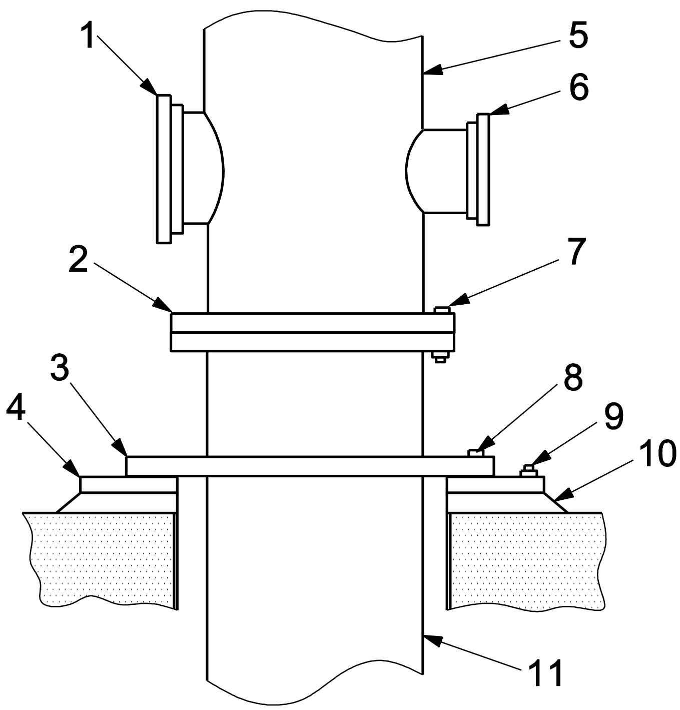
9.3.10.2 The discharge-head mounting surface shall be suitable for both grouting and mounting on a machined sole plate.

9.3.10.3 Thrust restraints are required at the pump if an expansion joint is installed on the discharge nozzle. Design review of the proposed installation and piping by the vendor is recommended.

● **9.3.10.4** If specified, bowl and line shaft bearings shall be furnished with hardened bearing journals under each bearing.

9.3.10.5 Unless otherwise specified, integral bushing spiders and rabbeted fits shall be used for all column sizes.

9.3.10.6 Unless otherwise specified, bowls shall be flanged and shall have metal-to-metal rabbeted fits.



Key

1 suction flange
2 main body flange
3 mounting flange
4 sole plate
5 pump head
6 discharge flange
7 main body flange through-bolting (typical)
8 hold-down bolts (typical)
9 anchor bolts (typical)
10 grout
11 can (outer casing)

Figure 43—Optional Mounting for Vertically Suspended, Double-case Pumps (VS6 and VS7) with Sole Plate

9.3.11 Single-casing Axial Flow (VS3) Pumps

9.3.11.1 Unless otherwise specified, integral bushing spiders and rabbeted fits shall be used for all column sizes.

9.3.11.2 Bowls shall have metal-to-metal rabbeted fits.

9.3.12 Single-casing Line Shaft (VS4) and Cantilever (VS5) Pumps

9.3.12.1 For VS4 pumps, bushings shall be provided to support the shaft and impeller.

9.3.12.2 VS5 pumps shall comply with Items a) through d) as follows.

a) The rotor shall be cantilevered from its bearing assembly. Submerged bottom bushings are not used to guide the shaft.

b) The shaft stiffness shall limit total deflection, without the use of a casing bushing, such that the impeller does not contact the pump casing under the most severe dynamic conditions over the complete head-flow curve with a maximum diameter impeller and at the maximum speed and liquid density.

c) Cantilever type pumps shall have their first dry critical speed, for their rotors, 30 % above their maximum allowable continuous speed.

d) For cantilever-type VS5 pumps, the shaft TIR shall not exceed 0.002 in. (50 µm) as measured on the shaft directly above the mechanical seal or stuffing box.

9.3.12.3 The components that constitute the pressure casing of VS4 and VS5 pumps are the casing, suction cover, and discharge line.

● **9.3.12.4** The purchaser shall specify whether sump-pump services for VS4 and VS5 pumps are open-system or closed-system arrangements. For closed-system arrangements with pressure-containing vessels or tanks, the purchaser shall specify the maximum pressure in the vessel or tank as the maximum suction pressure for the pumps.

9.3.12.5 For VS4 and VS5 pumps in closed-system arrangements, cover-plate joints shall be vapor-tight as a minimum. For VS4 and VS5 pumps in closed-system arrangements with pressure-containing vessels or tanks, the seal chamber, pump cover plate and tank cover shall be designed to contain the maximum suction pressure specified. The cover-plate design and its mounting interface with the pump-mounting nozzle of the vessel or tank shall be agreed to by the purchaser and vendor.

NOTE For closed-system arrangements with single small sump pumps, the purchaser and vendor typically agree to pump-mounting nozzles which conform to the pressure ratings and dimensional requirements of ASME B16.5 and ASME B16.47. Larger sump pumps may require special pump-mounting nozzles to accommodate the weight and size of the equipment.

9.3.12.6 For VS4 pumps, the thrust bearing shall be designed for either grease or oil lubrication. Bushings may be lubricated with water, grease or product, or be self-lubricated.

9.3.12.7 Bearings for VS5 pumps shall be grease-lubricated. The stabilized bearing-housing temperature shall not exceed a 70 °F (39 K) rise above ambient temperature.

9.3.12.8 Packing shall be supplied on VS4 and VS5 pumps except for closed-system services.

9.3.12.9 Mechanical seals, if supplied, shall be located at the cover plate, to seal the vapor in the supply tank or vessel. Mechanical seals normally seal vapor; however, they shall be designed to operate in liquid in the event of tank or vessel overfilling. The seal chamber shall have provisions for a high-point vent.

9.3.12.10 Lifting lugs shall be provided in the cover plate for lifting the pump assembly, including the driver.

9.3.12.11 The discharge nozzle and cover plate shall be designed as required in 6.3.3.

NOTE For pumps are mounted in pressure vessels or tanks, the pump-mounting nozzle of the vessel or tank is designed to withstand the allowable nozzle loads. See 6.5 for allowable nozzle loads.

9.3.12.12 Pump-out vanes may be used in lieu of wear rings to reduce leakage back to the sump.

9.3.12.13 Typically, spacer couplings are not used on VS4 and VS5 pumps. Coupling hubs shall be supplied with slip fits to the shaft. The coupling hubs and keys shall be secured to the shaft with set-screws to facilitate final coupling adjustment.

9.3.13 Double-casing Diffuser (VS6) and Volute (VS7) Pumps

● **9.3.13.1** If specified, bowls and column pipe shall be hydrostatically tested with liquid at a minimum of 1.5 times the maximum differential pressure developed by the bowl assembly. Hydrostatic testing shall be conducted in accordance with the requirements of 8.3.2.

9.3.13.2 Complete outer-case venting shall be ensured by means of a high-point vent connection.

9.3.13.3 Provision shall be made to ensure complete venting of the inner assembly within the seal chamber or associated auxiliary process piping.

● **9.3.13.4** If specified, the suction shall be supplied with a drain piped to the surface.

NOTE A drain is used to remove liquids inside the pump assembly that if not removed, can evaporate and cause a potential hazard when the pump is dismantled.

9.3.13.5 Column sections shall incorporate integral bushing spiders and rabbeted fits for all column sizes.

● **9.3.13.6** If specified, bowl and line shaft bearings shall be furnished with hardened bearing journals under each bearing.

10 Vendor's Data

● **10.1** The purchaser may specify the content of proposals, meeting frequency and vendor data content/format as described in Annex L. Annex L provides a general outline of information that potentially may be requested by the purchaser.

● **10.2** If specified, the information specified in Annex L shall be provided.

Annex A
(normative)

Specific Speed and Suction-specific Speed

Specific speed, n_S, is an index number relating to a pump's performance at BEP flowrate with the maximum diameter impeller and at a given rotational speed. Specific speed is defined by Equation (A.1):

$$n_S = n(q)^{0.5}/H^{0.75} \quad \text{(A.1)}$$

where

n is the rotational speed, expressed in revolutions per minute;

q is the total pump flowrate, expressed in U.S. gallons per minute (cubic meters per second);

H is the head per stage, expressed in feet (meters).

NOTE 1 Specific speed derived using USC units divided by a factor of 51.64 is equal to specific speed in SI units.

NOTE 2 For simplicity, industry omits the gravitational constant from the dimensionless equations for specific speed and suction-specific speed.

An alternative definition of specific speed is sometimes used (flowrate per impeller eye rather than total flowrate). The purchaser is cautioned to understand which definition is being used when comparing data.

Suction-specific speed, S, an index number relating to a pump's suction performance, is calculated at BEP flowrate with the maximum diameter impeller at a given rotational speed and is defined by Equation (A.2):

$$S = n(q)^{0.5}/(\mathrm{NPSH3})^{0.75} \quad \text{(A.2)}$$

where

n is the rotational speed, expressed in revolutions per minute;

q is the flowrate per impeller eye, expressed in U.S. gallons per minute (cubic meters per second) equal to one of the following:

— total flowrate for single-suction impellers,

— one-half the total flowrate for double-suction impellers;

(NPSH3) is the net positive suction head required, expressed in feet (meters).

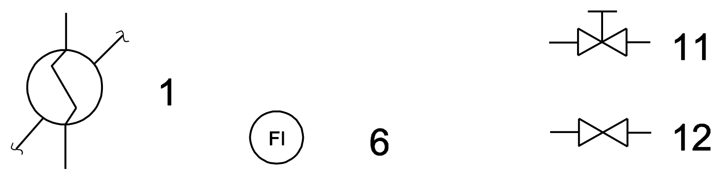
NOTE 3 Suction-specific speed derived using USC units divided by a factor of 51.64 is equal to suction-specific speed in SI units.

NOTE 4 The USC symbol N_{ss} is sometimes used to designate suction-specific speed.

Annex B
(normative)

Cooling Water Schematics

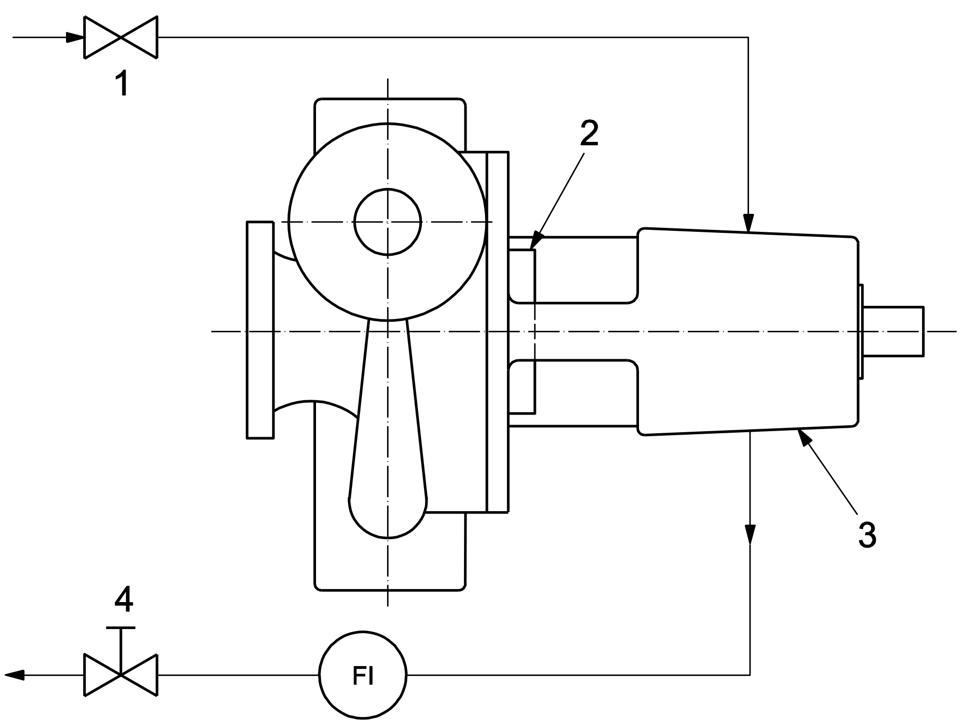
This annex contains schematic diagrams for cooling water systems. The symbols used in Figure B.2, Figure B.3, Figure B.4, Figure B.5, Figure B.6, Figure B.7, Figure B.8, and Figure B.9 are shown and identified in Figure B.1. These symbols represent commonly used systems. Other configurations and systems are available and may be used if specified or if agreed upon by the purchaser and the vendor.



Key

1	heat exchanger	11	flow-regulating valve
6	flowrate indicator	12	block valve (gate valve)

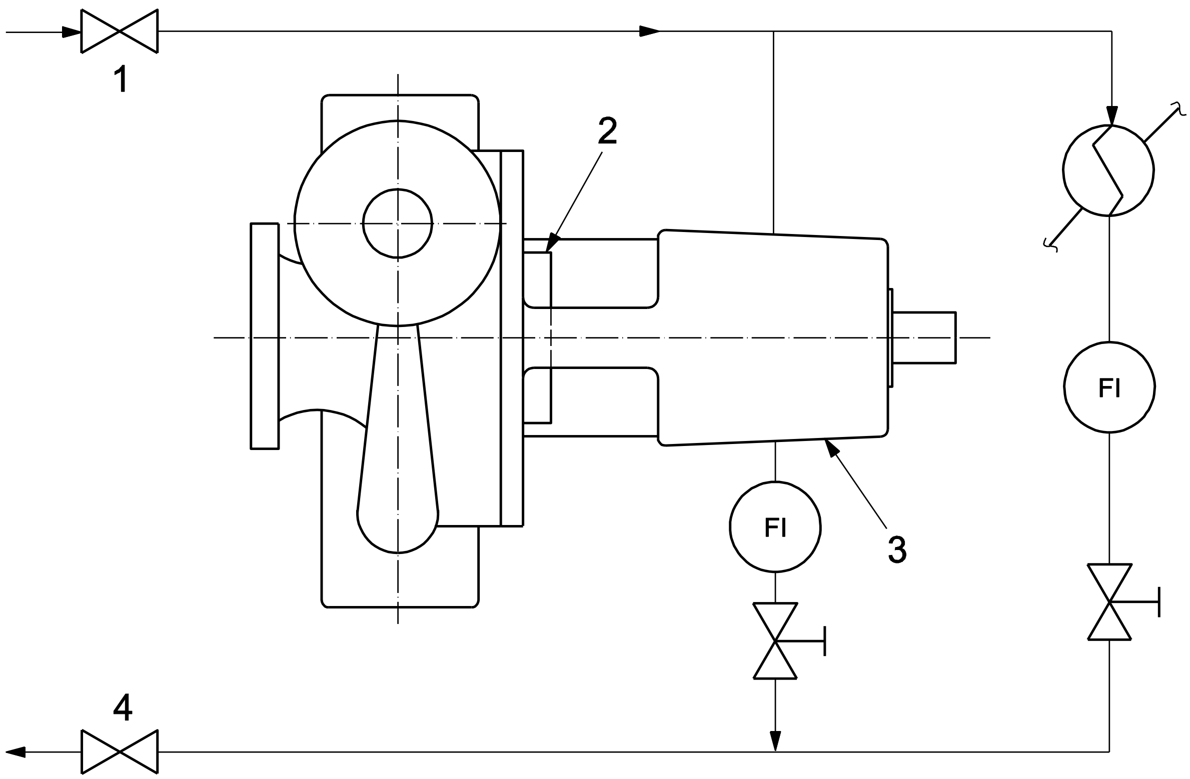
Figure B.1—Symbols Used in Figures B.2 to B.7



Key

1 inlet valve
2 gland
3 bearing housing
4 exit valve

Figure B.2—Piping for Overhung Pumps—Plan A, Cooling to Bearing Housing



Key

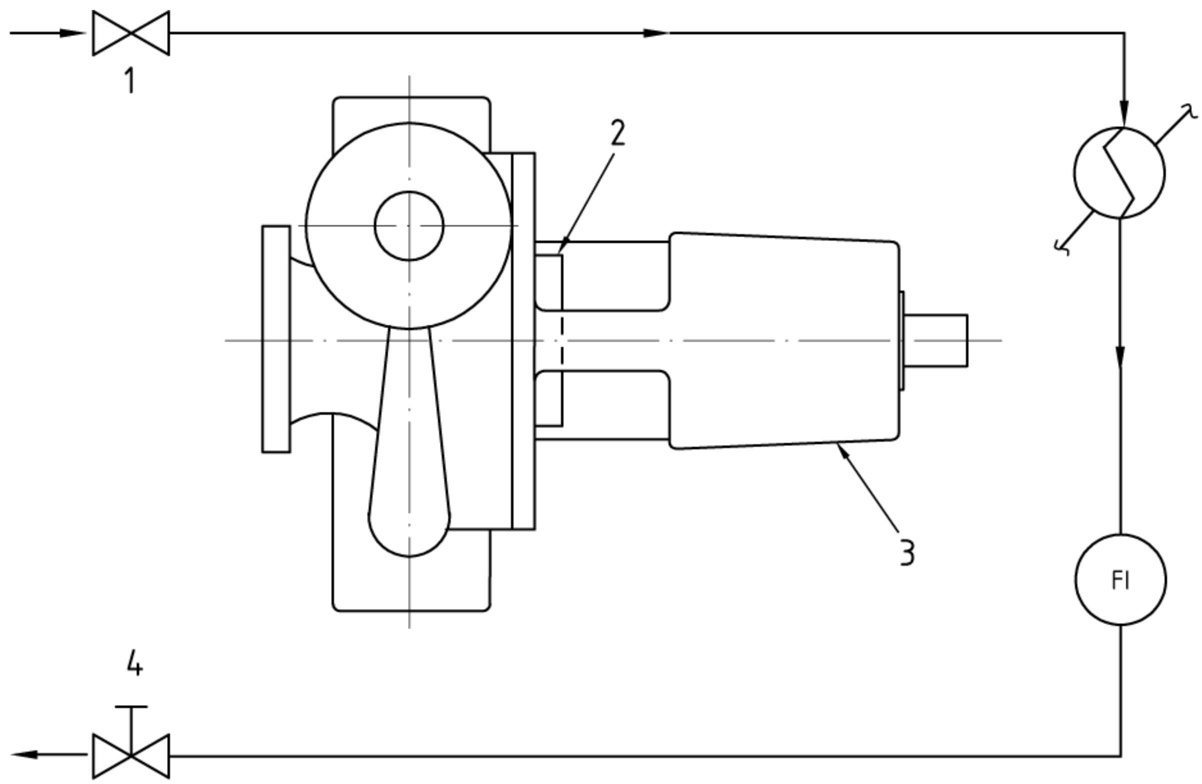
1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.3—Piping for Overhung Pumps—Plan K, Cooling to Bearing Housing with Parallel Flow to Seal Heat Exchanger



Key

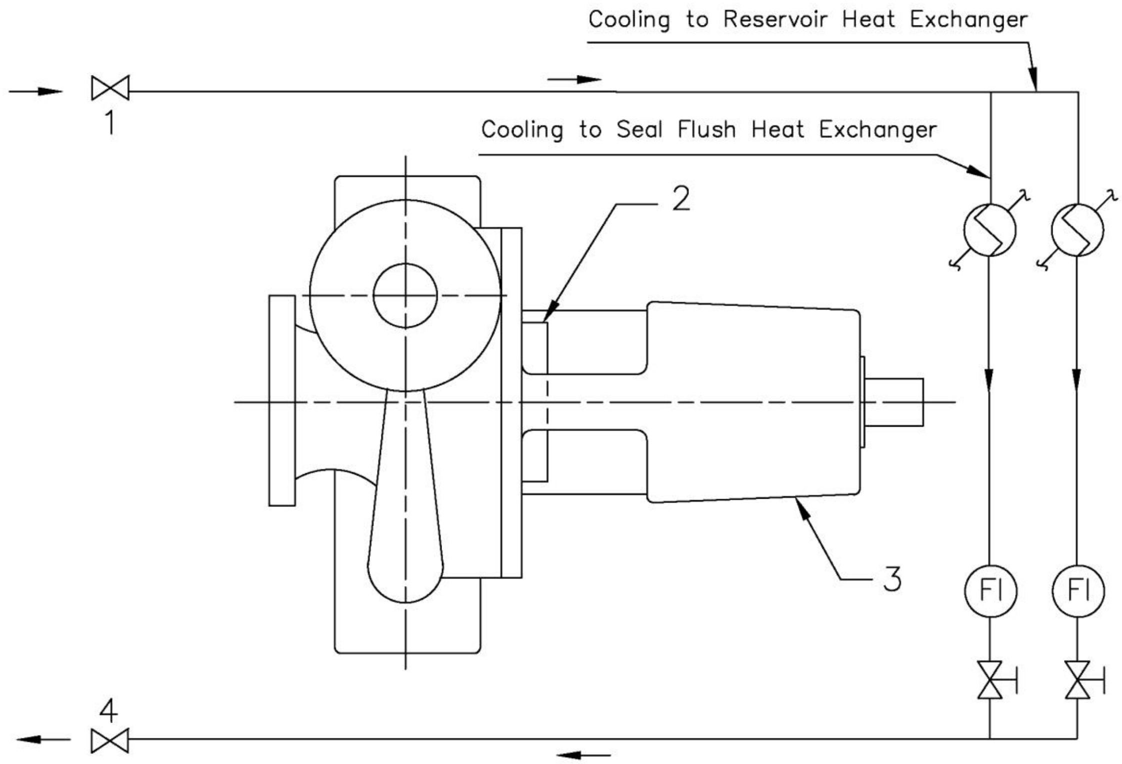
1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.4—Piping for Overhung Pumps—Plan M, Cooling to Seal Heat Exchanger



Key

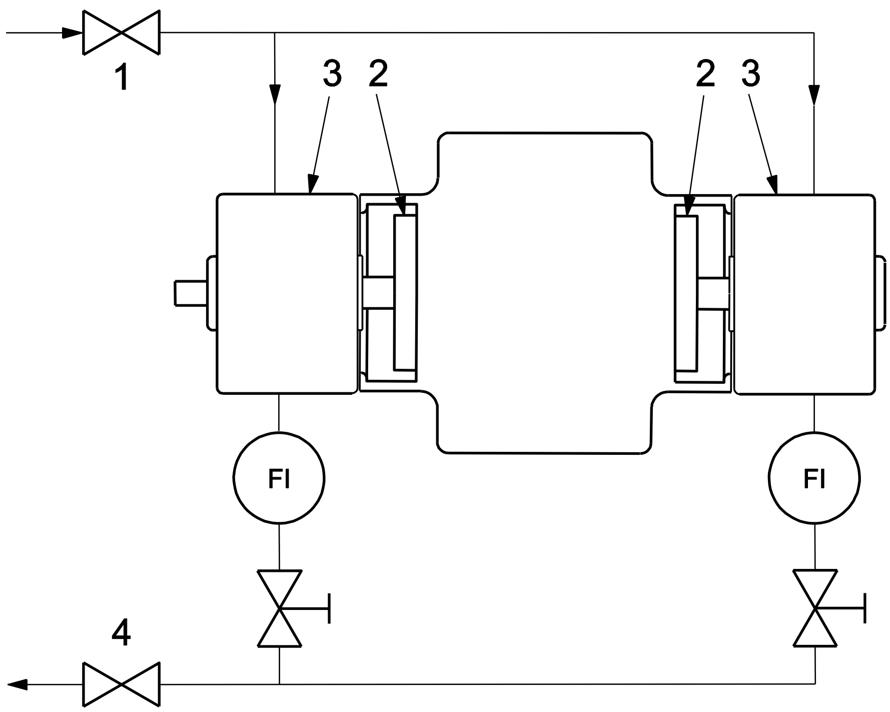
1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.5—Piping for Overhung Pumps—Plan M, Cooling to Seal Heat Exchanger and Reservoir



Key

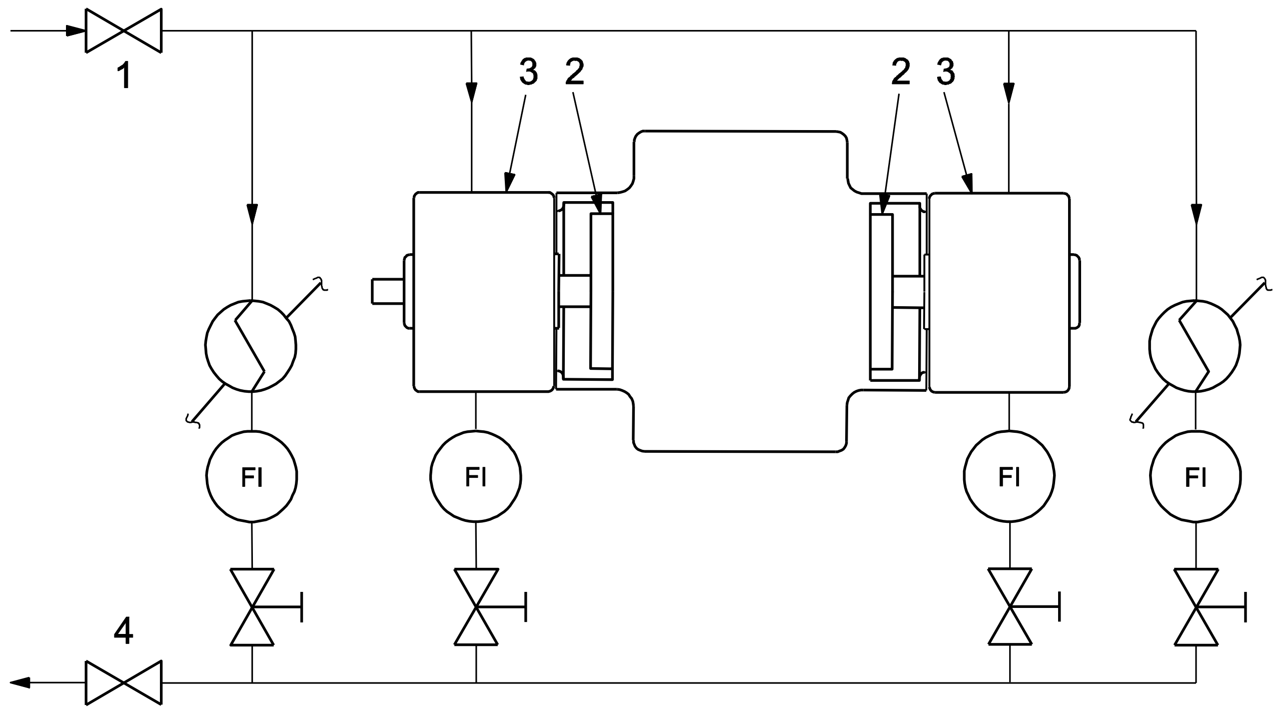
1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.6—Piping for Between-bearing Pumps—Plan A, Cooling to Bearing Housings



Key

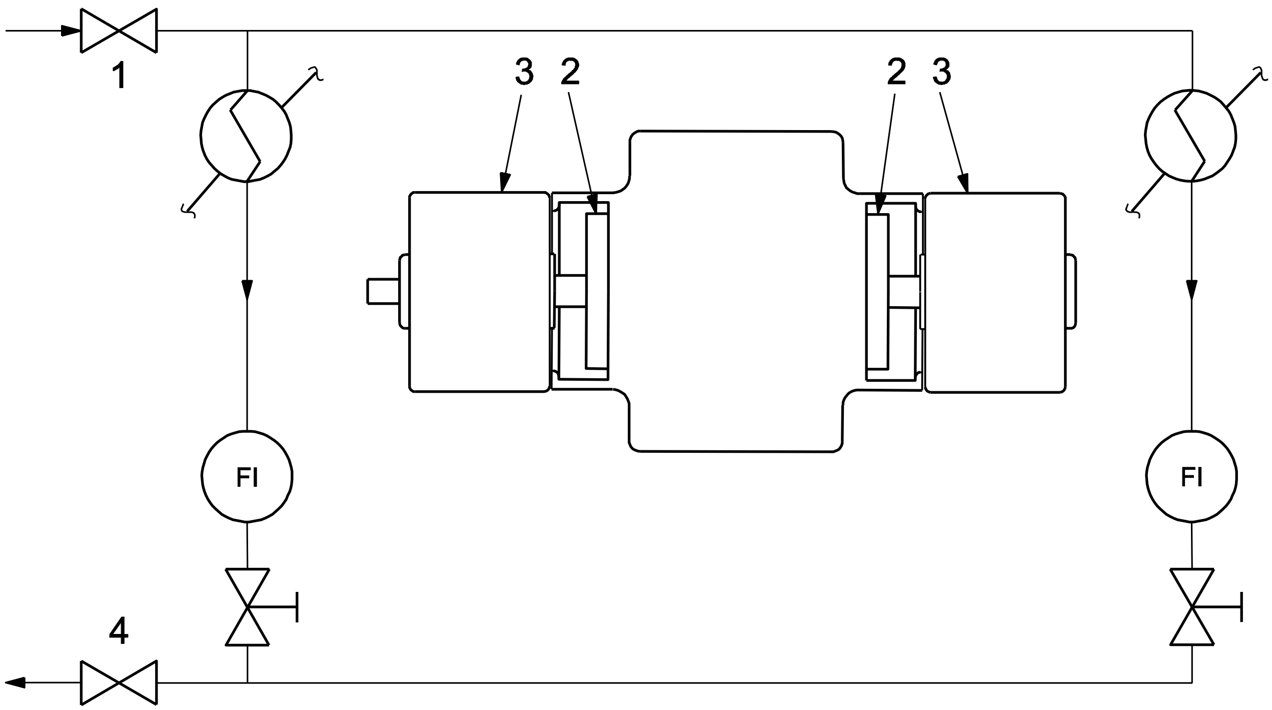
1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.7—Piping for Between-bearing Pumps—Plan K, Cooling to Bearing Housings with Parallel Flow to Seal Heat Exchangers



Key

1 inlet valve

2 gland

3 bearing housing

4 exit valve

Figure B.8—Piping for Between-bearing Pumps—Plan M, Cooling to Seal Heat Exchangers