

Draining arrangement for roof

The present invention is concerned with an apparatus for the draining of rain water from roofs or equivalent. The apparatus is based on the principle of providing closed flow in the vertical draining pipe at the dimensioned water quantity, so that the draining is intensified and smaller and less expensive conduits can be used as compared with pipe systems requiring mixed flow, in which, thus, both air and water flow.

In the dimensioning of rain water pipes, different modes are in use in different countries, and for the dimensioning of the conduits, so-called dimensioning rainwater quantities have also been defined, the maximum intensity being, e.g., in Finland 150 l/s/ha (litres per second per hectare), in Sweden 130 l/s/ha, in Germany in certain places 400 l/s/ha.

It is known in prior art to provide closed flow, e.g., by fitting a so-called roof well into the roof, into which the water flowing from the roof is collected and in whose bottom portion there is an opening for connecting the vertical draining pipe. The opening is covered by a solid cover, whose perforated edges have been bent downwards so as to form a water lock when the roof well is full of water. The objective is to prevent access of air and formation of a water vortex in the opening of the draining pipe (FI Patent 41,451).

According to another suggested construction in prior art, attempts are made to prevent access of air into the vertical draining pipe by placing such a plug-like conical cover member in the mouth opening of the pipe whose shape corresponds to the air vortex of water when water rushes into an opening freely (FI Patent 58,193).

Primary drawbacks of the prior art solutions are the high costs of roof wells, reduction in the

thickness of the insulation; and, moreover, that the water is not drained uniformly. The water flows into the roof well rather uniformly, but is emptied from it unevenly. So-called swinging is produced when the water level in the roof well is alternately going up and down. The efficient draining caused by closed flow empties the roof well rapidly. Thereupon air is mixed with the water for some time, whereat the flow rate is reduced until the well is again filled, whereat access of air is prevented and closed flow starts again. The phenomenon is noticed as a disturbing water shock and as noise.

The present invention eliminates the drawbacks. No roof well, i.e. recess, is needed at all, but the rain water is passed straight into the discharge opening placed in the roof surface.

It is characteristic of the principle of the apparatus in accordance with the invention that on the roof the water, flowing as open flow from the starting point towards the discharge point, is passed, without changing its flow direction and substantially at the speed of the open flow, into a space in which the open flow, when the intensity of rain increases, is continuously converted to closed flow so that, when the space is filled with water, the air is excluded. The water is passed into an opening placed in the space and fitted to the roof portion, through which opening the water is discharged through the pipe system into the ultimate discharge point. Under these circumstances, the level of the water on the roof exclusively complies with the rules of open flow. In the closed flow obtained in this way, the static pressure of the water column flowing in the discharge pipe is utilized for the flow resistances, and normal formulae of calculation of closed flow can be applied to the dimensioning of the rain water pipe systems. Under these circumstances, the loss of pressure in the pipe system

is equal to the difference in height from the roof to the point at which the water is ultimately removed from the area. This point is usually, e.g., within an area with city plan, the municipal storm sewer.

5 In the apparatus in accordance with the invention, a cover plate of specified dimensions is fitted above the discharge opening in the roof and at such a height that a predetermined quantity of water has space enough to pass within a unit of time underneath the cover towards
10 the discharge opening. As the layer of water on the roof is approaching the permitted maximum height, the access of air to underneath the cover is restricted. Thus, the content of air in the water underneath the cover is reduced as the intensity of rain increases,
15 until the said air content is zero and closed flow of water has been achieved. The removal of water is intensified and the level of water on the roof can be kept under control. It cannot rise to a level risking the load capacity of the roof or of the trough.

20 The invention provides apparatus for draining water from a roof, which apparatus comprises a water discharge opening together with related draining conduits as well as a disc element which is larger than the opening and

fitted above the opening, wherein the opening is provided in the roof plane and wherein the disc element is dimensioned so that the minimum length of its edge and the maximum height of the disc from the roof plane
5 (h_c) correspond to the quantity of water that, according to the rules of open flow, causes an overflow height (h_c) corresponding to the height with an opening of the edge length concerned and in which space underneath the disc the flow is converted to closed flow
10 continuously as the water flow increases and without changing the direction of the water flow.

The water collecting zones on the roof must, of course, be divided to zones of such a size that the level of the water on the roof does not exceed the
15 permitted limits at the initial end of the flow, owing to the rules of open flow prevailing there. This height is commonly 50 mm.

In order that the water could be drained from the roof in compliance with the rules of open flow, the
20 discharge opening must be large enough so that the

(A)

overflow or over-rushing can take place undisturbed. The overflow height or over-rush height of the water into such an opening follows the equation

5 $u_c = \sqrt{g \cdot h_c}$, wherein

u_c = speed at the beginning of overflow

h_c = overflow height (see Fig. 1)

10 In the case of very wide troughs, the water height at the initial end of the flow is about $3/2 \cdot h_c$.

In a circular opening whose diameter is d , the cross-sectional flow area F and, correspondingly, the quantity of water flow Q at the overflow point
15 are obtained as follows:

$$F = h_c \cdot \pi \cdot d$$

$$Q = u_c \cdot h_c \cdot \pi \cdot d$$

20 By in the above equation placing the equation of u_c , the interdependence of Q , h_c and d is obtained as follows:

$$Q = \pi \cdot d \cdot \sqrt{g \cdot h_c^3} \quad \text{or}$$

25

$$d = \frac{Q}{\pi \cdot \sqrt{g \cdot h_c^3}}$$

In order to illustrate the invention and the
30 construction in accordance with same, the following practical example is given. The area of the roof zone to be drained as assumed to be 500 m^2 , the maximum rain intensity 150 l/s/ha , whereat the quantity of water to be drained is 7.5 l/s . Thereat, according to experience,
35 the diameter of the inlet of the appropriate discharge pipe is about 50 mm . When the water height at the initial end of the flow is 50 mm , h_c at free discharge

is 33.3 mm. From these values, by means of the above formulae, as the diameter of the circular disc at least 125.5 mm is obtained, and as the length of the circumference, correspondingly, at least 394 mm. The flow speed of open flow at the edge of the disc is 0.57 m/s, and also equal to the quantity of water divided by the area of free opening. The speed of the water flow underneath the disc is accelerated as closed flow is produced, so that the speed of the water in the discharge pipe will be about 3.8 m/s. The flow rate is also affected by the pressure of the water column in the discharge pipe. By means of the suggested solution, it is possible to increase the speed of the water, as is indicated by experiments, without raising the water level on the roof, without a vortex phenomenon and without suction of air induced by that phenomenon.

After the maximum quantity of water to be drained from the roof zone concerned has been determined and after the maximum permitted height of water at the initial end of the flow has been decided - thus, usually 50 mm - above the roof surface and on top of the discharge pipe, a disc is fitted which is above the roof surface at the maximum at a height h_c and the length of the edge of which disc is at least equal to the length of circular edge obtained from the formula. A disc dimensioned and fitted in this way, together with a discharge pipe system dimensioned in accordance with the closed-flow principle, is, with an increase in the intensity of rain, capable of converting the open flow taking place on the roof, continuously, without changing the direction of flow on the roof, to closed flow when the water rises, in accordance with the rules of open flow, to the level of the disc height, and by means of the apparatus it is possible to drain the rain water from the roof by means of pipes of a diameter considerably smaller than in prior art solutions.

The disc may be, but does not have to be, solid, because, when the height of water is slightly lower than the overflow height, the little layer of water formed on the disc will seal the disc adequately to prevent the drawbacks of air sucked in, and to form a continuous column of water with the dimensioned quantity of water.

The attached drawing illustrates, in Fig. 1, the flow of water into the pipe or opening and, in Figures 2 to 5, different construction examples of the apparatus in accordance with the invention.

In Fig. 1, the speed of the water flow 2 on the plane 1 is at the beginning of overflow u_c , and the overflow height is h_c .

In Fig. 2, the rainwater pipe 3 opening in the roof plane 1 is denoted with numeral 4, and the disc fitted above the opening with numeral 5. The distance of the disc from the roof plane is at the maximum h_c .

Fig. 3 shows such a modification in which a screen element 6 has been attached to the edges of the disc 5.

Figures 4 and 5 show two other embodiments of the apparatus. In one of them, the plane of the disc 5 is bent, in the other one the screen element 6 extends, resembling a conical mantle face, from the edges of the disc 5 down to the roof plane.

Fig. 6 shows such an embodiment in which the disc is elastic and its shape is determined by the compression of a spring placed on top of the disc.

The disc may, of course, be of any arbitrary shape whatsoever, whereat the minimum length of its edge determines the maximum height position of the disc from the roof plane in accordance with the principle described above.

When the water flows between the roof plane and the disc, the speed of the water increases towards the opening 4 of the pipe 3 if the faces are parallel,

whereat the flow resistance also increases towards the starting point, Fig. 2.

In order to prevent this and, consequently, to reduce the flow resistance, the disc or the portion of the roof plane placed underneath the disc, or both of them simultaneously, may be shaped so that the flow resistance towards the starting point is not increased, Fig. 4.

Moreover, the form resistance caused by the transition to the starting point, into the opening 4 of the pipe 3, may be reduced by rounding the joint between the roof plane and the pipe, numeral 7, Fig. 3.

The disc or the portion underneath the disc, or both may also be shaped so that the said portions are provided with radial reinforcement ribs or grooves, which, at the same time, act as retarders of the tendency of whirling around of the water, by increasing the friction of the whirl flow of water. All of the above solutions may occur with or without a screen. Further, the disc may also be elastic and, e.g., by means of a spring device, designed adjustable in accordance with various desires.

As one modification of the apparatus, the disc element is fitted substantially in the plane of the roof plane, whereat the flow-in opening for the water is substantially annular between the disc edge and the roof plane. In such a case, the length of the disc edge and the width of the opening follow the rules described above.

CLAIMS:

1 Apparatus for draining water from a roof, which
apparatus comprises a water discharge opening together
with related draining conduits as well as a disc element
which is larger than the opening and fitted above the
5 opening, wherein the opening is provided in the roof
plane and wherein the disc element is dimensioned so
that the minimum length of its edge and the maximum
height of the disc from the roof plane (h_c) correspond
to the quantity of water that, according to the rules of
10 open flow, causes an overflow height (h_c)
corresponding to the height with an opening of the edge
length concerned and in which space underneath the disc
the flow is converted to closed flow continuously as the
water flow increases and without changing the direction
15 of the water flow.

2. Apparatus as claimed in Claim 1, wherein the
distance of the disc from the roof plane increases from
the outer edge of the disc to its central region
situated directly above the water discharge opening.

3. Apparatus as claimed in anyone of the preceding Claims, wherein the edges of the water discharge opening are rounded so as to reduce the flow resistance.

4. Apparatus as claimed in anyone of the preceding
5 Claims, wherein the disc or the roof are provided with formations, which act in a way to increase the friction to a swirling flow movement.

5. Apparatus for draining water from a roof,
substantially as hereinbefore described with reference
10 to, and as shown in, anyone of Figures 2-6 of the accompanying drawings.
