is deprived of its point of support. To do this a movable iron bar is used, which is placed a little above the level of the floor and is provided with projections; when the bar is put in motion these projections push in succession against the lower ends of the props and make these slide transversely until they are disengaged from their hurters. This bar is named the tripping-bar. There are two for each weir, and each is maneuvered by a stationary capstan in a well either in a pier or in the abutment of the dam; the lower pinion of the gearing acts on a rack attached to the extremity and in the prolongation of the tripping-bar.

To raise the wickets when they are down on the floor, a portable windlass is used, which is placed on the foot-bridge above the wickets. This windlass pulls on a chain fastened to the breech of the wicket and raises it up, at the same time turning it around its two axes of rotation until the prop again falls against its hurter.

When the horse is upright and supported by the prop, the wicket can swing around the upper journals of the horse; the angle of rotation of this wicket is limited by stops on the journal-boxes which strike against the uprights of the horses. On the dams on the Meuse the stops are arranged so that the wickets when on the swing will remain inclined up-stream at an angle of 21° with the horizon.

Under ordinary circumstances the movable wickets swing spontaneously around their axes of rotation as soon as the water of the upper pool rises about 6 inches above the normal level, which is at the height of the tops of the wicket. These wickets remain on the swing until the level of the upper pool falls sufficiently to allow them to right themselves. Usually after a rise the dam-tender, by means of a hook, raises in succession the wickets which had swung, and he does this as soon as the upper pool has fallen only a few inches below its normal level. This maneuver of righting the wickets is accomplished with the greatest ease from the top of the foot-bridge.

It takes but a few minutes to drop the wickets of the weir by means of the tripping-bar. The maneuver of raising them is slower; it usually requires a whole day, including the time employed in putting up the foot-bridge. But it may be stated that this does not result in any inconvenience, because after freshets the Meuse falls very slowly, and there is always more time than is necessary to complete the maneuver of raising the wickets before navigation can be embarrassed by too great a fall of the river surface.

MODIFICATIONS AND IMPROVEMENTS MADE IN BELGIUM IN THE WICKET DAMS OF THE CHANOINE SYSTEM.

Flutter-valves (*Vannes-papillon*).—In 1869 Mr. Dumon, then Chief Engineer of the province of Namur, proposed to adapt to the wickets of weirs in process of construction at La Plante, Tailfer, and Rivière the flutter-valves which Mr. Krantz, Chief Engineer in the French Corps of *Ponts-et-Chaussées*, had applied the year before to the wickets of the new system of movable dams, of which he is the inventor. This proposition was approved in consequence of experiments made on a full-sized wicket which had been installed on the Lesse at Anseremme, where use was made of the water-power of the Saint Jean factory.

The experiments showed that the ordinary Chanoine wickets, after having swung from the effects of an overflow 6 inches deep, only right themselves after the upper pool has fallen to about 4 inches below the crest of the inclined wicket. Thus, if a wicket should swing so that its crest falls to 3 feet 3 inches below the normal level of the upper pool, this pool must fall to 3 feet 7 inches below its normal level before the wicket will rise spontaneously. Therefore, the whole of the central portion of the chase has been removed, and a flutter-valve has been substituted, which, when open, makes an angle of 45° with the plane of the wicket.

A series of experiments showed that in order to obtain a spontaneous righting of the wicket without too great a fall in the upper pool, it was necessary that the plane of the wicket when on the swing should be inclined up-stream at an angle of 21° with the horizon; the crest of the wicket was then 20 inches above its position when the wicket was swung horizontally. Under these circumstances the wicket provided with the flutter-valve would automatically right itself when the upper pool fell to from 14 inches to 16 inches below its normal level.

This modification has been applied to all the wickets of the dams of the Meuse; it has both advantages and inconveniences.

Wickets provided with flutter-valves are more easily righted after being swung than ordinary wickets. The valves themselves are useful for the ready regulation of the upper pool in time of small freshets, without the necessity of dropping a few large wickets or of partly swinging a number of them.

In practice the wickets thus modified are not sufficient to regulate the upper pool automatically. The following facts have been noted: When after a rise the river commences to fall, some of the wickets which had swung may spontaneously right themselves before the surface of the upper pool drops appreciably below its normal level. As the river continues to fall, the water level below the dam continues to lower and the counter pressure diminishes, the wickets that remained on the swing do not right themselves even though the level of the upper pool falls to a point which might be detrimental to navigation; under these circumstances, in order to avoid too great a lowering of the upper pool, it is necessary to raise successively most of the inclined wickets; this is done from the top of the foot-bridge by means of a boat-hook. This maneuver, which is easily done, causes no inconvenience, for although the rises of the Meuse are occasionally very rapid, the fall of that river is always very slow, and the dam-tender has more time than is necessary to raise the swung wickets in succession, and to prevent the upper pool from falling below the normal level.

We have already seen that the wickets are so constructed that they swing and remain inclined up-stream at an angle of 21° with the horizon.

This is a serious drawback, because when the wickets are thus inclined they obstruct almost half of the free vertical opening of the weir, hence the necessity of lowering the dams when small rises occur much oftener than if the wickets could swing into a nearly horizontal position.

The inclination which the wickets of the Meuse dams can take when they swing is limited to 21° by the stops on the journal-boxes of the wickets, which strike against the horses. When a wicket is raised from the top of the footbridge, these stops come in contact with the horse long before the raising is finished; the wicket then acts as if it formed a part of the horse and rotation only takes place around the lower journals; this circumstance makes the raising of the wickets much more difficult, and often obliges the assistant dam-tenders at the last moment to pull a wicket by its chase so as to bring the prop to its place against the hurter, and this operation is not without danger.

Tripping-bar and its capstan.—The movement of the tripping-bars of the Meuse dams is not unfrequently impeded, especially by stones or bowlders carried by the current and wedged under the bar or in the slides. In order to lessen as far as possible the serious inconveniences which might result from the stoppage of the tripping-bar at a time when the dam had to be lowered on account of a rise in the new dams, very large dimensions have been given to this bar and to the capstan intended to maneuver it. The capstans especially have been calculated so as to transmit to the tripping-bar pressures of from 28,000 to 33,000 pounds, capable of crushing or breaking ordinary obstructions which might impede its movement.

Apparatus for flushing out tripping-bar well.—In spite of all precautions it often happens, specially during freshets, that considerable quantities of gravel get into the wells which contain the tripping-bar gearing. In the new dams we have remedied the inconveniences which might result from gravel accumulated on the pinion-wheel or on the rack by placing in each well a flushing apparatus communicating with the upper pool; it consists of a cast iron pipe of 4 inches inside diameter, built into the masonry of the abutment a few inches below the normal level of the pool; the head of this pipe, which opens in the upper pool, is provided with a valve which can be operated by hand; in the interior of the well the horizontal inlet pipe is prolonged by a cast-iron elbow bent at right angles, and the elbow is itself prolonged by an iron gas-pipe which descends to the bottom of the well and terminates a few inches above the rack. The elbow is connected with the horizontal pipe set in the masonry by a grooved collar, which permits the vertical pipe which it supports to describe an angle of about 90° in the plane of the rack; thus the jet which issues from the discharge-pipe with all the velocity due to the lift of the dam may be directed on all points of the rack. The water thus brought in flows away through the opening, which gives passage to the tripping-bar, and prevents the introduction into the well of gravel and other material transported by the river.

METHOD OF MANEUVERING A MIXED DAM ON THE MEUSE COMPOSED OF A NAVIGABLE PASS WITH TRESTLES AND A WEIR WITH WICKETS.

Suppose that it is necessary to raise the dam after the winter freshets. As soon as the upper pool is down to its normal level, say 8 feet 2 inches above low-water, the trestles of the navigable pass are raised by means of a traveling-windlass, and afterwards those of the weir. Communication being then established between the two sides of the river, the wickets of the weir are raised from the top of the footbridge, and they are kept inclined by fastening each chase-chain to its corresponding trestle. As the level of the river continues to fall, a few needles are placed above the trestles of the navigable pass so as to lessen the discharge of the dam and to always keep the upper pool at its normal level. In proportion as the discharge of the river diminishes, other needles are put in place until all the bays of the navigable pass are closed and allow but very little water to pass. At this time the entire discharge of the river passes over the weir, the wickets of which are all on the swing; the discharge still decreasing a few wickets right themselves spontaneously, then the dam-tender raises successively, and according to the necessities of the case, the other wickets, using for that purpose a boat-hook with which he grasps the chase of the wicket to be raised. All the flutter-valves are still open; the lockkeeper shuts them with a pike pole as the discharge of the river lessens. As the flow becomes smaller, joint covers are placed over the spaces between the wickets of the weir and almost the entire discharge flows over the tops of the wickets.

The navigable pass, which has been completely shut from the time it was first closed, has become almost water-tight, as the small joints between the needles have become obstructed by grass and small branches, and even by the mud which the current brings during freshets.

In summer time the regulation of the upper pool is done by means of the flutter-valves, which the dam-tender readily opens and shuts with a boat-hook while standing on the foot-bridge.

If a freshet comes a few wickets of the weir will swing; if the freshet increases so as to swing all the wickets of the weir, some openings are then made in the navigable pass by escaping as many sets of needles as is required to maintain the upper pool at a point slightly above its normal level, care being taken to alternate the openings systematically in order to maintain the current of the river truly normal to the line of the dam and to avoid scour.

Thus the dam-tender follows the freshet in its rise, and successively enlarges the discharge of the dam.

When, in consequence of the increase in the discharge of the river, the difference in level is reduced to 16 inches, the last sets of needles which may be in place are removed, then the trestles of the weir are let down and the wickets are tripped by the tripping-bar; then if the rise still continues the trestles of the navigable pass are lowered.

COST OF CONSTRUCTION.

The following is the estimated cost of constructing the dam at Dinant, now in process of execution. This estimate agrees very nearly with the average cost of the four dams of the same system which have been built or contracted for up to date:

Lock	$70,429 48
Stockade above lock	2,921 31
Miscellaneous, work and material	482 35
Navigable pass (150 feet long)	21,087 04
Pier	3,692 88
Weir 178 feet 6 inches long	25,954 80
Abutment	1,789 33
Works in the vicinity of the lock and of the dam, and work in the bed of the river	32,613 00
Surplus material	2,800 90
Lockkeeper's house	2,039 16
Assistant lockkeeper's house	1,362 74
Storehouse	685 80
Surroundings of lockkeepers' houses	333 87
Total	166,192 66