A draining arrangement for removing water from roofs or equivalent areas. The aim of the arrangement is to improve the draining effect making it possible to use smaller draining pipes, and further to avoid disturbing noise in the pipes. The arrangement is mainly characterized therein that the opening (4) of the vertical water pipe (3) is situated directly at the surface (1) of the roof and is covered by a lid element (5). This lid is situated at such a height (hc) over the roof that a certain beforehand defined amount of water can flow under the lid where the water stream on its way to the opening of the vertical draining pipe and without changing its direction, continues to flow simultaneously as the air entrance becomes closed.
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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 alternatingly 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.

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 the discharge opening. As the layer
of water on the roof is approaching the permitted
maximum height, the acces 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, 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.

In view of the accomplishment of the above
occurrence, the apparatus in accordance with the inven-
tion is characterized in an opening in the surface of
the roof and in a disc member fitted above the opening.
The magnitude of the disc, its height above the roof
surface, as well as the diameter of the water discharge
pipe and of the discharge opening are precisely dimen-
sioned in accordance with the quantity of water to be
drained.

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
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 discharge opening must be large enough so that the
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

\[ u_c = \sqrt{g \cdot h_c}, \]  
\[ u_c = \text{speed at the beginning of overflow} \]
\[ h_c = \text{overflow height (see Fig. 1)} \]

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 are obtained as follows:

\[ F = h_c \cdot \pi \cdot d \]
\[ Q = u_c \cdot h_c \cdot \pi \cdot d \]

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

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

In order to illustrate the invention and the 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 m², the maximum rain intensity 150 l/s/ha, whereby the quantity of water to be drained is 7.5 l/s. Thereat, according to experience, 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 the draining of water from the 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, characterized in that the opening is fitted directly in the roof plane and that 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 open flow, causes an overflow height \( h_o \) 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 of the water flow.

2. Apparatus as claimed in claim 1, characterized in that a screen element (6) is connected to the edge of the disc (5).

3. Apparatus as claimed in claim 1, characterized in that the distance of the disc (5) from the roof plane (1) changes when going from the edge towards the centre.

4. Apparatus as claimed in claims 1 and 3, characterized in that the edges (7) of the opening (4) of the rain-water pipe, placed underneath the disc (5) in the roof plane (1), are rounded so as to reduce the flow resistance.

5. Apparatus as claimed in claim 1, characterized in that the disc (5) or the roof (1) portion placed underneath same, or both, are provided with formations, e.g. ribs or grooves, which act in the way of increasing the friction of a swirling flow movement.

6. Apparatus as claimed in claim 1, characterized in that the disc is solid.
7. Apparatus as claimed in claim 1, characterized in that the disc element (5) is fitted substantially in the plane of the roof face, whereat the inlet opening for water to underneath the disc becomes substantially annular between the edge of the disc and the roof.
# INTERNATIONAL SEARCH REPORT

**International Application No.** PCT/83/00021

## I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC:

- **E 04 D 13/04**

## II. FIELDS SEARCHED

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Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched:

SE, NO, DE, FI classes as above

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## IV. CERTIFICATION

- **Date of the Actual Completion of the International Search:** 1983-04-28
- **Date of Mailing of this International Search Report:** 1983-05-05
- **International Searching Authority:** Swedish Patent Office
- **Signature of Authorized Officer:** Vilho Jurvinen

Form PCT/ISA/210 (second sheet) (October 1981)