Operating Instructions

HM 160 Multi-Purpose Teaching Flume

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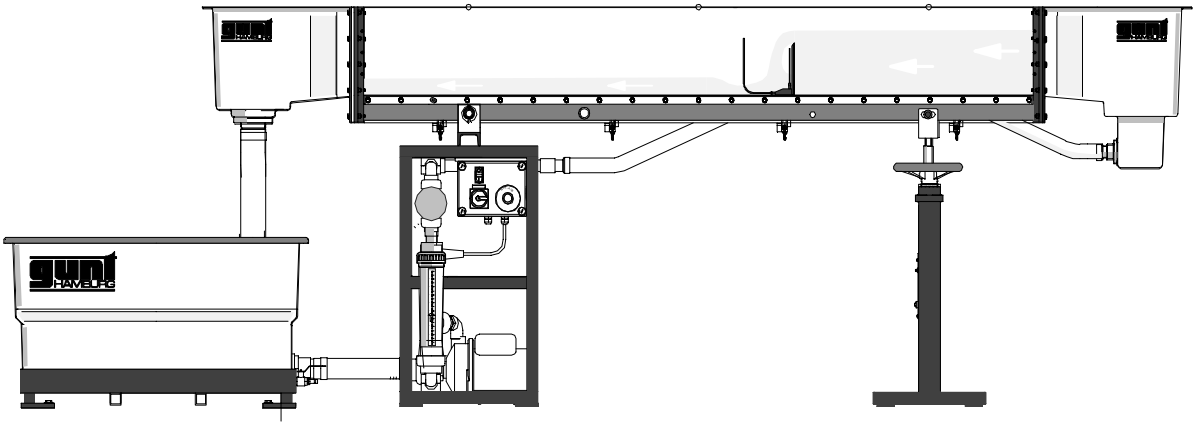

Operating Instructions

Please read and follow the safety comments before the first installation!

This apparatus is ment to be used only for Education, Teaching or Research.

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HM 160 Multi-Purpose Teaching Flume

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HM 160 Multi-Purpose Teaching Flume

1 Introduction

The **HM 160 multi-purpose teaching flume** is a base unit offering wide-ranging experimentation options in connection with **open flumes** such as weirs, overflows and sluice gates, **oceanography and offshore engineering** . It is designed for research and training purposes.

The base unit, with a measuring length of 2.5 m, can be **extended** by an additional **2.5 m** segment to a maximum measuring length of **5 m.** The modules have transparent side walls, providing virtually **full view of the measurement section**.

A GRP tank provides for a closed water circuit and adequate supply of water. Once filled, the flow channel is **independent of the mains water supply**. A **centrifugal pump**, a **shutoff valve** and a variable-area flowmeter are integrated into the water circuit.
At a through-flow rate of approx. 230 l/min (13.8 m^3/h) and with maximum flow cross-section, flow speeds of 0.2 m/s are reached.

By means of an **inclination adjustment device** the channel can be steplessly tilted from + 3% to - 0.5% in longitudinal direction using a handwheel, in order to equalise flow losses or to simulate a natural gradient, for example.

HM 160 Multi-Purpose Teaching Flume

In conjunction with the broad range of **accessory units** supplied by **G.U.N.T.,** experiments can be performed with the HM 160 multi-purpose teaching flume on the following topics:

Flow in open flumes:

- Through-flow
- Pressure, pressure ratios
- Flow speed and speed profiles
- Influence of wall shape (venturi channel)
- Influence of roughness (flow bed)
- Flow coefficient
- Natural gradient
- Accelerated or decelerated flow
- Application of the energy and continuity equations
- Measurements on various resistance bodies
- Lifting and drag forces

Weirs in a wide variety of designs:

- Overflow and banking height
- Banked-up water level and settling curve
- Hydraulic jump
- Outflow processes underneath weirs
- Change of flow state

2 Unit description

Hydraulic investigations of open waterways, such as rivers and canals, are made to obtain information in order to assist shipping, or to optimise coastal protection measures.
The HM 160 multi-purpose teaching flume covers these and other scientific investigations of a hydraulic and fluidic nature. The flume is characterised by the following features:

- Modular construction of the channel based on pre-fabricated and pre-assembled segments allows for quick and easy installation on-site.
- An additional channel segment permits extension to 5 metres without problem.
- Very precise and exact adjustment of inclination by means of a spindle-type lift gear.
- The working segment of the flow channel is freely accessible from above at every point.
- The transparent sides of the working segment are made of transparent polycarbonate, which is particularly abrasion-proof, non-discolouring, and easy to clean.
- The floor of the working segment is of stainless steel. This ensures a smooth, even surface without costly and complex calibration work.
- In the outflow segment, made from GRP, a damming effect can be created in the channel by inserting a spillover weir. The water discharge into the drain tank is splash-protected.
- Continuation of the flow cross-section into the inflow and outflow segment extends the length of the working segment.
- The water tank is made from resistant GRP, thus providing high strength and durability with low weight.

2.1 Construction of the system

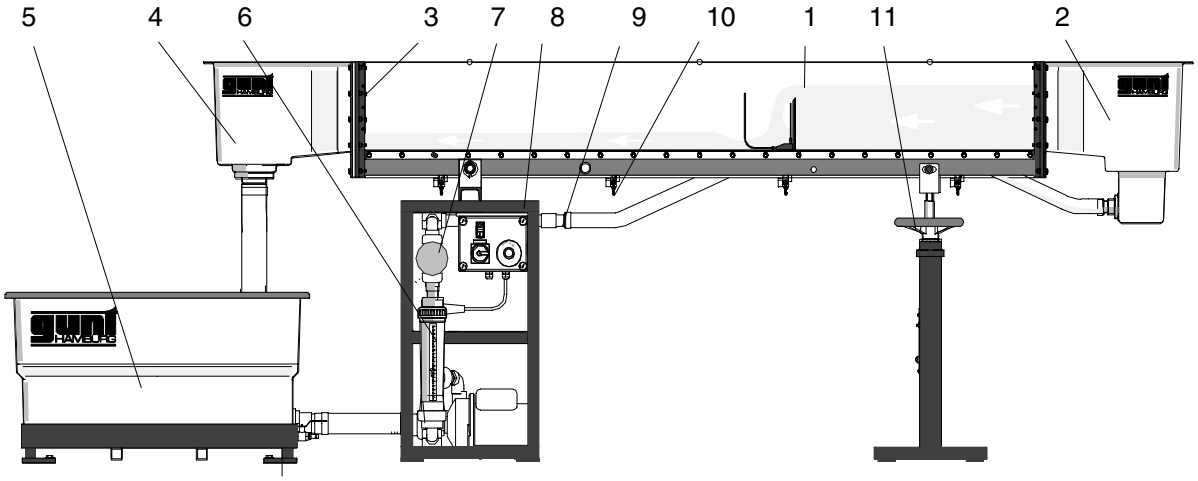


Fig. 2.1:
Designation of components; water circuit diagram

1	Channel element 2,5 m	7	Shut-off valve
2	Flow channel element	8	Bearing pedestal with fixed bearing, centrifugalpump and switch box
3	Groove for overflow weir		
4	Outflow segment	9	Pressure line
5	Tank with outflow valve	10	Outflow valve with measuring glands
6	Flowmeter	11	Inclination adjustement device

The direction of flow is shown in Fig. 2.1 by arrows.

2.2 Function of the flow channel

The reservoir (5) holds around twice as much water as the capacity of the channel, so that it can be operated at maximum water level.

The pump is started by the main switch on the switchbox (8).

The water is pumped by the centrifugal pump out of the reservoir (5) through the volumetric flowmeter (6) and the pressure pipe (9) into the inflow

segment (2). The flow can be regulated by a shutoff valve (7).

The water then flows through the actual working and metering segment of the flow channel (1), which is terminated by a slot-in spillover weir. The spillover weir is inserted into the groove (3) provided, in the form of plastic panels. A variety of accessories from the broad G.U.N.T. range can be used in the working segment.

The flow rate can be precisely regulated on the shutoff valve (7) and read from the volumetric flowmeter (6).

To prevent the water from rising above the maximum level of 250 mm, float switches are installed in the inflow and outflow segments which interrupt the flow to the pump when the specified water level is reached and thus prevent the channel from overflowing.

The water flows out of the outflow segment (4) back into the reservoir (5).

2.3 Components

2.3.1 Pump

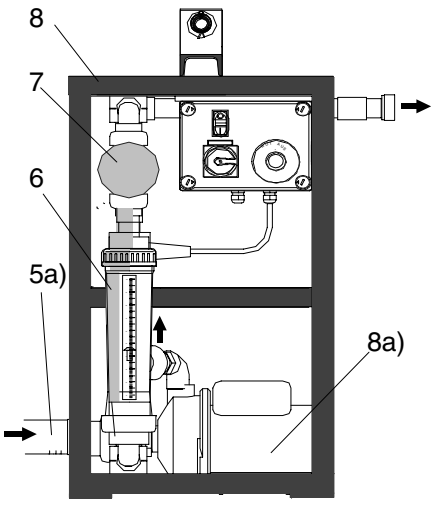


Fig. 2.2

The pump is mounted in a stator (8) which conducts the forces due to weight out of the channel and the vibrations of the pump into the substrate (Fig. 2.2). The pump (8a) is a centrifugal pump with a flanged-on AC motor. On the intake side the pump is connected to the reservoir by way of a tube line Ø60 (5a); the volumetric flowmeter (6) is flanged onto the delivery side. In subsequent operation the flow is adjusted by means of the shutoff valve (7) downstream of the volumetric flowmeter.
Important! To prevent the water in the inflow segment splashing, the **pump** should always be switched on **with the shutoff valve closed!** Only then should the shutoff valve be carefully opened!

The bearings of the pump motor are lifetime-lubricated, and the pump is designed for water as the delivery medium.

The system is not suitable for sediment transport. The variable-area flowmeter and the pump in particular may cease to function as a result of incursion by solid matter!

2.3.2 Flowmeter

A variable-area flowmeter is flanged onto the delivery side of the pump to measure the flow. Only minor pressure losses occur. The measuring range is 0 (0%) - 10 m^3/h (100%, max. flow). The current flow rate is read from the rim (a) of the float in %; the reading relates to the maximum flow.

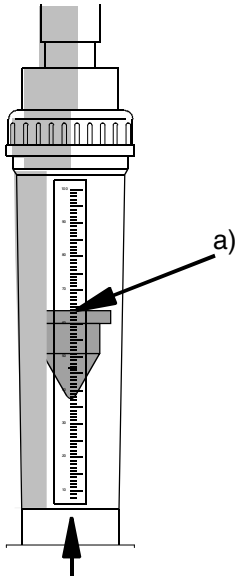


Fig. 2.3

2.3.3 Inclination adjustment

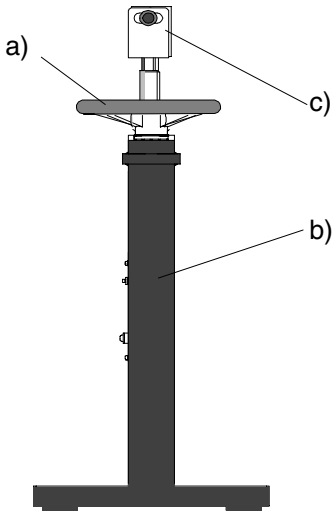


Fig. 2.4

The inclination adjustment device (5) is a spindle-type lift gear with fixed trapezoidal spindle. It is actuated by way of a handwheel (a). To be able to turn the handwheel using a small amount of force and to set a precise inclination, the spindle lifts 0.25 mm per crank revolution. A scale (b) with the exact inclination ratios is affixed on the front panel underneath the handwheel. **Important! Only adjust the inclination within the range on the scale.** The inclination adjustment is executed as a sliding bearing (c). To safeguard functioning over long periods of time, the trapezoidal spindle and the sliding bearing should be lubricated with machine grease **once a year**.

2.3.4 Inflow segment

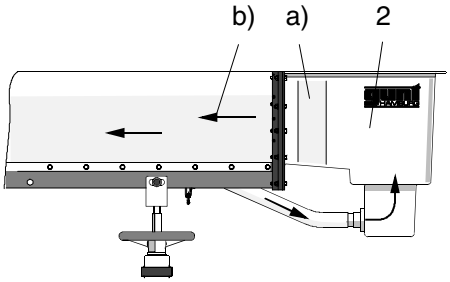


Fig. 2.5

The water entering the inflow segment (2) flows for the most part calmly and with a low degree of swirl into the jet segment (a), where the flow (b) is accelerated at an even rate. The contour of the jet segment is calibrated such that a constant velocity profile is ensured across the entire inflow cross-section. The same water level prevails throughout, and the pressure is constant transverse to the direction of flow.

2.3.5 Channel segment

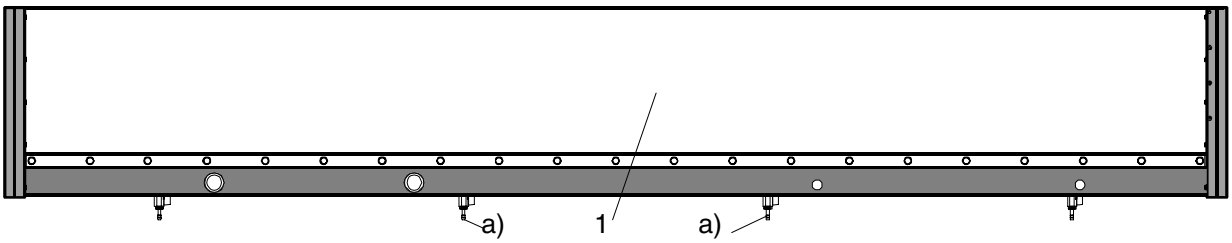


Fig. 2.6

The HM 160 laboratory flow channel is delivered with a channel length of 2.5 m. A **HM 160.10 modular channel segment** (accessory) can be used to extend the channel length of the **G.U.N.T.** HM 160 flow channel to 5 metres. It can also be easily retrofitted in existing channels, since all components required for extension are supplied with this module.

The channel segment (1) has a length of 2.5 m and a flow cross-section of 86 mm (width) x 300 mm (depth).

The transparent side walls are made of transparent polycarbonate, which is particularly abrasion-proof, non-discolouring, and easy to clean. The floor is of stainless steel. The channel segment contains four **measuring glands** (a) with threaded holes (M8). These glands serve, firstly, as fixings for built-on elements such as weirs etc. and, secondly, as fixings for measuring sensors or transmitters, which are installed from below into the measuring glands. To prevent water from leaking out during operation, the measuring glands are fitted with ball cocks, which are only opened when required.

2.3.6 Switchbox

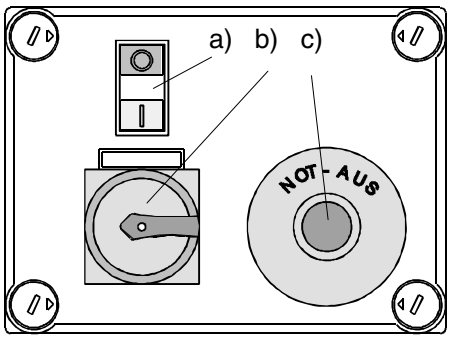


Fig. 2.7

The lid of the switchbox contains all electrical switchgear necessary for operation. Each time prior to operating the system, it should be checked that all switches are set to 0/Off and the Emergency-Off switch (c) is not pressed. If it is locked in the on condition, it can be released by pulling out the knob.

The system is activated by turning the main switch (b) and pressing the pushbutton switch I (a). **It should be ensured that the shutoff valve is closed**, to prevent the water splashing due to pressure surges in the inflow segment. Only then should the shutoff valve be slowly opened.

2.3.7 Outflow segment

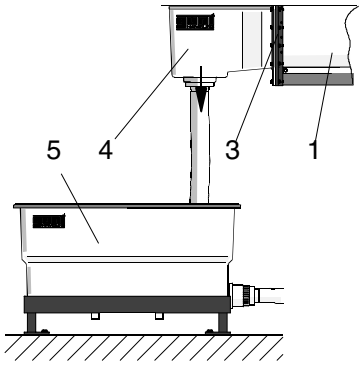


Fig. 2.8

The outflow segment (4) is made of resistant GRP and conducts the water emerging from the channel (1) through a generously dimensioned outflow opening back into the reservoir (5).
To be able to dam the working segment of the flow channel, two grooves (3) were made, into which a rectangular panel weir, comprising several plastic panels, can be inserted from above. The plastic panels can also be arranged such that a sluice (outflow below the water level) is created.

Important! If the inclination on the outflow side is extreme, and plastic panels are used, there is a danger of spillover!

2.4 Installation

2.4.1 Installing the flow channel

- Installation of the 2.5 m long channel segment requires **three people** or appropriate lifting gear (weight approx. 70 kg)
- Installation of the 5 m long channel requires **five people** or appropriate lifting gear (weight approx. 140 kg)
- The unit must stand on a firm, flat, even surface.

2.4.1.1 2.5 metre version

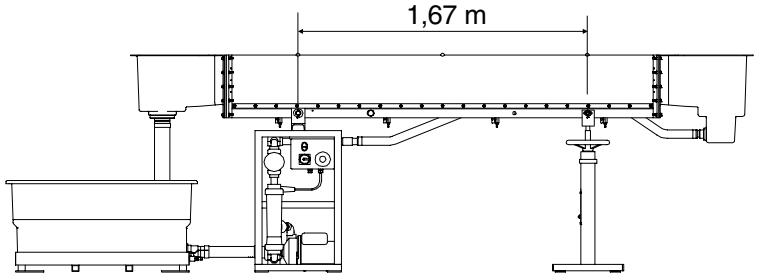


Fig. 2.9

If you have the 5 metre version, follow the instructions given in Chapter 2.4.1.2.

- Mount the bearing pedestals at intervals of 1.67 metres (Fig. 2.9)
- Lift the segment with two people and mount it first in the pump-side pedestal. **Important! For the 2.5 metre version the outer suspension points of the segment are used!** (see Fig. 2.9)
- Grease bolt Ø30 and insert it
- Mount the segment in the other side of the movable bearing pedestal such that the bolt is seated **in the centre of the slot** of the bearing fork (Fig. 2.10). Grease bolt Ø20 before inserting it.

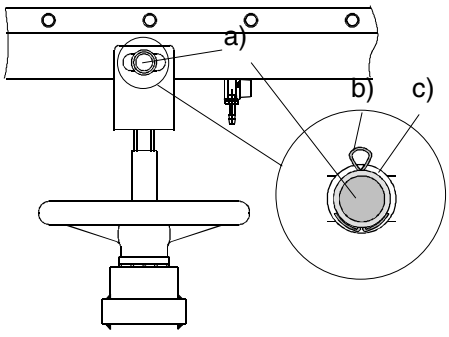


Fig. 2.10

- Secure both bolts (a) as shown with the washer (c) and splint (b)

2.4.1.2 5 metre version (HM 160.10)

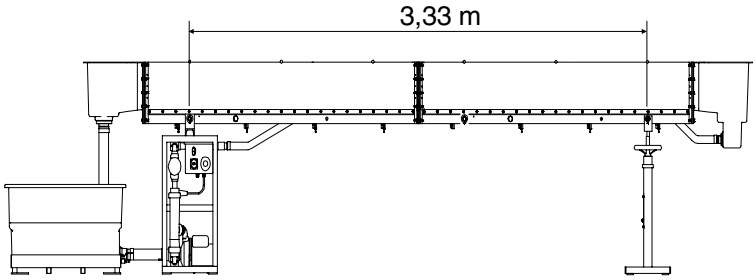


Fig. 2.11

- Mount the bearing pedestals at **intervals of 3.33 m** (Fig. 2.11)
- Place the channel segments on the floor. **Place wood chocks underneath them to ensure the measuring glands do not snap off.**
- Align the transitions
- Bolt the channel segment together on the floor: **inflow side (hole Ø20) is bolted to outflow side (hole Ø30) (Fig.2.12)!** Insert the intermediate plate (d=5mm) beforehand, and ensure the sealing cords fit properly in the grooves of the channel head panel.

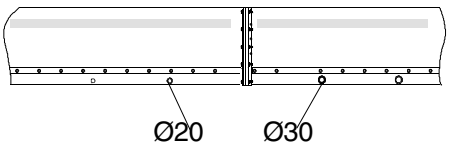


Fig. 2.12

- Lift the bolted segments, using four people, and first mount them in the pump-side pedestal. **Important! For the 5 metre version the inner suspension points of the segment are used!** (see Fig. 2.11)
- Grease bolt Ø30 and insert it
- Mount the segment in the other side of the movable bearing pedestal such that the bolt is seated **in the centre of the slot** of the bearing fork (Fig. 2.13). Grease bolt Ø20 before inserting it.

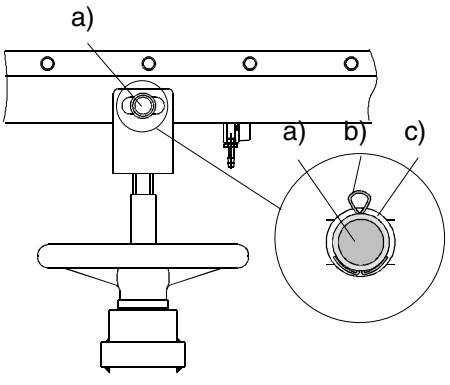


Fig. 2.13

- Secure both bolts (a) as shown with the washer (c) and splint (b)

2.4.2 Aligning the channel

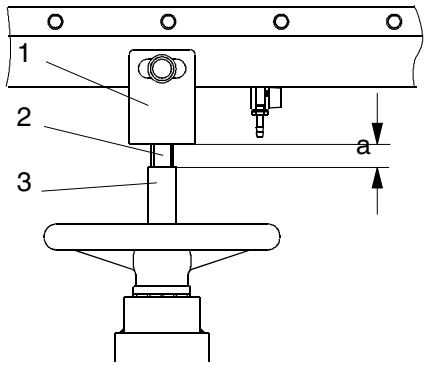


Fig. 2.14

- Adjust the spindle (2) of the movable bearing pedestal such that the **distance *a*** between the spacer sleeve (3) and the bearing fork (1) is **25 mm (2.5 metre version)** or **40 mm (5 metre version)**.
- Important! If the HM 160.10 extension (5 metre version) is to be retrofitted, the spacer sleeve (3) must be shortened by 15mm!
- Grease the spindle and axial bearing
- Insert a spirit level into the channel. If the channel is not horizontal, the pedestals must be raised accordingly by means of packing.
- After alignment both pedestals must be permanently fixed to the floor anchorages!

2.4.3 Installing the inflow and outflow segments

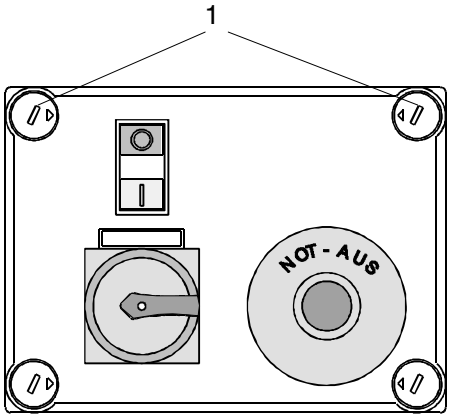


Fig. 2.15

- The **inflow** is located on the **movable bearing side**; the **outflow** correspondingly on the **pump side**.
- Mount the inflow and outflow segments on the front faces, align the transitions, and bolt them in place. Ensure the sealing cords fit properly in the grooves of the channel head panel. **On the outflow side additionally insert the weir frame panel.**
- Connect the float switches; to do so, feed the cables through the clamps on the underside of the channel and the side cable glands into the switchbox.
- IMPORTANT! Disconnect the mains plug!
- Open the switchbox on the front at the four outer plastic screws (quarter-turn locking screws) (1, Fig. 2.15) and connect the float

switch cables as shown (Fig. 2.16). The polarity is irrelevant, because the voltage is alternating.

- Close the switchbox

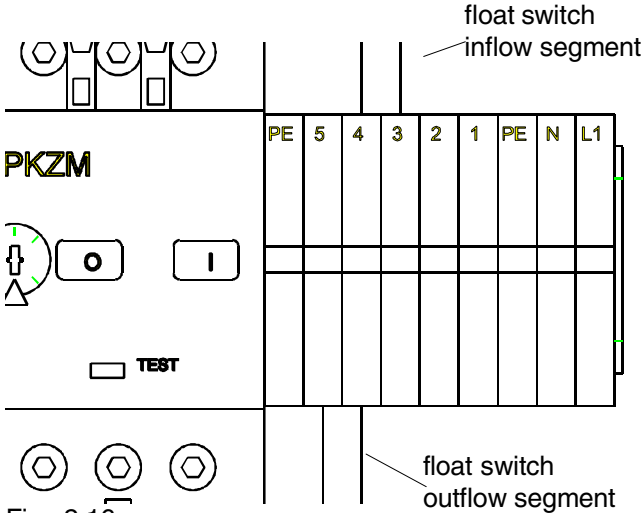


Fig.: 2.16

2.4.4 Mounting the connecting tubes and the tank

- Attach pipe segments to the rear side of the channel.

Making the tube connections:

- Fit the tubes strain-free; they may need to be shortened.
- The **tubes** Ø40 and Ø60 **must be fitted warm** (heat to 80-100°C with a hot-air blower or in a water bath)
- After warming the tubes, push them over the grommets and secure them immediately to the appropriate tube clamp. The clamp must fit over the ribbed part of the grommet!
- Place the reservoir under the outflow and secure the tube to the outflow connection fitting with the tube clamp
- Push the outflow tube (b) as shown through the lid into the reservoir (5) underneath the bracket (a)

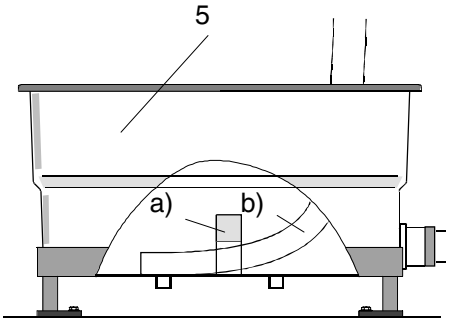


Fig. 2.17

2.4.5 Function check

- Fill the reservoir 3/4 full with clear water; water can be topped up subsequently as necessary
- Close the shutoff valve!
- Connect the mains power
- Switch on the pump
- Check both float switches by actuating by hand: the pump must stop
- Switch the pump back on
- Slowly open the shutoff valve and check the system for leaks

The system is now ready for operation!

2.5 Starting and stopping the system

The following describes all the steps necessary for fault-free, safe operation of the HM 160 laboratory flow channel.

2.4.1 Starting

- Ensure that all switches on the control panel of the switchbox are set to 0 (Off).
- Ensure that the ball cock in the bottom section of the inflow segment (7) is closed.
- Close all drain valves (10) on the measuring glands in the floor of the channel.
- When the system is properly installed, the tank can be filled with water from a hose.
- Important! Maximum filling level approx. 10cm below the rim of the tank.
- Check the tube connections for leaks.
- Set the inclination adjustment device (11) to the desired inclination.

- Close the shutoff valve (7) on the delivery side. It is closed when the lever is standing vertical.
- Switch on the pump.
- Slowly open the shutoff valve (7) and set the desired flow.

2.4.2 Stopping

- Switch off the pump and set the main switch to OFF
- Reduce the inclination setting to -1/40
- Open the shutoff valve (7). Water flows through the pressure pipe back into the reservoir.

2.4.3 Shutdown

- Switch off the pump and set the main switch to Off
- Reduce the inclination setting to -1/40
- Open the shutoff valve (7). Water flows through the pressure pipe back into the reservoir.
- Ensure drainage by connecting a tube to the connection fitting on the drain valve of the reservoir (5)
- Open the drain valve of the reservoir; the reservoir is drained

2.5 Care and maintenance

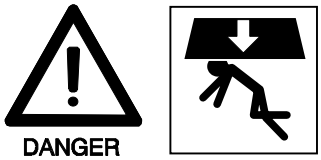
The following gives a few hints on care and maintenance of the HM 160 laboratory flow channel. Following these hints will enable the system to operate correctly and free of fault over many years:

- Lubricate the trapezoidal spindle and the sliding bearing of the inclination adjustment device once a year with machine grease.
- The recommended general rust and corrosion protection is FLUID FILM made by Hodt Korrosionsschutz. This product can be ordered from G.U.N.T. under article number 929.00000A00160. Spray this lanolin-based spray onto all metal parts requiring special and lasting corrosion protection and then wipe them off with a cloth. Do this when the first signs of corrosion are seen.
- Always keep the reservoir covered, as light will accelerate algae growth.
- Clean the panels with a mild detergent or plastics cleaner. Clean off algae growth as soon as it occurs.
- Clean all GRP parts with a mild detergent. Do not use abrasive cleaning agents.

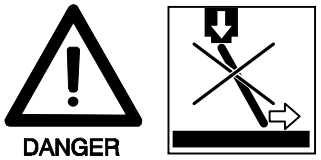
3 Safety

3.1 Dangers for life and limb

- **DANGER!** Take care when opening the switch cabinet and in contact with the electrical equipment!
  Danger of electric shock.
  Repairs must be carried out only by trained personnel.
- **Protect the switch cabinet against water incursion!**



- **DANGER!** Never work underneath the flow channel while it is in operation. Danger of injury from falling objects.
- **DANGER!** Never adjust the inclination beyond the specified range. One of the supports may slip under load.



3.2 Protection of the unit

- IMPORTANT**!** Store the system in a frost-free location.
  There is risk of damage from frost. If the system is at risk from frost drain it.

- **IMPORTANT!** Fill the tank up to max. 10 cm below the rim.
  Risk of spillover.

- **IMPORTANT!** Take care when working in the operating area of the flow channel, especially with heavy tools.
  The Plexiglas may break.

- **IMPORTANT!** Check the tanks, pump and connecting lines routinely for leaks. Leaks may allow large amounts of water to escape unnoticed.

- **IMPORTANT!** Never allow the system to run unsupervised. Operators must be instructed as to the technical features of the system, especially the safety features.

- **IMPORTANT!** Never run the system with sediment!
  The centrifugal pump and variable-area flowmeter would be destroyed.

- **IMPORTANT!** Ensure that no small items, such as screws, tubes etc., are swept into the reservoir!
  Items sucked into the centrifugal pump may destroy it.

- **IMPORTANT!** Only switch on the pump with the shutoff valve closed!
  The pressure surge may cause the water in the inflow segment to splash up and out of the channel.

4 Theory and experiments

A **wide range of accessory units** are available for the HM 162 laboratory flow channel. Some topics, such as overflow weirs, flow metering etc., can only be properly investigated in conjunction with such accessories.

For this reason, the respective theoretical background to topics covered by an accessory unit is detailed in the **instructions for the accessory unit** in question. They also give numerous hints regarding experiments to perform, as well work sheets or other teaching materials.

5 Technical data

Main dimensions:

Length	4300	mm
(with HM 160.10	6800	mm)
Depth	660	mm
Height	1350	mm
Measuring range	2500	mm
(with HM 160.10	5000	mm)
Flow cross-section		
Width	86	mm
Depth	300	mm
Max. filling level	250	mm
Weight	500	kg
(with HM 160.10	650	kg)

2.5 m segment (HM 160.10):

Length	2500	mm
Weight	150	kg

Reservoir:

Capacity:	280	l

Flowmeter:

Type:	Variable-area flowmeter	
Max. flow rate:	10	m^3/h
Measuring range:	0 - 100	%

Inclination adjuster:

Spindle-type lift gear		
Max. lifting load	50	kN
Lift per crank revolution	0.25	mm

Centrifugal pump

Max. delivery height	12.5	m
Max. delivery rate	24	m^3/h
Voltage	230	VAC
Frequency	50	Hz
Power output	0.55	kW
Rotational speed	2850	rpm

Alternatives optional, see type plate