PRESSURE CONTAINERS WITH BLOCKED OR INOPERABLE VALVES

AIGA 025/13

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1 Introduction

Gas container valves can become blocked by corrosion and foreign material, or made inoperable due to external or internal damage. When this happens, there is a tendency for containers to be put to one side and left for long periods of time. If left, such containers can become a potentially serious hazard. It is an essential safety requirement that such containers are dealt with without delay – the difficult operation of safely releasing the trapped residual gas must be carried out, the container emptied, purged and made safe. It is recommended that Gas Suppliers are prepared with both equipment and trained personnel for dealing with such containers.

This document is applicable to industrial, medical and specialty gases.

2 Scope and purpose

This document gives recommendations on how to handle containers with non operational valves for suppliers of industrial, medical and specialty gas containers.
It sets out practical techniques which have been tried and tested over some years within the Gas Industry. **It must be used in conjunction with the latest revision of the AIGA 083 ' Disposal of Gases'.**

The techniques described should only be followed by those who already have a good working knowledge of gas container maintenance and who are fully trained in handling a wide range of industrial and medical gases including specialty gases.

Before any intervention on a problem container, a specific risk assessment needs to be carried out and documented by a competent team.

3 Definitions

Containers are as defined by the UN Recommendations. They comprise cylinders, tubes, cryogenic containers (up to 1000 litres) and bundles of cylinders.

4 Why container valves become inoperable

Container valves can become either blocked or inoperable in the open or closed position. The reasons are usually one of the following:

4.1 Internal corrosion

Internal corrosion may prevent the operation of the valve where the valve operating mechanism is constructed from materials that are prone to corrosion by the environment or the gas. Many corrosive gases are hygroscopic, i.e. absorb water from the atmosphere, and if gas users fail to purge valve outlets properly before and after use, highly corrosive conditions can occur inside the valve. If the valve operating mechanism is in contact with this corrosive material, seizure can occur.

4.2 Mechanical failure

This may be directly resulting from internal corrosion as per 4 above (e.g. seizure of the valve operating mechanism followed by breakage due to attempts to overcome the seizure).

Mechanical failures can also occur as a result of material or construction faults, excessive wear in the valve's moving parts, impact damage and weaknesses in the valve design or because the operator has forced the valve closed by applying too much tightening torque. In some valve designs the spindle can be operated without lifting the valve sealing device. Therefore a full container can appear empty but the valve sealing device may suddenly lift and release gas.

4.3 Blockages

Blockage of a container valve is normally due to one or more of the following materials entering the valve and compacting at the point where there is minimal cross section in the gas passage:

- Debris from inside the container – examples include: PTFE thread tape, shot and grit remaining from container cleaning operations, rust/corrosion production/millscale from container walls.
- Debris compacted into the valve during filling – examples include: Swarf, PTFE thread tape, grit and dirt, purifier bed packings such as alumina and molecular sieve.
- Decomposition or other reaction products of the gas – examples include:
    - ethylene oxide polymer,
    - metal and silicon oxides which can result from their gaseous hydrides, e.g. phosphine and silane, coming into contact with air,
    - various reaction products that can result if the user permits feedback of reactive materials into the container or container valve,
    - metal halides which can result from reaction of halogens with the container or valve material, e.g. ferrous and ferric chloride can be produced from the action of wet hydrogen chloride on steel.
- Valve seat material – valves fitted with a soft seat may become blocked by extrusion of the soft valve seat into the gas passage.
- Valve outlet connection cap seal – this can cause a blockage to the valve outlet when the connection cap seal has been extruded into it.
- Restricted flow orifice – restricted orifice screwed inside the valve outlet connection can be easily blocked because of the small diameter, typically 0.5 mm.

5 Precautions when releasing gas from containers with blocked or inoperable valves

5.1 Personnel safety and training

Operations to depressurize containers with blocked or inoperable valves must only be undertaken by trained and experienced technicians operating in accordance with the fundamental safe practices for handling gas containers.

Technicians who undertake this work must also have:

- A formal training in the AIGA 083 ‘Disposal of Gases’.
- A good understanding of the properties of the container content and the necessary precautions to be taken.
- A good practical understanding of the container valve and the method of fitment to the container.
- A practical knowledge of action to be taken in the event of an emergency situation developing.

A second person should be in the work area during all operations involving the depressurization of containers with blocked or inoperable valves.
Proper precautions must be taken in the work area to protect personnel from gas and particle discharges.

Appropriate personal protection equipment must be worn and emergency equipment must be readily available.

5.2 Equipment

All equipment must be designed (where appropriate) to withstand the maximum anticipated pressure and must comply with relevant statutory requirements relating to pressure vessels or systems.

The equipment must also be compatible with the gas (es) with which it will be used:

- for oxygen (in excess of 23.5 volume percent) and any other oxidants (some of which have a higher oxidising potential than oxygen), the system must be constructed of compatible materials free from flammable materials and cleaned in accordance with the AIGA 012 – Cleaning of equipment for oxygen service. For certain very powerful oxidants (such as fluorine) pre-passivation of the equipment may be necessary.
- for flammable and pyrophoric gases, the system must be purged and free from air and oxidants.
- for flammable and pyrophoric gases, the dedicated work area shall comply with the requirements of the local or national regulation.
- for corrosive gases, the system must be constructed from compatible materials and dried before use.

5.3 Facilities

Operations to depressurize containers with blocked or inoperable valves should be carried out in a responsible manner to ensure no hazardous conditions are created and that the environment is not harmed. Subsequent disposal of gases should be in accordance with the AIGA 083 ‘Disposal of Gases’:

- for flammable gases released to atmospheres, ignition sources should be excluded.
- for flammable gases contained in a system for subsequent disposal, the system must be purged and free from air and other oxidants to avoid the build up of explosive flammable gas/air or oxidant mixtures.
- for toxic gases, forced draft ventilation is preferred.

6 Introduction to depressurization techniques

6.1 Summary of techniques

There are three basic techniques for release of gas from containers with blocked or inoperable valves:

- unconventional operation of the container valve.
- loosening or removal of the container valve.
- creation of an additional vent in the container valve or container body.

Application of the above techniques will result in one of two modes of container depressurization:

- where the gas remains contained until disposed of.
- where the gas is released to atmosphere.

6.2 Choice of technique

Examples are provided to illustrate the principles of the techniques.

Where practicable, methods which contain the gas (for subsequent disposal) should be chosen for flammable or toxic gases. Where it is necessary to use techniques which release such gases to atmosphere, the work should be carried out in a well-ventilated area or under a fume hood/inside a fume cabinet.

In the event of doubt, or the absence of identification of the container content, the selected method must make it possible to safely deal with all possible hazards that may arise, with operators anticipating the most hazardous.

7 Release of gas by unconventional operation of the container valve

7.1 Partial stripping of the valve to facilitate movement of a broken spindle

Application: Gland packed valves fitted with a solid one-piece spindle where the spindle has sheared, limited to valves where the gland nut is independent of the spindle thread.

Typical arrangement: See Appendix drawing 1.

Procedure:

- The container is secured to prevent toppling.
- Removal of the gland nut and packing will often reveal a sufficient part of the spindle to enable a wrench to be fitted. Penetrating oil can be sparingly applied (except in the case of oxygen and oxidants) and left to penetrate around the spindle operating threads. The auxiliary valve is fitted to the container valve outlet and opened.

- The broken valve spindle is then gripped with a suitable wrench and the valve is opened. Gas will escape from the valve outlet (through the auxiliary valve) and from around the spindle. The packing and gland nut is replaced. The auxiliary valve is closed. Subsequent disposal of the gas is in accordance with the AIGA 083 ‘Disposal of Gases’.

Key safety points:

- Do not attempt unless a sectioned drawing and/or example of the valve is available. There must also be a good understanding of its arrangement and operation.
- Wear appropriate personal protective equipment (PPE).
- When removing the gland nut, ensure that the valve spindle does not rotate with it.
- When the gland nut is removed, take care not to unscrew the valve spindle completely from the valve body.
- Beware of possibility of sudden gas release, and ejected valve parts/particulate matter.
- Care must be taken when using penetrating oil. Oil must not be used on valves in oxygen or oxidant service.
- This technique involves some gas discharge to atmosphere. Consider carrying out work involving toxic gases under forced ventilation. The gas released should be disposed of in accordance with the AIGA 083 ‘Disposal of Gases’.
- Before removing the valve from the container, ensure the valve port or opening is clear of obstruction by blowing nitrogen or air through the opening into the container and observing the free passage in and out.

7.2 Unblocking gas passages in valves

Application: Any valve, containing pressure of maximum 10 bars. Also applicable to valve outlets only containing higher pressure but where the valve can be closed.

Equipment: Stiff thin steel wire, chemical solution, pressurized nitrogen supply.

Typical procedures: The container is secured to prevent toppling. Blocked valves are normally very difficult to “unblock”.

A gas passage can sometimes be cleared by the careful use of a length of stiff wire and/or chemical solution compatible with the gas. Alternatively it may be possible to clear the blockage by careful use

of a pressurized nitrogen supply connected to the valve outlet. Sudden pressure pulses are most likely to succeed. Do not over pressurize the cylinder.

Key safety points:

- Wear appropriate personal protective equipment (PPE).
- Particulate matter may be discharged at high velocity from the valve outlet.
- Extreme caution must be exercised when dealing with powerful oxidising or corrosive gases.
- Consider carrying out work involving toxic gases under forced ventilation.
- Care must be taken to avoid over pressurization of containers and valves when using high pressure nitrogen. Pressure regulation is essential in the nitrogen supply where the available nitrogen pressure exceeds the safe working pressure of the container and valve.
- Before removing the valve from the containers, ensure the valve port or opening is clear of obstruction by blowing nitrogen or air through the opening into the container and observing free passage in and out.

8 Release of gas by loosening or removal of the container valve

8.1 Container and valve enclosed inside coffin or jacket (gas contained)

Application: All gases (except acetylene).

Typical arrangement: See Appendix drawing 2.

Procedure: There must be a documented operating procedure applicable to the design of coffin being used and the gas contained. Generally the following applies:

- The container is inserted into the coffin and secured if necessary.
- The devalving head is fitted to the valve.
- The end plate/motor drive or hand wrench is fitted.
- Where necessary the system is pressurized to ensure absence of leaks, and/or purged of air and moisture.
- The container valve is loosened or removed to permit gas discharge by opening valve A.

Key safety points:

- The coffin must be constructed from materials compatible with the gas to be contained. Special care must be taken in selecting materials for highly oxidising gases.
- The coffin must be capable of withstanding the resultant pressure after release of gas from the container.
- Gas coffins are pressure vessels and must be designed and periodically tested to conform to relevant legislation.
- For flammable gases, the coffin must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen, either through valve A or through additional connections.
- For oxygen (in excess of 23.5 volume percent) and oxidants, the coffin, gaskets and external surface of the container and valve must be compatible, degreased and dried. (Ref. AIGA 012/04 – Cleaning of equipment for oxygen service).
- For corrosive gases, the system must be dry.
- For toxic gases, the system must be pressurized and leak tested prior to operation.
- Subsequent disposal of the waste gas should be in accordance with the AIGA 083 ‘Disposal of Gases’.
- After use, the coffin must be purged and free from all contaminants.
- Before opening the coffin, ensure the pressure has been released by blowing nitrogen or air through valve A into the coffin and observing free passage in and out.

8.2 Valve end of container enclosed (gas contained)

Application: All gases, except acetylene.

Typical arrangement: See Appendix drawing 3.

Procedure: The container is secured firmly into the frame. The devalving head is fitted to the valve and the gas tight cap is secured. Where necessary the system is pressurized to ensure absence of leaks and purged either through valve A or through additional connections. The container valve is loosened to permit gas discharge through valve A.

Key safety points:

- The equipment must be constructed from materials compatible with the gas to be contained. Special care must be taken in selecting materials for highly oxidising gases.
- The container neck ring must be secure and in good condition in order to obtain a gas tight seal on its surface.
- The cap/mechanical securing system must be periodically inspected and capable of withstanding the resultant pressure and force after release of gas from the container. Local statutory requirements relating to pressure testing must be complied with.
- For flammable gases, the cap must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen.
- For oxygen (in excess of 23.5 volume percent) and oxidants, the cap, gaskets and container valve must be compatible, degreased and dried. (Ref. AIGA 012 Cleaning of equipment for oxygen service).
- For toxic gases, the system must be pressurized and leak tested prior to operation.
- For corrosive gases, the system must be dry.
- Subsequent disposal of the waste gas should be in accordance with the AIGA 083 ‘Disposal of Gases’.
- Before removing the gas tight cap, ensure the pressure is released by blowing nitrogen or air through valve A into the cap and observing free passage in and out.

8.3 Container valve loosened (gas released to atmosphere)

Application: Gases that can be disposed of safely when released.

Typical arrangement: See Appendix drawing 4.

Procedure:

- The container is secured to prevent toppling and the valve restrainer is clamped to the container and adjusted to give a safe clearance to prevent ejection of the valve. The lock nut is tightened. The valve is carefully loosened up to the restrainer and the gas allowed to escape.
- Gas escape is monitored using an approved leak test solution on the container neck thread. When evidence of gas release is observed, stop unscrewing the valve and monitor the gas leak prior to any further loosening of the valve.
- It may be necessary to change the valve restrainer adjustment in order to achieve the required gas discharge rate.

Key safety points:

- The restrainer should be of robust construction, capable of being firmly clamped to the container.
- Wear appropriate personal protective equipment (PPE)
- Consideration should be given to the installation of an appropriate screen between the container valve and the operator.
- For toxic or flammable gases, the procedure should be carried out in a well-ventilated area, fume hood or fume cubicle.
- Beware of sudden gas release.
- Disposal of the gas released should be in accordance with the AIGA 083 ‘Disposal of Gases’.

Before completely removing the valve from the container, ensure the container is depressurised.

8.4 Container contents cooled by external refrigeration and inoperable valve exchanged (gas contained)

Application: Gases transported in containers (except pyrophoric gases or acetylene) that can be positively identified and be cooled below their boiling point at atmospheric pressure (e.g.: Chlorine -34°C) in containers that can be cooled without embrittlement occurring (see below).
Container
Procedure:

- The container is evenly cooled in a controlled manner to just below the boiling point of its content. The cooling method used is dependent on the required temperature.
- The temperature of the cooling medium and the top of the container shoulder is monitored during the cooling process.

- When the desired cooling has been achieved (i.e. stable temperature of the container shoulder) and the container has been secured against falling over, the faulty valve is carefully loosened, removed and replaced with a serviceable, pre-taped valve with the same inlet thread inserted at a sufficient torque to create a seal.
- As the container begins to warm the gas can be transferred to another container or disposed of in accordance with the AIGA 083 'Disposal of Gases'.

Key safety points:

- Due account must be taken of the physical properties of the container content to ensure it will fully condense at the proposed refrigeration temperature. Special consideration is necessary when dealing with gas mixtures whose composition may change as cooling takes place.
- Cooling should be evenly distributed to avoid excessive temperature gradients across the container.
- Precautions shall be taken when cooling down containers. The cooling process shall be slow enough to ensure that the gas and the container shell remain at the same temperature. This is particularly important with steels where cold embrittlement may occur. Advice on the minimum acceptable temperature for any particular containers should be sought from a competent expert e.g. a metallurgist. In the absence of such advice, the following minimum temperatures must be observed:
    - Seamless steel containers: -20 °C.
      If the temperatures used are lower than those given above or accepted by the competent expert, seamless steel containers shall be hydraulically tested before being put back into service.
    - For welded steel containers similar temperatures may be used after ensuring the good behaviour of the weld at low temperature.
    - Aluminium alloys are not sensitive to cold embrittlement. Consequently they may be cooled down slowly even to cryogenic temperatures provided **the mechanical integrity of** the valve and the container to valve connection are not compromised.

- Care should be taken when handling cold containers. They must not be dropped or handled violently. Containers with loosened valves should not be moved if they contain gas.
- Cooling operations involving the use of gaseous coolants should only be undertaken in well-ventilated areas and operators must be made aware of the risks of asphyxiation.
- Wear appropriate safety equipment which includes protection against cold burns.
- For flammable gases, special precautions may be necessary as air may enter the container during the valve exchange operation.
- For toxic gases, valve exchange should be carried out in a well-ventilated area, fume hood or fume cubicle.
- Disposal of the gas released should be in accordance with the AIGA 083 'Disposal of Gases'

8.5 Container contents cooled by flash cooling and inoperable valve exchanged (gas released to atmosphere)

Application: Low pressure liquefiable gases that can be positively identified and safely discharged. This method has been successfully used for large diameter, thin-walled containers of anhydrous ammonia.

Typical arrangements: See Appendix drawing 5.

Procedure: The container is held in a vice with the valve uppermost. The valve is loosened, usually one to one and a half turns is sufficient. The remote valve removal tool is then fitted to the valve and valve removal is completed from a safe distance. The gas discharge rate will reduce rapidly as the surface of the liquid in the container cools. A new valve is fitted as soon as the gas discharge rate permits it.

Key safety points:

- This method can only be used in well-ventilated remote locations away from personnel.
- Wear appropriate personal protective equipment (PPE).
- Care should be taken as liquefied gas may eject from the container, particularly if the container is full, is of small diameter or is thick-walled.
- The valve must be removed from a safe distance.

9 Release of gas by creation of additional vent in container valve or container body

9.1 Drilling on axis of valve outlet (gas contained)

Application: Valves whose designs permit destruction of the seat by drilling on the axis of the valve outlet. Gases, except powerful oxidants and acetylene.

Typical arrangement: See Appendix drawing 6.

Procedure:
The container is secured to prevent toppling and the drilling adaptor is fitted to the valve outlet using an appropriate gasket. Where necessary the system is pressurized to ensure absence of leaks and purged with inert gas. The drill is rotated slowly until a gas path across the valve seat is obtained Gas is discharged by opening valve A. The discharge rate can be monitored by a pressure indicator installed on the purge/vent line. If leakage occurs around the drill, the gland nut is tightened.

Key safety points:

- Equipment must be constructed from materials that are compatible with the gas to be contained.
- A sectioned drawing and/or example of the valve should be available to enable the operator to drill into the gas path.
- Wear appropriate personal protective equipment (PPE).
- The largest practicable drill diameter should be used to minimise the risk of breakage.
- The cap/securing system must be periodically inspected and capable of withstanding the resultant pressure and force after release of gas from the container. Local statutory requirements relating to pressure testing must be complied with.
- The container neck ring must be secure and in good condition in order to obtain a gas tight seal on its surface.
- Special care should be taken if the container is fitted with a dip tube and contains liquefied gas. It is recommended that the container is positioned to avoid liquid entering the cap.
- The drill should be fitted with a collar to prevent its ejection under pressure.
- A guide mark should be made on the visible part of the drill to avoid excessive entry into the valve body.
- For flammable gases, the system must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen.

- For a gas mixture with a partial pressure of oxygen in excess of 30 bar and all highly oxidising gases, all components shall be oxygen compatible and clean. (Reference: AIGA 012). The drilling must proceed very slowly to avoid risk of hot spots. This method is not suitable for some oxidants such as fluorine (F_2), nitrogen trifluoride (NF_3), nitrous oxide (N_2O).
- For toxic gases, the system must be pressurized and leak tested prior to operation.
- Subsequent disposal of waste gas should be in accordance with the AIGA 083 'Disposal of Gases'.

9.2 Before removing the valve from the container, ensure the opening made by drilling is clear of obstruction by blowing nitrogen or air through the port or opening into the container and observing the free passage in and out. Drilling into valve body, valve end of container enclosed (gas contained)

Application: All valves. Gases, except powerful oxidants and acetylene. Not recommended for high pressure compressed gases.

Typical arrangement: See Appendix drawing 7.

Procedure:

- The container is secured to prevent toppling and the container neck ring is cleaned. The cap/drilling adaptor and gasket are fitted. The restraining device (to prevent ejection of the cap under pressure) is fitted (see 6.2.). The centre punch is inserted through the drilling adaptor (drill, gland packing and gland nut removed) and the drilling position is marked on the valve body. The centre punch is removed. The drill, gland packing and gland nut are assembled.
- Where necessary the system is pressurized to ensure absence of leaks and purged either through valve A or through additional connections.
- The drill is rotated slowly until a gas path through the valve body is obtained. If leakage occurs around the drill, the gland nut is tightened.
- The gas is discharged through valve A.

Key safety points:

- Equipment must be constructed from materials that are compatible with the gas to be contained.
- A sectioned drawing and/or example of the valve should be available to enable the operator to drill into the gas path.
- Wear appropriate personal protective equipment (PPE).
- The largest practicable drill diameter should be used to minimise the risk of breakage.
- The cap/securing system must be periodically inspected and capable of withstanding the resultant pressure and force after release of gas from the container. Local statutory requirements relating to pressure testing must be complied with.
- The container neck ring must be secure and in good condition in order to obtain a gas tight seal on its surface.
- Special care should be taken if the container is fitted with a dip tube and contains liquefied gas. It is recommended that the container is positioned to avoid liquid entering the cap.
- The drill should be fitted with a collar to prevent its ejection under pressure.
- A guide mark should be made on the visible part of the drill to avoid excessive entry into the valve body.
- For flammable gases, the system must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen.
- For a gas mixture with a partial pressure of oxygen in excess of 30 bar and all highly oxidising gases, all components shall be oxygen compatible and clean. (Reference: AIGA 012). The drilling must proceed very slowly to avoid risk of hot spots. This method is not suitable for some oxidants such as fluorine (F_2), nitrogen trifluoride (NF_3), nitrous oxide (N_2O).
- For toxic gases, the system must be pressurized and leak tested prior to operation.
- Subsequent disposal of waste gas should be in accordance with the AIGA 083 'Disposal of Gases'.
- Before removing the valve from the container, ensure the opening made by drilling is clear of obstruction by blowing nitrogen or air through the port or opening into the container and observing the free passage in and out.

9.3 Drilling into valve body (gas contained)

Application: Gases except powerful oxidants and acetylene.

Typical arrangement: See Appendix drawing 8.

Procedure:

- The container is secured to prevent toppling and the outlet sealed with a plug or cap nut. The drilling adaptor is secured to the valve body either by drilling and tapping into the valve body or by clamping.
- Where necessary the system is pressurized and leak tested prior to operation.
- The drill is rotated slowly until a gas path through the valve body is obtained. If leakage occurs around the drill, the gland nut is tightened.
- The gas is discharged through valve A.

Key safety points:

- Equipment must be constructed from materials that are compatible with the gas to be contained.
- A sectioned drawing and/or example of the valve should be available to enable the operator to drill into the gas path.
- When drilling and tapping, care must be taken to select a part of the valve body with sufficient material to machine the drilling adaptor thread without breaking through into the gas path. There must be sufficient thread engagement to withstand the container pressure.
- The largest practicable drill diameter should be used to minimise the risk of breakage.
- The drill should be fitted with a collar to prevent its ejection under pressure.
- A guide mark should be made on the visible part of the drill to avoid excessive entry into the valve body.
- Special care should be taken if the container is fitted with a dip tube and contains a liquefied gas.
- Wear appropriate safety equipment.
- For flammable gases, the system must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen.
- For oxygen (in excess of 23.5 volume percent) and oxidants, all components must be compatible and degreased. (Ref. AIGA 012 – Cleaning of equipment for oxygen service). The drilling must proceed very slowly to avoid the risk of hot spots. The method is not suitable for powerful oxidants.
- For toxic gases, the system must be pressurized to ensure absence of leaks.
- Subsequent disposal of waste gas should be in accordance with the AIGA 083 ‘Disposal of Gases’.
- Before removing the valve from the container, ensure the opening made by drilling is clear of obstruction by blowing nitrogen or air through the opening and observing the free passage in and out.

9.4 Sawing into container valve shank (gas released to atmosphere)

Application: Gases, except powerful oxidants, acetylene and pyrophoric gases, that can be disposed of safely when released.

Typical procedure:

- The container should be properly secured in a convenient position.
- A saw cut is made into the valve shank at a point that is convenient and which offers the minimum depth of cut to the gas path. The cut is made using a handsaw fitted with a thin fine-toothed blade. Careful use of the saw will enable a small flow of gas to be achieved at the point of the break through into the gas path.
- For flammable gases, in order to minimise the risk of sparking a water spray may be used to cool the cut or by inerting the cut area.

Key safety points:

- A sectioned drawing and/or example of the valve should be available to enable the operator to cut into the gas path. Some valves do not have concentric bores in their shanks.
- It should be noted that sawing into the valve weakens its mechanical properties.
- Wear appropriate personal protective equipment (PPE).
- Beware of possibility of sudden gas release and ejected particulate matter.
- Special care should be taken if the container is fitted with a dip tube and contains liquefied gas. The container should be positioned such that the tube end is in the vapour space.
- For oxygen (in excess of 23.5 volume percent) and oxidants, the valve body and saw must be free from dirt and grease. Sawing must proceed very slowly to avoid risk of hot spots. This method is not suitable for powerful oxidants or pyrophoric gases.
- For toxic of flammable gases, the procedure must be carried out in a well-ventilated area, fume hood or fume cubicle.
- Disposal of the gas released should be in accordance with the AIGA 083 'Disposal of Gases'.
- Before removing the valve from the container, ensure the opening made by the cut is clear of obstruction by blowing nitrogen or air through the opening and observing the free passage in and out.

9.5 Drilling into container body (gas contained)

Application: All gases except acetylene and powerful oxidants. Containers with a low working pressure (less than 20 bar) or containers with a higher working pressure when their diameter does not exceed 80 mm.

Typical arrangement: See Appendix drawing 9.

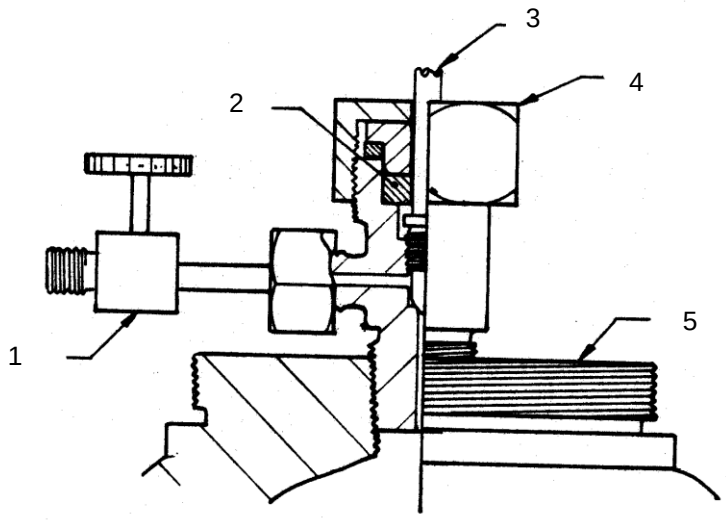
Procedure:

- The container should be properly secured in a convenient position.
- The drilling adaptor is secured to the container wall. Various methods of securing can be used including a belt and heavy steel jaws mounted to a frame in which the container is inserted.
- Where necessary the system is pressurized and leak tested prior to operation.
- The drill is rotated until a gas path through the container wall is obtained. If leakage occurs around the drill, the gland nut is tightened.
- The gas is discharged through valve A.

Key safety points:

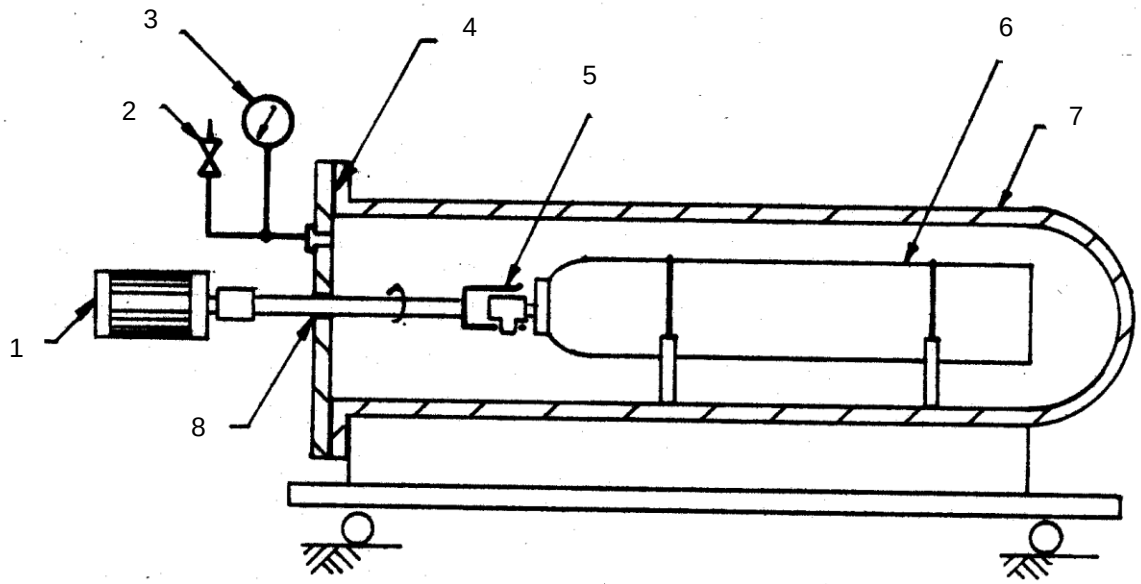
- When dealing with containers at higher pressures than 20 bars, it should be noted that only limited experience is available in the industry. The operator should only use this method if he is confident that the container wall is in good condition and that drilling the hole will not impair the overall safety of the container.
- Equipment must be constructed from materials that are compatible with the gas to be contained.
- The drill diameter should not be too small to minimise the risk of breakage and not too large to minimise the risk of container rupture. A diameter of between 3mm and 5mm is recommended.
- The drill should be fitted with a collar to prevent its ejection under pressure.
- Special care should be taken with liquefiable gases. Drill into the vapour space.
- For flammable gases, the system must be freed from air. This can be done by evacuation and/or purging with an inert gas such as nitrogen.
- For oxygen (in excess of 23.5 volume percent) and oxidants, all components must be compatible and degreased, (including gaskets) and the drilling must proceed very slowly to avoid risk of hot spots. Drilling chips may be hot enough to trigger a dangerous reaction with oxidants. The method is not suitable for powerful oxidants.
- For toxic gases, the system must be pressurized and leak tested prior to operation.
- Subsequent disposal of waste gas should be in accordance with the AIGA 083 'Disposal of Gases'.
- Before removing the valve from the container, ensure the opening made by drilling is clear of obstruction by blowing nitrogen or air through the opening into the container and observing the free passage in and out.
- The container must be destroyed after it has been emptied and purged.

APPENDIICES



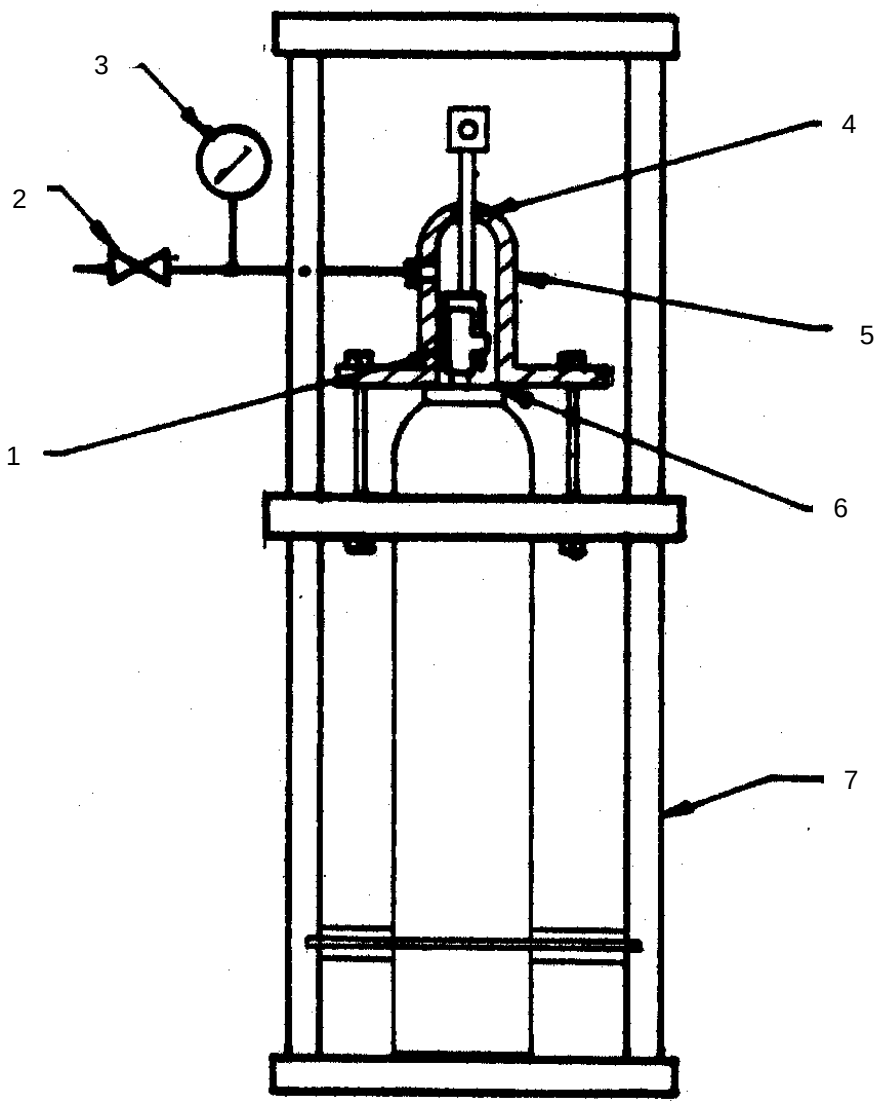
1 - Auxiliary valve
2 - Gland packing
3 - Broken valve spindle
4 - Gland nut
5 - Container

Drawing 1: Partial stripping of the valve to facilitate movement of a broken spindle



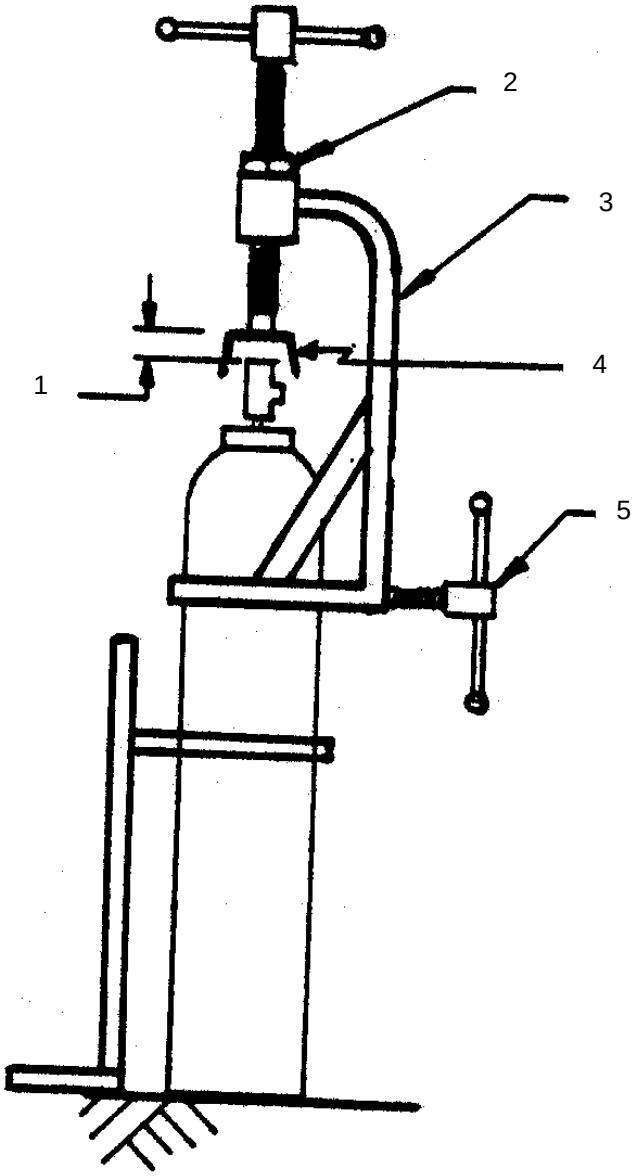
1 - Motor drive (or hand wrench)
2 - Valve A
3 - Pressure gauge
4 - Gasket
5 - Devalving head
6 - Container
7 - Container
8 - Coffin

Drawing 2: Container and valve enclosed inside coffin or jacket (gas contained)



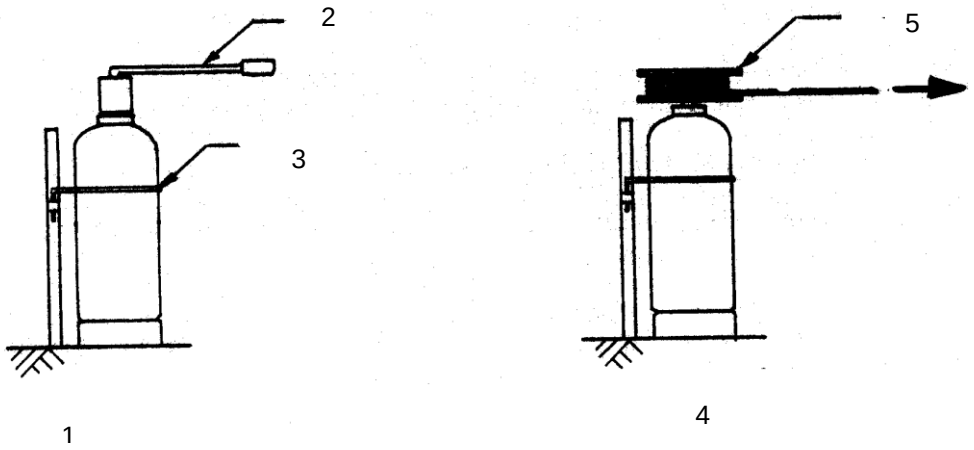
1 - Devalving head
2 - Valve A
3 - Pressure gauge
4 - Gas tight gland
5 - Gas tight cap
6 - Gasket
7 - Container securing frame

Drawing 3: Valve end of container enclosed (gas contained)



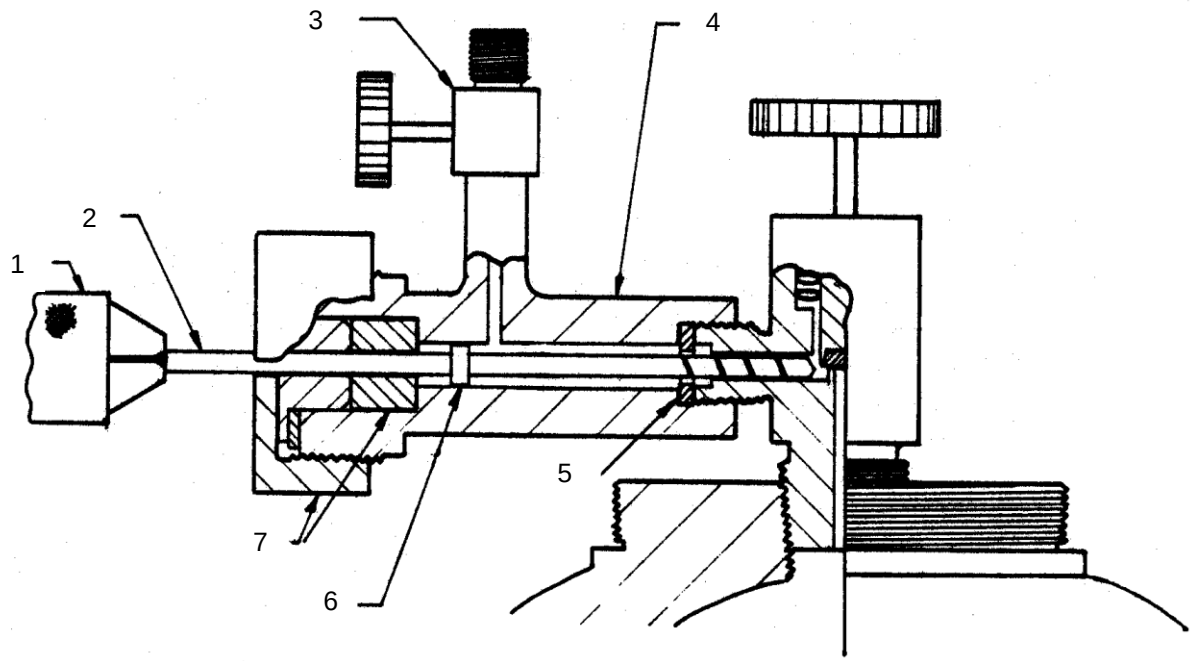
1 - Screw to required clearance
2 - Lock-nut
3 - Valve restrainer
4 - Restrainer cup
5 - Screw to clamp to container

Drawing 4: Container valve loosened (gas released to atmosphere)



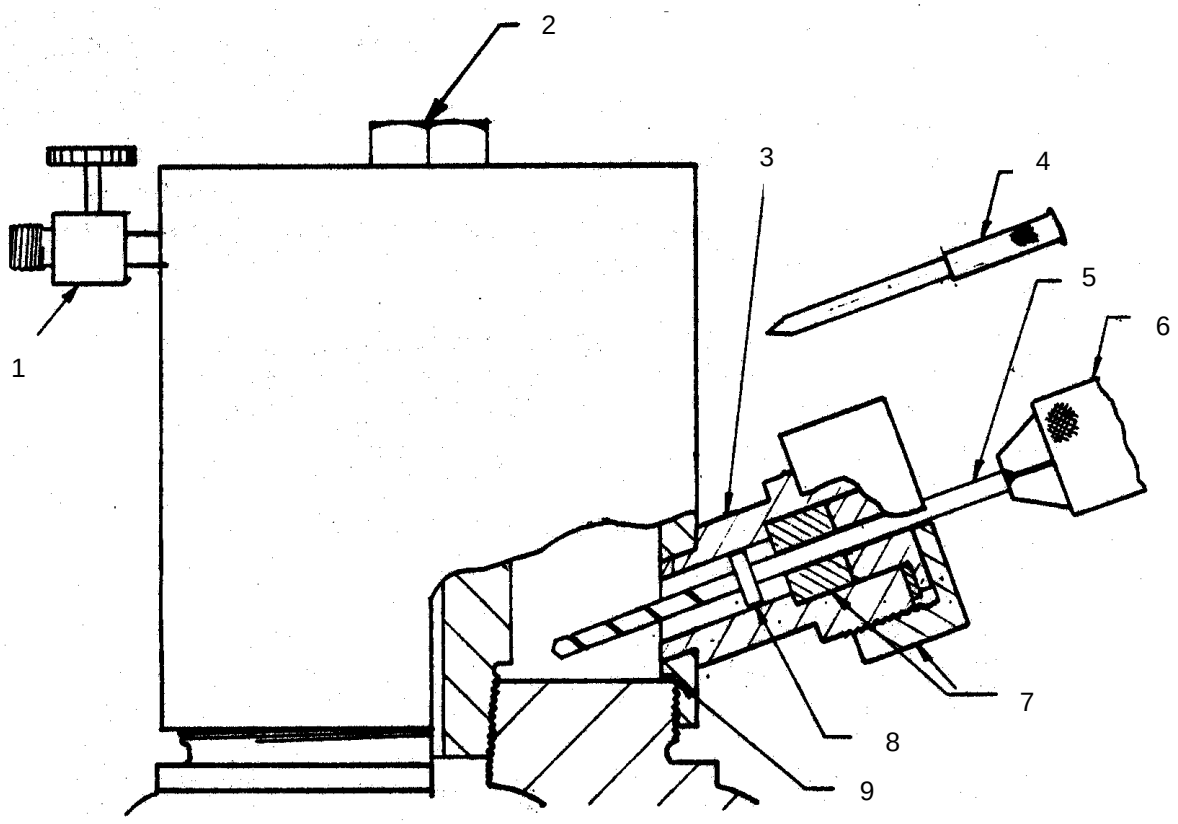
1 - Technician ‘loosens” valve using a wrench
2 - Wrench
3 - Clamp
4 - Technician pulls rope from a safe place to complete the removal of container valve
5 - Drum with circa 15m of rope. Centre has clamp to fit container valve

Drawing 5: Container contents cooled by flash cooling and inoperable valve exchanged (gas released to atmosphere)



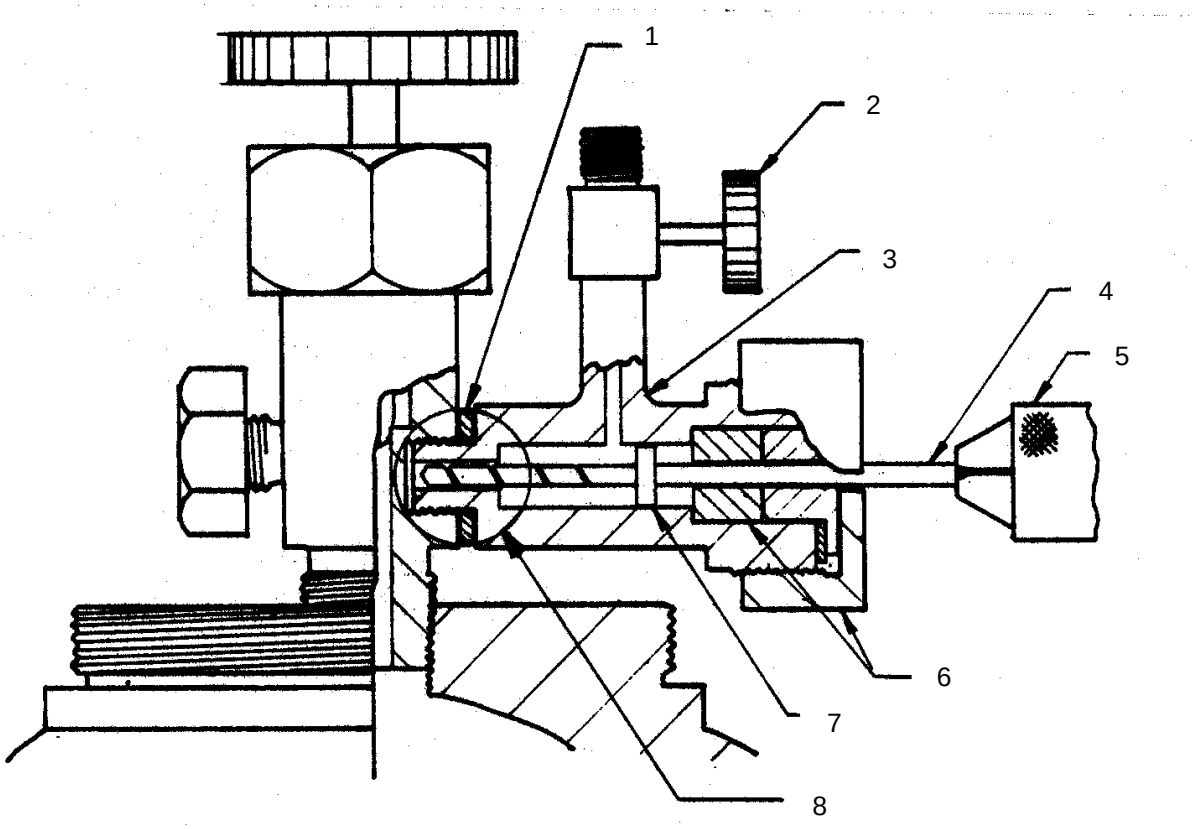
1 - Hand drill
2 - Drill
3 - Valve A
4 - Drilling adaptor
5 - Gasket
6 - Retaining collar
7 - Gland packing and gland nut (around drill)

Drawing 6: Drilling on axis of valve outlet (gas contained)



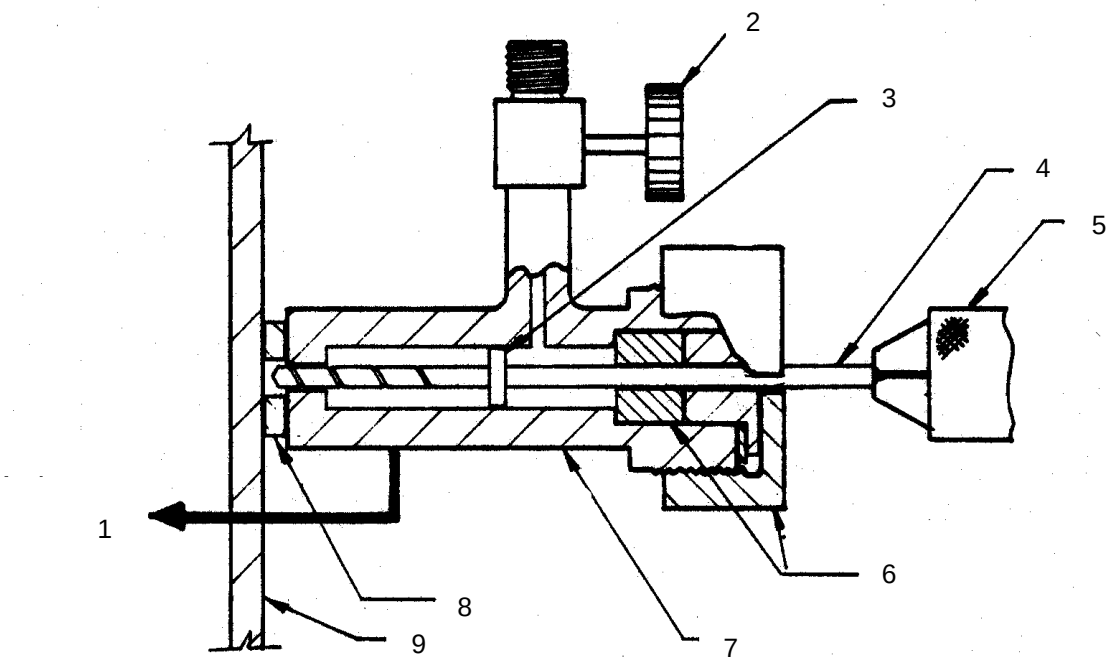
1 - Valve A
2 - Cap held by restraining device
3 - Drilling adaptor
4 - Centre punch
5 - Drill
6 - Hand drill
7 - Gland packing and gland nut (around drill)
8 - Retaining collar
9 - Gasket

Drawing 7: Drilling into valve body, valve end of container enclosed (gas container)



1 - Gasket
2 - Valve A
3 - Drilling adaptor
4 - Drill
5 - Hand drill
6 - Gland packing and gland nut (around drill)
7 - Retraining collar
8 - Drilling adaptor threaded into or clamped onto valve body

Drawing 8: Drilling into valve body (gas contained)



1 - Device to firmly clamp drilling adaptor to container wall
2 - Valve A
3 - Retaining collar
4 - Drill
5 - Drill chuck
6 - Gland packing and gland nut (around drill)
7 - Drilling adaptor
8 - Gasket
9 - Container wall

Drawing 9: Drilling into container body (gas contained)