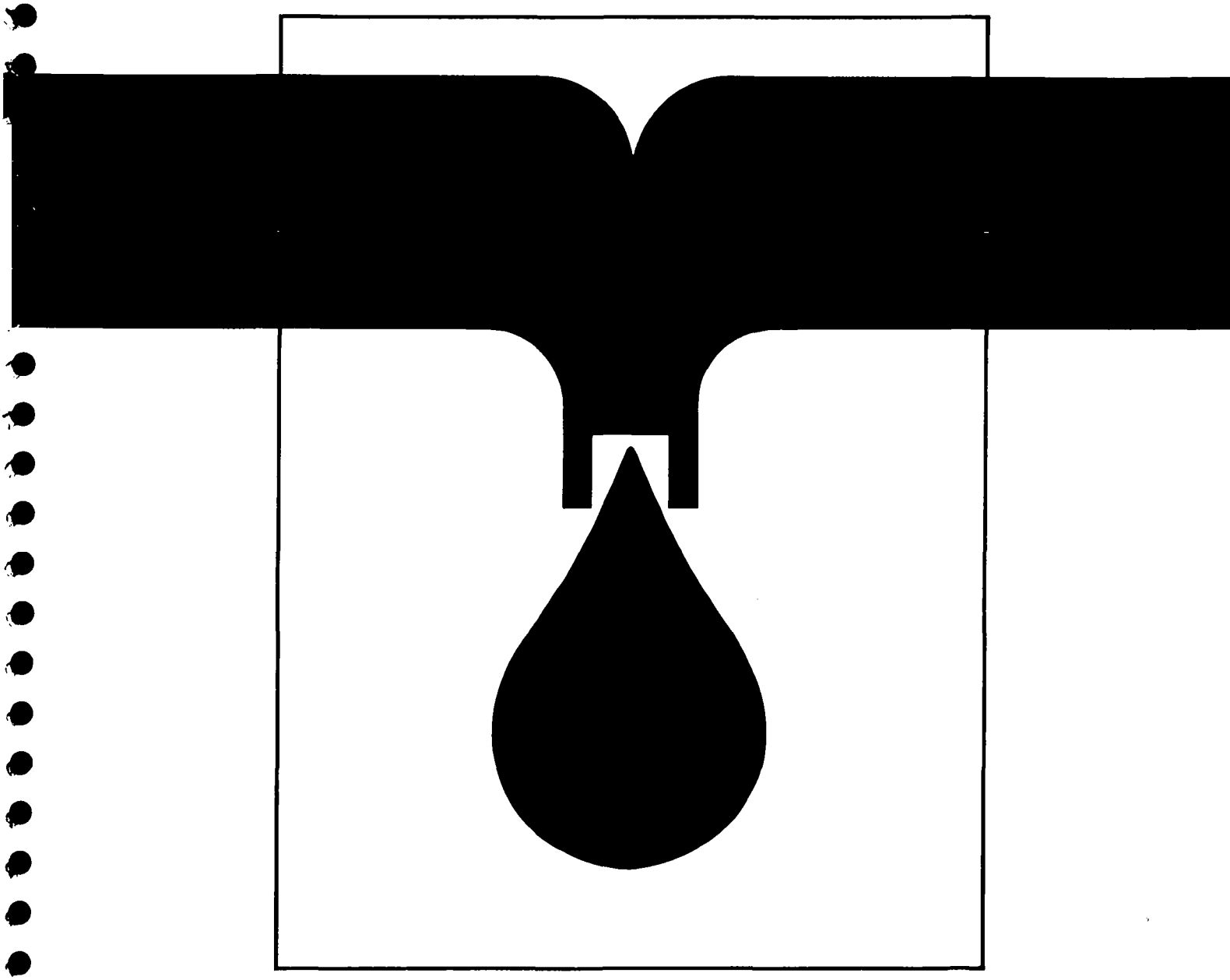
TRAINING MODULES
FOR
WATERWORKS PERSONNEL



Special Skills

3.3 g

Handling, maintenance and repair
of pipe fittings

Foreword

Even the greatest optimists are no longer sure that the goals of the UN "International Drinking Water Supply and Sanitation Decade", set in 1977 in Mar del Plata, can be achieved by 1990. High population growth in the Third World combined with stagnating financial and personnel resources have led to modifications to the strategies in cooperation with developing countries. A reorientation process has commenced which can be characterized by the following catchwords:

- use of appropriate, simple and – if possible – low-cost technologies,
- lowering of excessively high water-supply and disposal standards,
- priority to optimal operation and maintenance, rather than new investments,
- emphasis on institution-building and human resources development.

Our training modules are an effort to translate the last two strategies into practice. Experience has shown that a standardized training system for waterworks personnel in developing countries does not meet our partners' varying individual needs. But to prepare specific documents for each new project or compile them anew from existing materials on hand cannot be justified from the economic viewpoint. We have therefore opted for a flexible system of training modules which can be combined to suit the situation and needs of the target group in each case, and thus put existing personnel in a position to optimally maintain and operate the plant.

The modules will primarily be used as guidelines and basic training aids by GTZ staff and GTZ consultants in institution-building and operation and maintenance projects. In the medium term, however, they could be used by local instructors, trainers, plant managers and operating personnel in their daily work, as check lists and working instructions.

45 modules are presently available, each covering subject-specific knowledge and skills required in individual areas of waterworks operations, preventive maintenance and repair. Different combinations of modules will be required for classroom work, exercises, and practical application, to suit in each case the type of project, size of plant and the previous qualifications and practical experience of potential users.

Practical day-to-day use will of course generate hints on how to supplement or modify the texts. In other words: this edition is by no means a finalized version. We hope to receive your critical comments on the modules so that they can be optimized over the course of time.

Our grateful thanks are due to

Prof. Dr.-Ing. H.P. Haug
and
Ing.-Grad. H. Hack

for their committed coordination work and also to the following co-authors for preparing the modules:

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It is my sincere wish that these training modules will be put to successful use and will thus support world-wide efforts in improving water supply and raising living standards.

Dr. Ing. Klaus Erbel
Head of Division
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Eschborn, May 1987

Title: Skills

Handling, maintenance and repair of pipe fittings

Table of contents:

1. Gate valves

When installing gate valves, it must be ensured that the flanges of the adjacent pipes are parallel with each other, since otherwise extremely high stresses will occur, particularly at the valve body.

When the cover is being fitted, the connecting bolts should be tightened in a diagonal sequence.

At the point where the stem emerges from the valve cover, gate valves have a housing to accommodate the stem collar or the yoke and the sealing elements.

During closing with full pressure on one side, the force (in kp/cm^2) to be absorbed by the stuffing box towards the end of the travel is many times greater than the fluid pressure in the body.

In some makes of gate valve, the stem seal consists of tallowed hemp rings with a square cross-section.

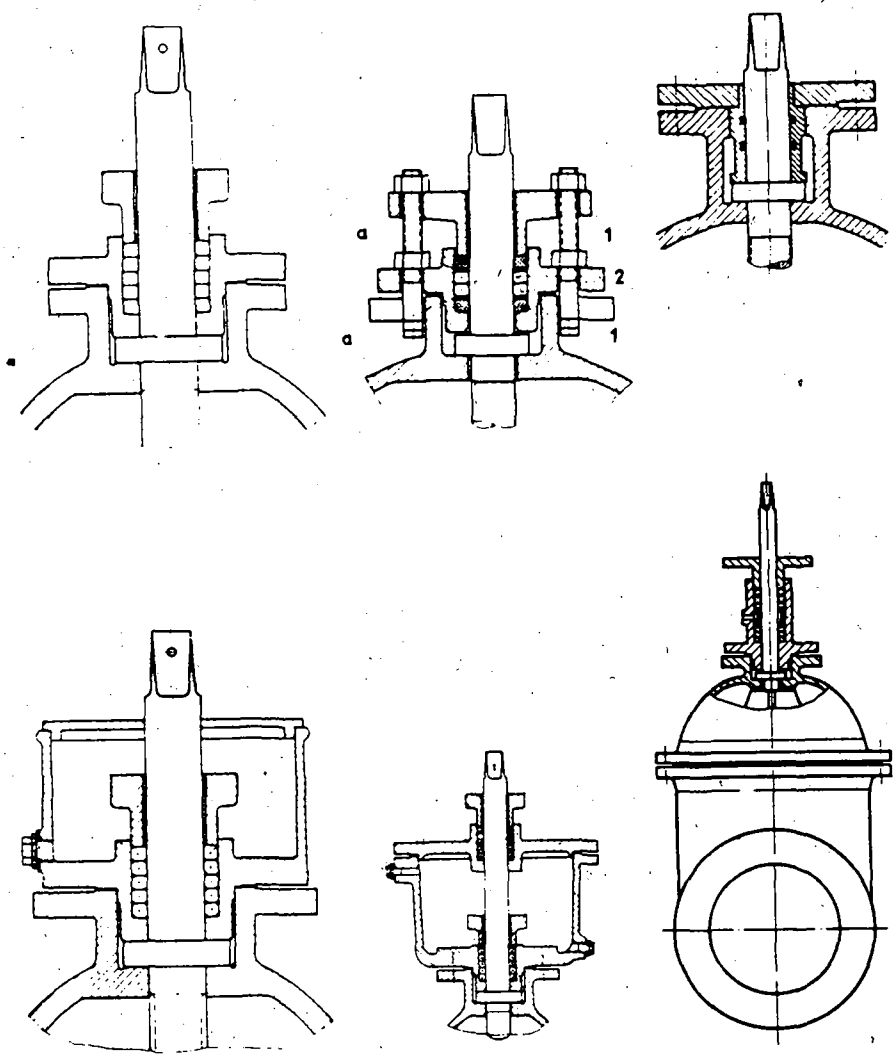
Newer makes have rubber washers (1) and tallowed hemp rings (2), which are separated from each other by a metal washer (a).

In some designs the stem shaft is sealed by means of round rubber washers fitted in grooves in the metal part (Fig. 1).

In gate valves used in water supply systems, the seal between the valve body and the slide generally takes the form of seating rings made of non-ferrous metal or stainless steel, caulked into special grooves.

The stuffing-box packing must be tightened from time to time and coated with a grease approved for use with foodstuffs.

For this purpose the screws at the stuffing-box gland must be carefully tightened in a diagonal sequence until water no longer emerges. They must not be adjusted too much, however, otherwise operation will be hindered.



1. Rubber washer
2. Tallowed hemp ring
a. Metal washer

Fig. 1: Stuffing-box packing

2. Operation and handling of saddle clips

Various types of tapping devices are commonly used for tapping pipes under internal pressure.

Each of these units has its own shutoff device (cock or gate valve), through which the drilling rod with drill is routed in order to tap the pipe.

Parts
1. Head unit
2. Body
3. Retainer

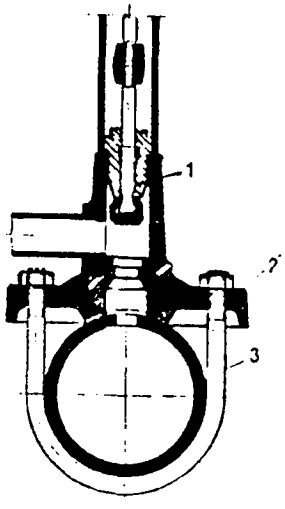


Fig. 2: Saddle clip

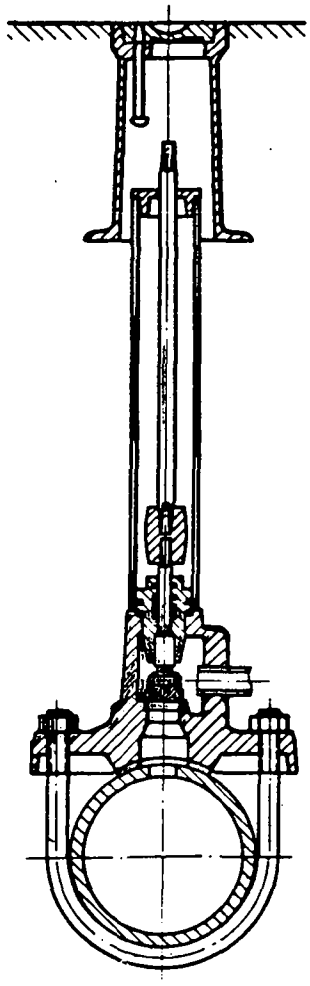


Fig. 3: Saddle clip with fittings

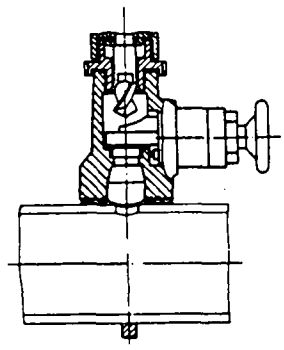


Fig. 4: Saddle clip with auxiliary shutoff valve

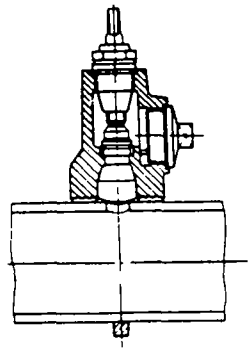


Fig. 5. Saddle clip with plug

The shutoff device makes it possible to remove the drilling rod and drill once the pipe has been tapped and to insert the head unit (1) with stem and valve (Fig. 2) in the body of the saddle clip without any water loss.

Once this valve has been closed, the complete tapping device is removed and the fittings (Fig. 3) installed.

Lighter tapping devices without shutoff device can be used if the body of the saddle clip additionally has a tapped hole for the installation of an auxiliary shutoff valve (Fig. 4).

This auxiliary valve, which assumes the function of the shutoff device, is replaced by a plug following tapping and the subsequent fitting of the head unit valve (Fig. 5).

3. Guidelines for installing valves

When valves are installed in pipelines it must always be ensured that their drive can be operated.

In the case of ball cocks and globe valves it is also essential to make sure that the lubrication devices are readily accessible upon installation.

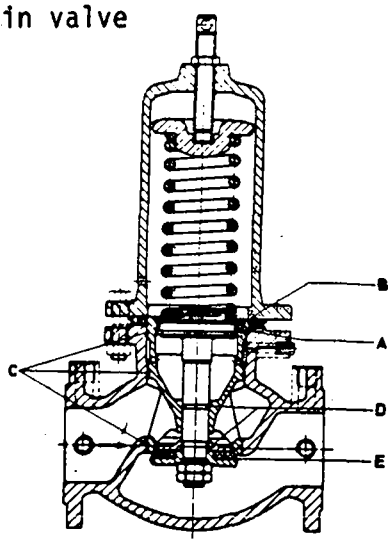
In general, the following procedure should be followed for the maintenance and repair of pipe fittings:

- Disassemble the fitting into its component parts
- Clean all parts thoroughly
- Bearing surfaces and sealing faces of O-rings must be free of deposits
- Replace damaged seals and O-rings
- Check poppets/discs and seats, if necessary smooth down with emery cloth and grind using abrasive paste
- Grease moving parts
- Reassemble with care

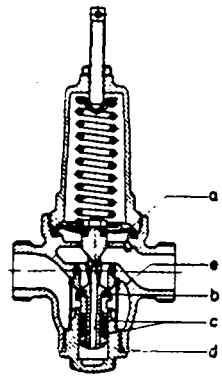
The operating instructions supplied by the manufacturers should be consulted for details.

4. Maintenance of pressure-reducing valves

Main valve



Pilot valve



A O-ring in counter-piston	a Diaphragm
B Back-up washer in counter-piston	b Washer
C O-ring at guide faces of insert	c Seal
D O-ring at valve rod	d O-ring
E Poppet seal ring	e Filter

Fig. 6: Pressure-reducing valve and pilot valve

Pressure-reducing valves are control devices and require regular maintenance, with the maintenance interval being largely dependent on the water quality. It is advisable to perform the first inspection after one year at the latest; the further maintenance schedule can then be established on the basis of the findings, particularly as regards deposits.

Faults:

- High pressure comes through on low-pressure side
  Main valve and pilot valve:
  Valve seat leaking as a result of:
  - contamination (particularly in new systems or after a pipe burst)
  - erosion (after a lengthy period of service), caused by
    large pressure drop
    sand in the water
    aggressive water

Main valve:

Defective lower O-ring at insert C (as a result of improper fitting of the insert during maintenance).

Pilot valve:

Defective seals c at the lower piston guide (as a result of deposits on the sliding surface).

- Water emerging from hole in cover
  Main valve:
  O-ring in counter-piston A defective as a result of:
  - penetration of dirt through the hole
  - deposits on the piston sliding surface

- Fluctuating low pressure as a result of deposits on the piston sliding surface

Both valves can be left in the pipe during maintenance work. The overhaul time for the main valve can be considerably reduced if a complete insert, including piston rod an poppet, is kept in reserve. The complete insert comprises all the wearing parts of the main valve. During maintenance, particular attention should be devoted to the following parts:

Seat and poppet seal, sliding surfaces and piston seals, pilot valve diaphragm. Clean and level seat and sliding surfaces using emery cloth, then apply Molycote or stopcock grease to the sliding surfaces.

5. Maintenance of safety valves

Safety valves must be checked at specific intervals to make sure that they are in a state of operational readiness.

The pressure on the poppet can be relieved by operating the lifting lever, so that the valve opens with the prevailing operating pressure. This operation can be performed if the operating pressure is at least 80% of the response pressure. Only a small valve lift is required (FIg. 42, Module 2.3g).

If safety valves start to leak, foreign bodies adhering to the sealing face can be blown off by lifting the poppet. If this does not achieve freedom from leaks, the sealing faces must be refaced during the next pause in operation.

6. Operating instructions for O-ring butterfly valves
(see 2.3g, Fig. 30)

- Installation

During transportation the pipe fitting must not be damaged as a result of impacts. It must not be suspended on parts having a lightweight construction such as handwheels.

Before the fitting is installed, it must be checked that the pipe is clean. There must be no contamination or foreign bodies such as remnants of welding rods, slag, dirt, bolts etc., since these will have an adverse effect on operation.

The pipe flanges to be connected must be parallel to the flanges of the fitting and must give when the connecting bolts are tightened, so that there are no sizeable distorting forces acting on the valve body. The connecting bolts should be tightened evenly and in a diagonal sequence.

- Maintenance

The relatively simple maintenance of such valves takes the form of lubrication.

- Operation

Clockwise rotation will cause the valve to close. The position of the disc at any given time is usually shown by an indicator on a scale located on the cover of the gear casing.

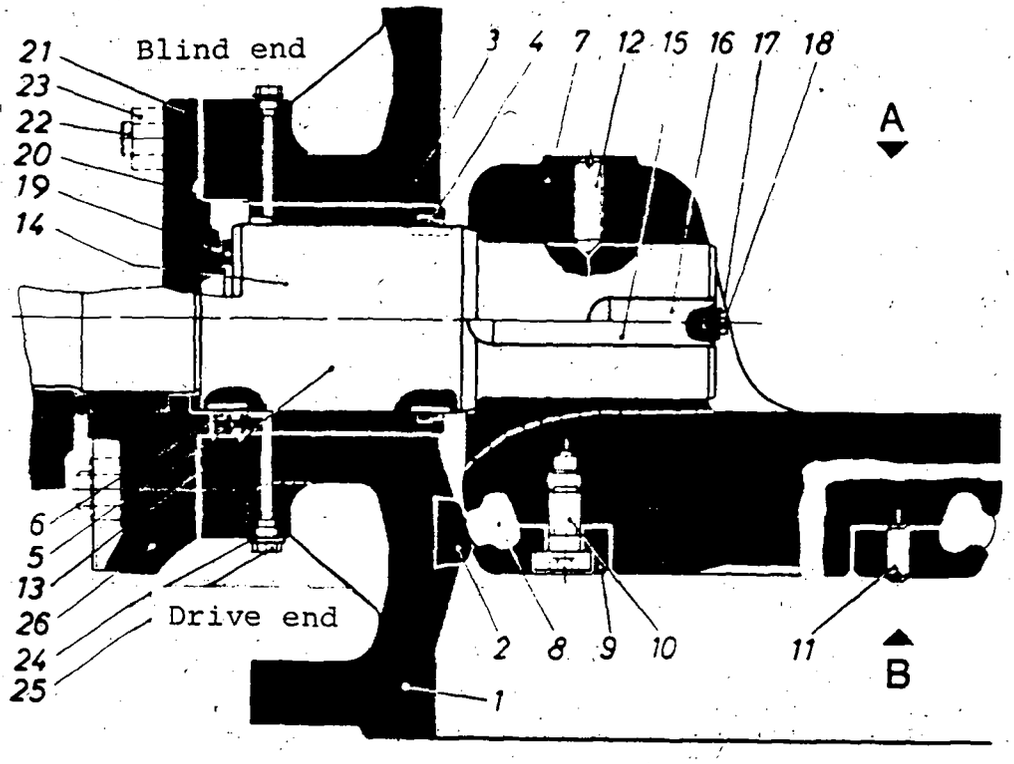
Mounting and sealing components (as shown in Fig. 7)

The O-ring butterfly valve is a butterfly valve with eccentrically mounted disc and yields a totally tight seal.

The disc (7) is mounted in the valve body (1) by means of the shafts (13 and 14) such that it can rotate. The shaft penetration is sealed with O-rings (6). The bushes (3) are protected against dirt by a guard ring (4). The drive shaft is securely connected to the disc by means of a key (15).

The seal is provided by an endless moulded sealing ring (8), which is pretensioned by means of screws(10) via a clamping ring (9) and is pressed against the seat (2). Depending on the pretensioning, a seal against a larger or smaller pressure is provided. Lock pins (11) secure the clamping ring in position.

Adjustment and replacement of the moulded sealing ring
In the event of leaks, e. g. caused by a worn seal, the contact pressure of the moulded sealing ring at the seat can be increased. The lock pins (11) must be loosened and the locking screws (10) tightened at the point of the leak. Once a tight seal is once again achieved, the lock pins must be tightened again.



1 Valve body
2 Seat
3 Bush
4 Guard ring
5 Cage
6 O-ring
7 Disc
8 Moulded sealing ring
9 Clamping ring
10 Locking screw
11 Lock pin
12 Set screw
13 Drive shaft
14 Journal
15 Key
16 Feather key
17 Locking plate
18 Bolt
19 Shim
20 Seal ring
21 Dummy cover
22 Stud bolt
23 Hexagon nut
24 Gasket
25 Screw plug
26 Drive housing

Fig. 7: Mounting and sealing components

The moulded sealing ring (8) can be replaced without removing the disc. The disc must be in the closed position. The locking screws (10) must be unscrewed, together with two lock pins (11) located opposite. With the aid of the locking screws, the clamping ring can then be pressed off through the tapped holes for the lock pins. The moulded sealing ring (8) can then be replaced. The clamping ring must be refitted with the sequence of operations reversed and adjustment as described above is to be performed in order to ensure freedom from leaks.

7. Air valves

(detailed description: Fig. 39, Module 2.3g)

Correct admission and discharge of air is essential if pressurized water pipes are to function reliably and without problems. A distinction must be made between two types of operation: the admission or discharge of air in the non-pressurized condition (i. e. when the pipe is emptying or filling) and the discharge of air under pressure. Special conditions may arise in the case of pump operation if a partial vacuum occurs briefly when the pumps are switched off and large quantities of air are drawn in, which must then be discharged again under pressure in a very short time.

Each of the various sets of operating conditions calls for specific procedures and correspondingly careful selection of air valves.

Basic features: The flexible sealing elements are made of perbunan, so that they are also resistant to any contaminants which may be deposited. The valves are largely maintenance-free. It is advisable to perform functional checks at intervals of around one year; inspection and cleaning must be carried out earlier if the water quality is poor and leads to heavy deposits. All internal surfaces, including ball guide, air discharge holes and seat, must be carefully cleaned. For this purpose the interior is depressurized: shutoff by means of centre valve or separate shutoff device, pressure relief via screw connection. Never use force to move or press in the balls.

For long-distance pipelines, the dimensioning of the air valves is determined through the calculation of the water hammer. If large supply lines or power-station lines are to be filled, air should additionally be discharged by means of manually operated shutoff devices.

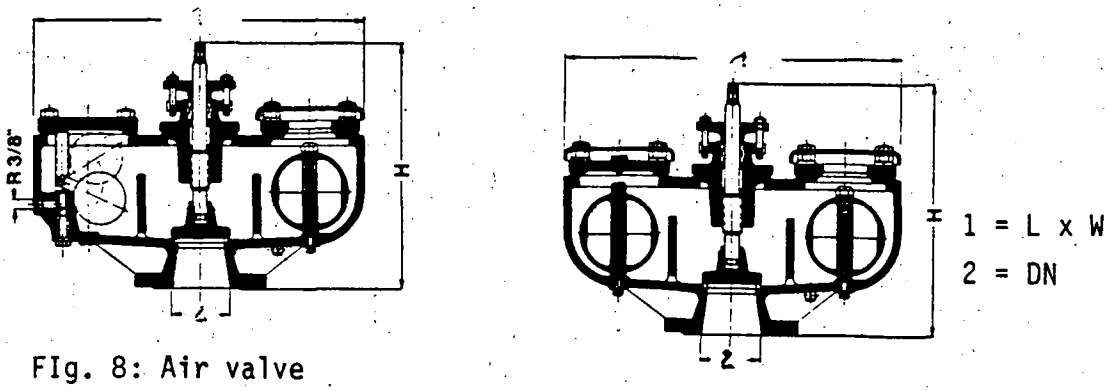
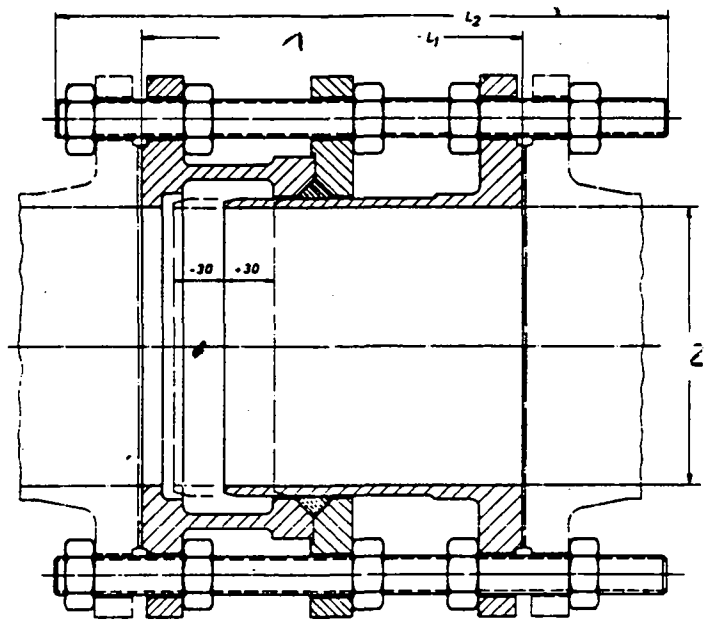


FIg. 8: Air valve

In order to check the operation of the valve, it is recommended to install a 1/2" manual air discharge device upstream or downstream of the automatic air valve.
When this manually-operated device is opened, it can be immediately established whether there is an air cushion in the pipe. After the interior components have been cleaned, all moving parts should be lubricated with a grease approved for use in the vicinity of drinking water.

8. Disassembly elements and expansion joints

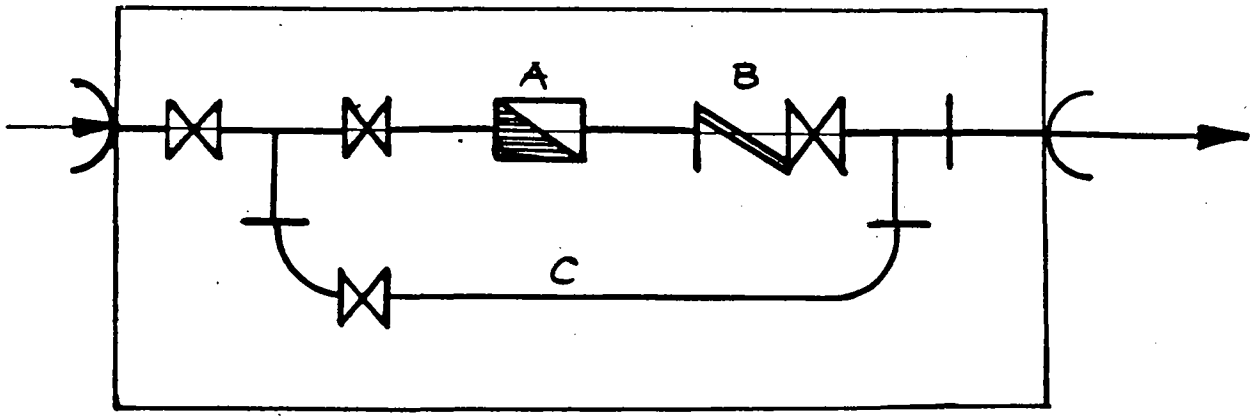
Disassembly elements are installed in pipes with a large nominal diameter in excess of DN 100 in order to permit the installation and removal of fittings without destruction of the pipe.
There are various types of disassembly elements, both fixed and flexible.
Flexible elements can absorb changes in length occurring during operation as a result of temperature.
Fixed disassembly elements can be turned into flexible ones if the appropriate nuts are loosened.
Fig. 9 shows a fixed disassembly element.



1 = Length in centre position
2 = DN

Fig. 9: Fixed disassembly element

This element can be adjusted by up to ± 30 mm.
Disassembly elements are used primarily in structures, pipe galleries or shafts. Fig. 10 shows an example.



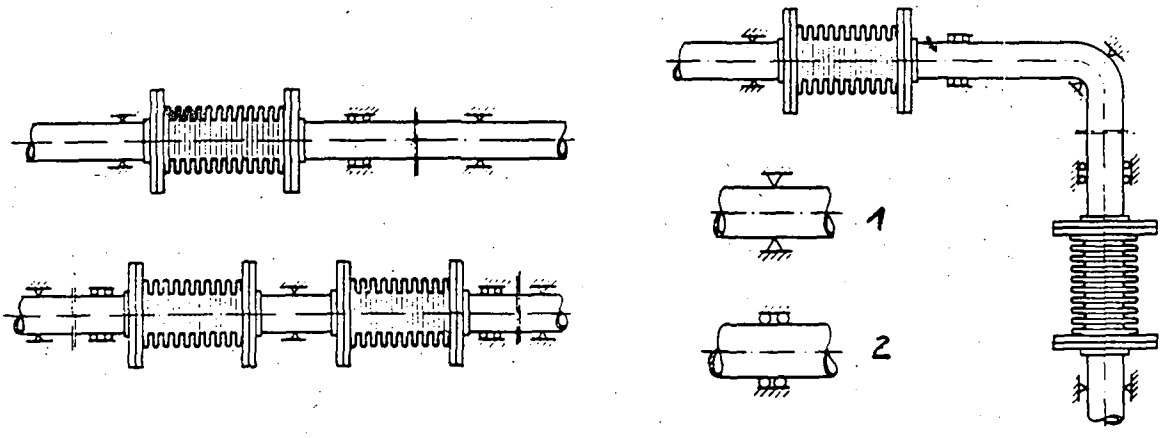
A Water meter B Disassembly element C Bypass

Fig. 10: Gate valve and water meter shaft

If the water meter A has to be removed, the supply can be maintained via the bypass C.
The appropriate gate valves are closed or opened and the screws of the disassembly element B are loosened until the pipe can be shifted a few millimetres and the water meter removed.

It must be ensured that the screws are greased for the installation process.

Expansion joints are used in a similar manner to facilitate the installation and removal of pipe fittings. In addition, however, they have further advantages in that they can be used to compensate for elongation of the pipe and also act as vibration dampers or silencers.



1 = Fixed support
2 = Sliding support

Fig. 11: Examples of the installation of expansion joints

If the fitting is being used as an axial expansion joint, the pipe sections between which it is to be connected must be precisely in alignment and particularly well guided. The fixed and sliding supports should be fitted as close to the expansion joint as possible; only one expansion joint should be installed between two fixed pipe supports. Fixed supports should be designed for the maximum forces occurring at these points and sliding supports should be suitably long so that there is no possibility of jamming. If expansion joints are to be used as vibration dampers, they should not be pretensioned. In particular, expansion joints must not be subjected to any torsional stresses; in the case of types with a flange connection, it is advisable for this reason to use versions with loose flanges, since these can rotate and the flange holes can thereby be matched to those of the mating flanges.

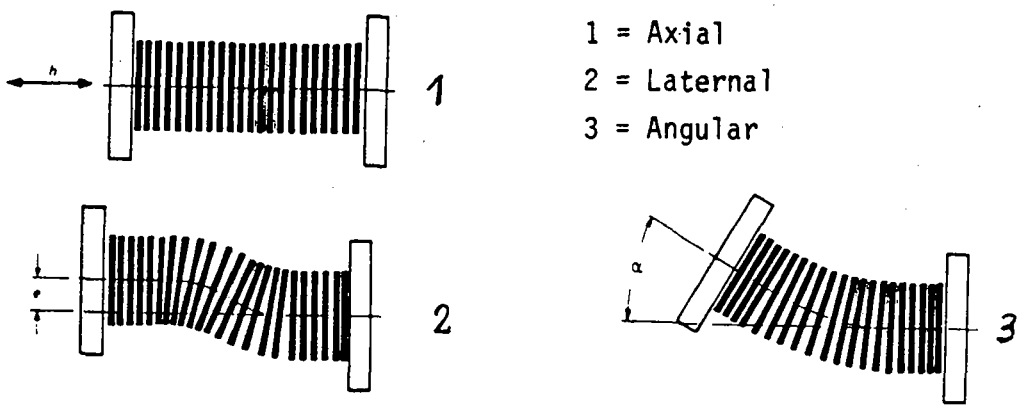
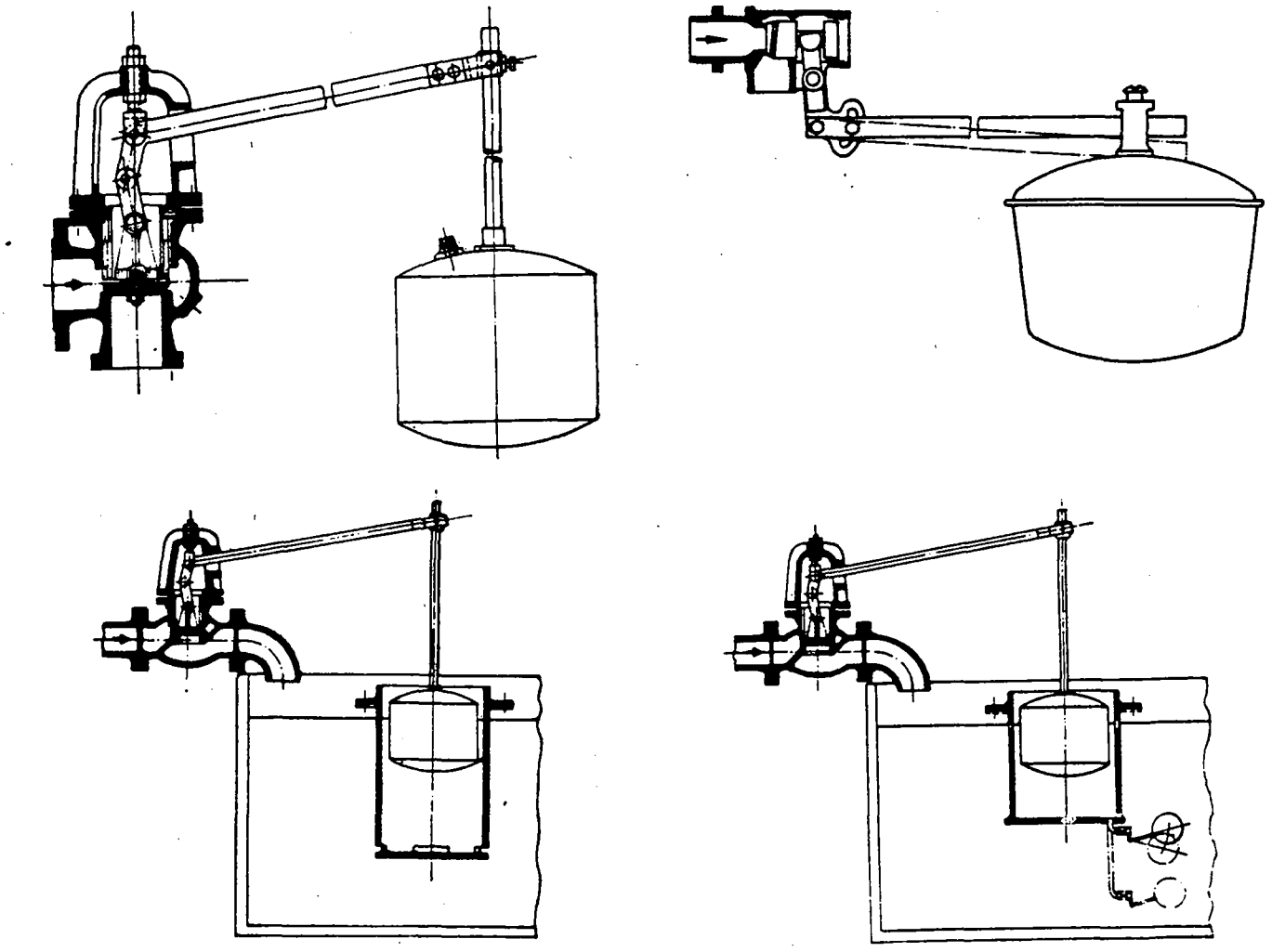


Fig. 12: Directions of movement

9. Float valves - discharge valves - taps



13.1 Non-compensated single-seat valve
13.2 Pressure-compensated single-seat valve, angle type
13.3 Pressure-compensated single-seat valve with float guide tube
13.4 Pressure-compensated single-seat valve, pilot operated

Fig. 13: Various types of discharge valves with float control

In supply systems, float valves are used to regulate the flow into tanks and containers, break pressure tanks, settling basins etc. They operate basically without the aid of external power, being controlled by floats

1. either directly via toggle levers or threaded stems
   or
2. indirectly as pilot-operated valves, utilizing the inflow pressure with piston drive.

Directly controlled valves

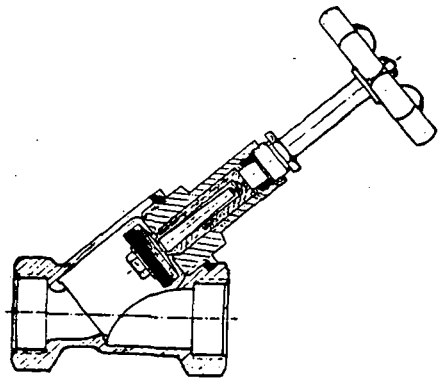
If the flow into a tank is to be matched to the flow out of it, i. e. if a constant level is desired, directly controlled valves are used. The operating position in which they are maintained by the float depends on the inlet pressure, the valve's pressure loss and the volume of water withdrawn from the tank, and is therefore generally a throttling position. The valves must be designed such that they guarantee the maximum requirement per unit time, but also operate perfectly if only the minimum requirement is in effect. They thus perform a purely regulative function. With these valves, the tank is never totally empty, unless this is effected by manual intervention. For reasons of hygiene, this is a point which must be considered when the inflow and outflow are being determined, as well as during maintenance.

The following types of directly controlled float valves are commercially available:

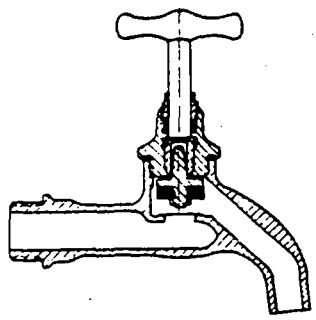
Non-compensated single-seat valves are used only in nominal diameters 15 - 50 and only in the case of low inlet pressures, since these pressures act directly on the shutoff element.

Pressure-compensated single-seat valves are commercially available from DN 40 up to around DN 500 in both straightway and angle designs. The shutoff element is pressure-compensated, with free discharge downstream of the valve. When the valve and the pipe following it are being positioned, therefore, it is essential to make sure that no back pressure can occur. In the case of some makes the float must be filled with sand before the valve is put into operation, such that approximately two thirds of it are immersed in the water. It must be guided in the tank, preferably by a float guide tube as shown in Fig. 13.3. A tube of this type also protects the float from the movement of the surface of the water and allows it to operate smoothly.

Pilot-operated float valves (Fig. 13.4) are installed in tanks in which there are large fluctuations in the water level. The float of pressure-compensated single-seat valves must be buoyant enough to maintain equilibrium with the sleeve friction, the weight of the individual parts and the valve operating force.



14.1. Free-flow valve



14.2. Discharge valve

Fig. 14: Discharge valves

The valves shown in Fig. 14 are used primarily to withdraw water and represent the simplest form of tap. Regular maintenance is nevertheless essential. The leather washer, shown in black, should be replaced at regular intervals; in addition, the stem must be greased and the stuffing box checked for leaks.

Older valves may require re-milling of the valve seat; useful hand millers with centring insert, which are commercially available, can be used for this purpose.

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The government-owned GTZ operates in the field of Technical Cooperation. Some 4,500 German experts are working together with partners from some 100 countries in Africa, Asia and Latin America in projects covering practically every sector of agriculture, forestry, economic development, social services and institutional and physical infrastructure. – The GTZ is commissioned to do this work by the Government of the Federal Republic of Germany and by other national and international organizations.

GTZ activities encompass:

- appraisal, technical planning, control and supervision of technical cooperation projects commissioned by the Government of the Federal Republic of Germany or by other authorities
- advisory services to other agencies implementing development projects
- the recruitment, selection, briefing and assignment of expert personnel and assuring their welfare and technical backstopping during their period of assignment
- provision of materials and equipment for projects, planning work, selection, purchasing and shipment to the developing countries
- management of all financial obligations to the partnercountry.

The series **"Sonderpublikationen der GTZ"** includes more than 190 publications. A list detailing the subjects covered can be obtained from the GTZ-Unit 02: Press and Public Relations, or from the TZ-Verlagsgesellschaft mbH, Postfach 36, D 6101 Roßdorf 1, Federal Republic of Germany.

TRAINING MODULES FOR WATERWORKS PERSONNEL

List of training modules:

Basic Knowledge

0.1 Basic and applied arithmetic
0.2 Basic concepts of physics
0.3 Basic concepts of water chemistry
0.4 Basic principles of water transport
1.1 The function and technical composition of a watersupply system
1.2 Organisation and administration of waterworks

Special Knowledge

2.1 Engineering, building and auxiliary materials
2.2 Hygienic standards of drinking water
2.3a Maintenance and repair of diesel engines and petrol engines
2.3b Maintenance and repair of electric motors
2.3c Maintenance and repair of simple driven systems
2.3d Design, functioning, operation, maintenance and repair of power transmission mechanisms
2.3e Maintenance and repair of pumps
2.3f Maintenance and repair of blowers and compressors
2.3g Design, functioning, operation, maintenance and repair of pipe fittings
2.3h Design, functioning, operation, maintenance and repair of hoisting gear
2.3i Maintenance and repair of electrical motor controls and protective equipment
2.4 Process control and instrumentation
2.5 Principal components of water-treatment systems (definition and description)
2.6 Pipe laying procedures and testing of water mains
2.7 General operation of water main systems
2.8 Construction of water supply units
2.9 Maintenance of water supply units Principles and general procedures
2.10 Industrial safety and accident prevention
2.11 Simple surveying and technical drawing

Special Skills

3.1 Basic skills in workshop technology
3.2 Performance of simple water analysis
3.3a Design and working principles of diesel engines and petrol engines
3.3b Design and working principles of electric motors
3.3c –
3.3d Design and working principle of power transmission mechanisms
3.3e Installation, operation, maintenance and repair of pumps
3.3f Handling, maintenance and repair of blowers and compressors
3.3g Handling, maintenance and repair of pipe fittings
3.3h Handling, maintenance and repair of hoisting gear
3.3i Servicing and maintaining electrical equipment
3.4 Servicing and maintaining process controls and instrumentation
3.5 Water-treatment systems: construction and operation of principal components: Part I - Part II
3.6 Pipe-laying procedures and testing of water mains
3.7 Inspection, maintenance and repair of water mains
3.8a Construction in concrete and masonry
3.8b Installation of appurtenances
3.9 Maintenance of water supply units Inspection and action guide
3.10 –
3.11 Simple surveying and drawing work

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