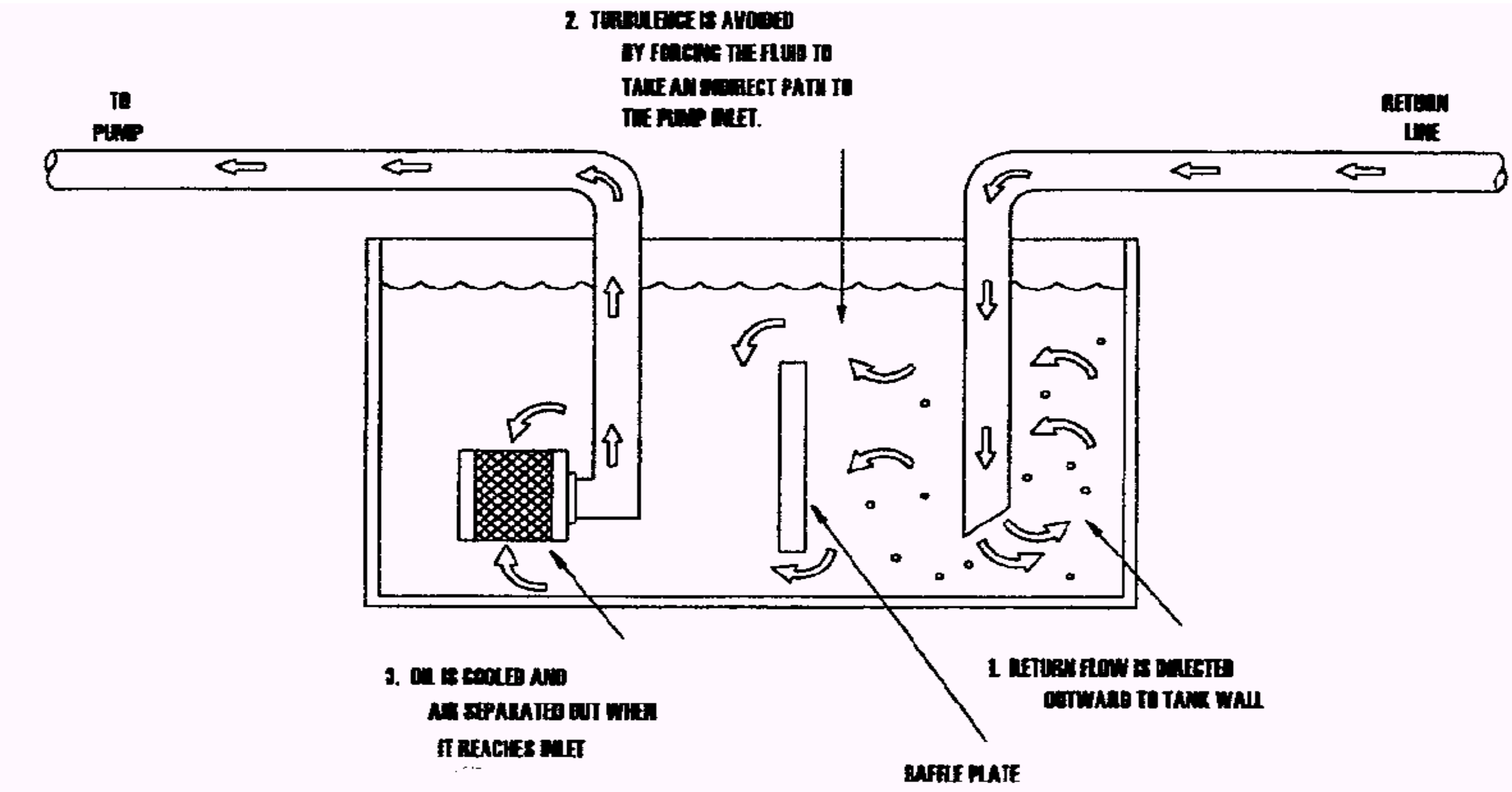
# Reservoirs


2. TURBULENCE IS AVOIDED
BY FORCING THE FLUID TO
TAKE AN INDIRECT PATH TO
THE PUMP INLET.
TO
PUMP
RETURN
LINE
3. OIL IS COOLED AND
AIR SEPARATED OUT WHEN
IT REACHES INLET
1. RETURN FLOW IS DIRECTED
OUTWARD TO TANK WALL
BAFFLE PLATE

# Reservoirs

**Heat Exchange**

**Sedimentation**

**Deaeration**

**Dehydration**

**Alternative Devices**

**Reservoir Construction**

**Breathers**

**Strainers**

**Pump Inlet** and **Return Lines**

**Tanks of Mobile Hydraulic Equipment**

**Pressurized Tank**

**Vented Tank**

# Reservoirs

To most of us, **Reservoir**, see **Fig.1**, is simply
A **Tank** in which to **Store Hydraulic Fluid**.

**Fluid Flows** from the **Reservoir** to the **Pump**,
**Circulates** through the **System**,
and **Returns** to the **Tank**.

**Reservoir** actually plays several **Major Roles**, including:

- **Heat Exchanger** (To **Cool** the **Fluid**).
- **Filter** (To **Remove Solid Particles**).
- **Deaerator** (To **Remove Air** and **Gases**).
- **Dehydrator** (To **Remove Water**).

**Holding Fluid** is only one of a **Reservoir**'s **Roles**,
and **it** may **Not** be the **Most Important One**,
depending on the **System Design**

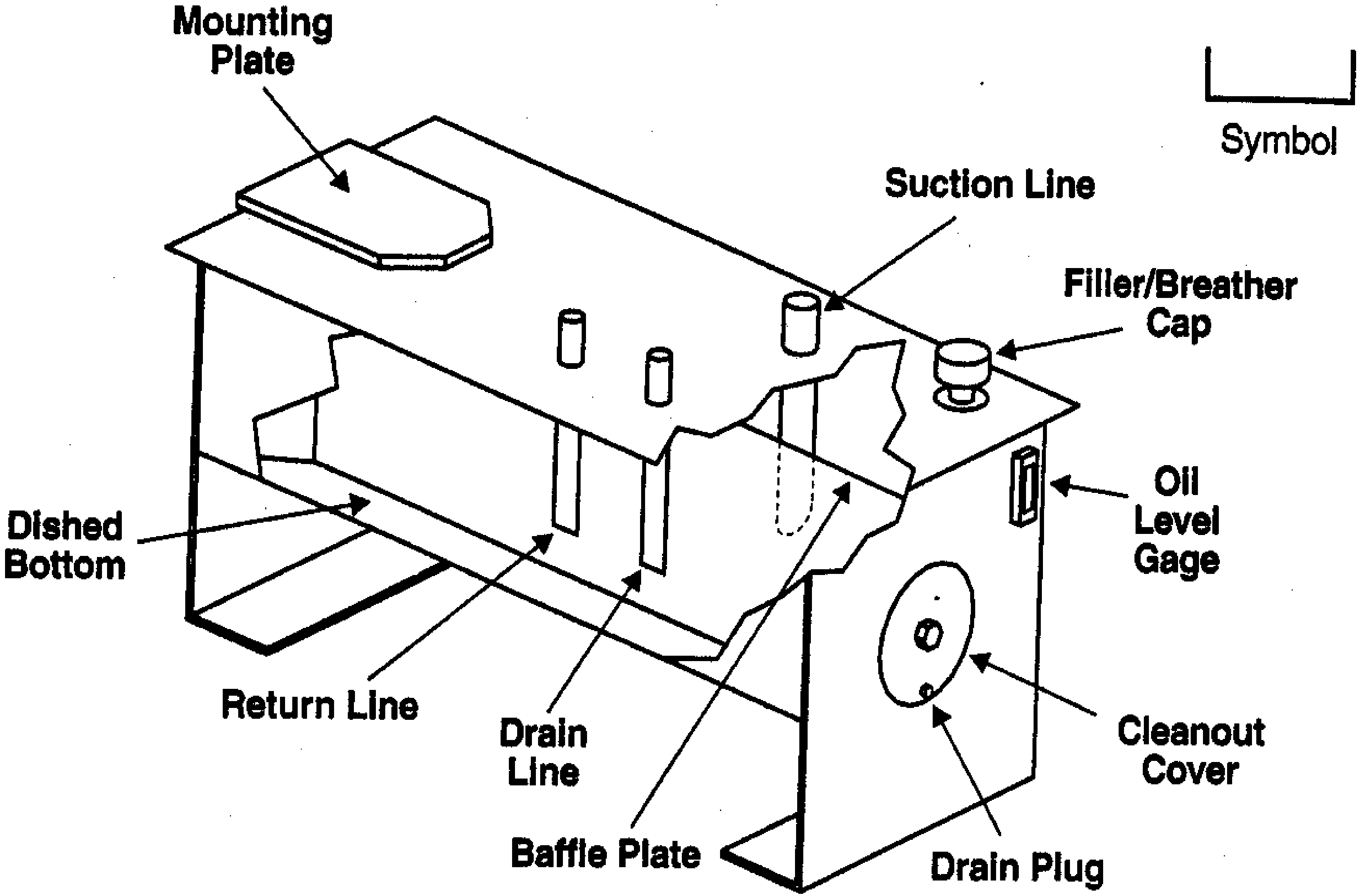
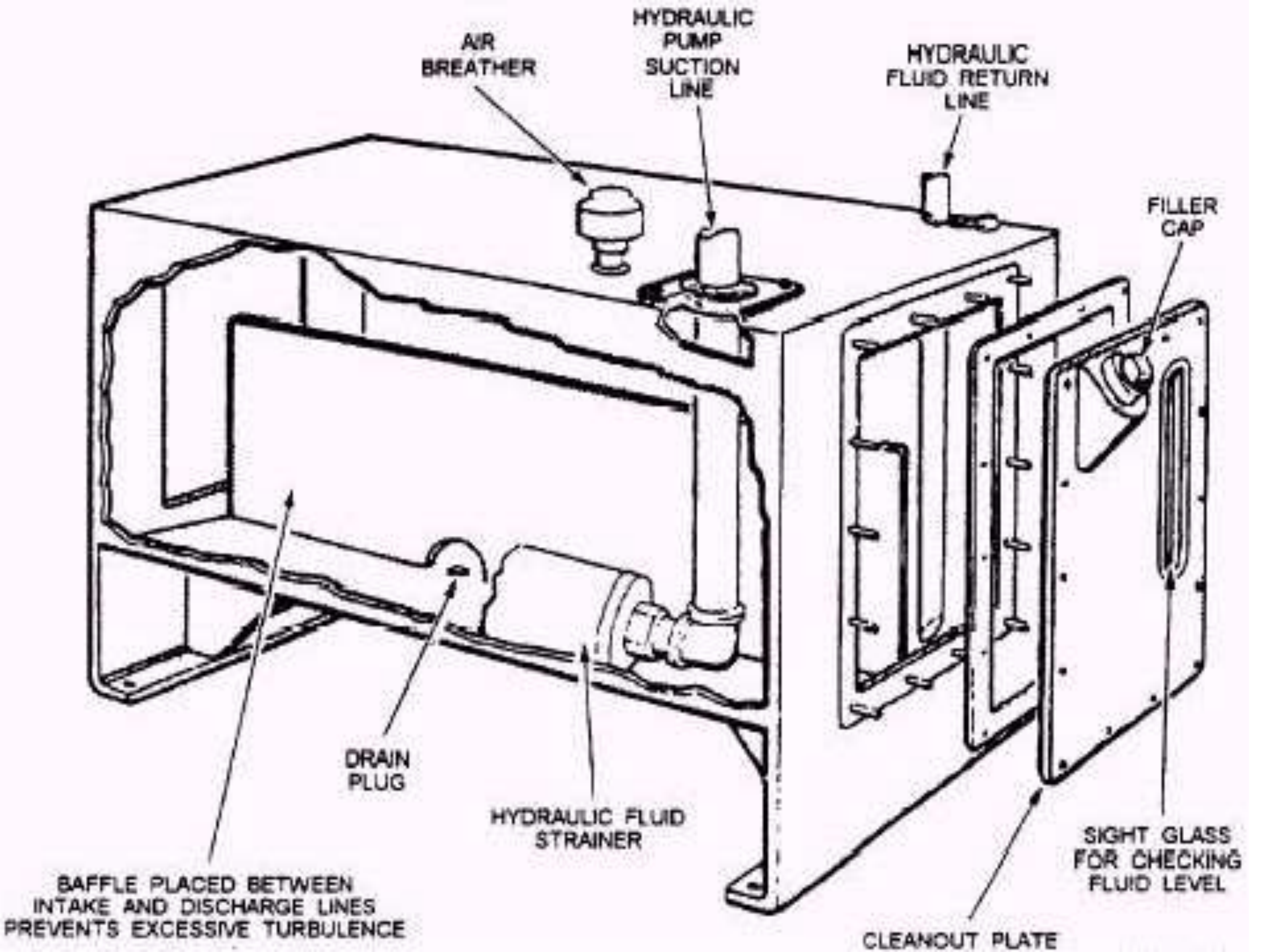
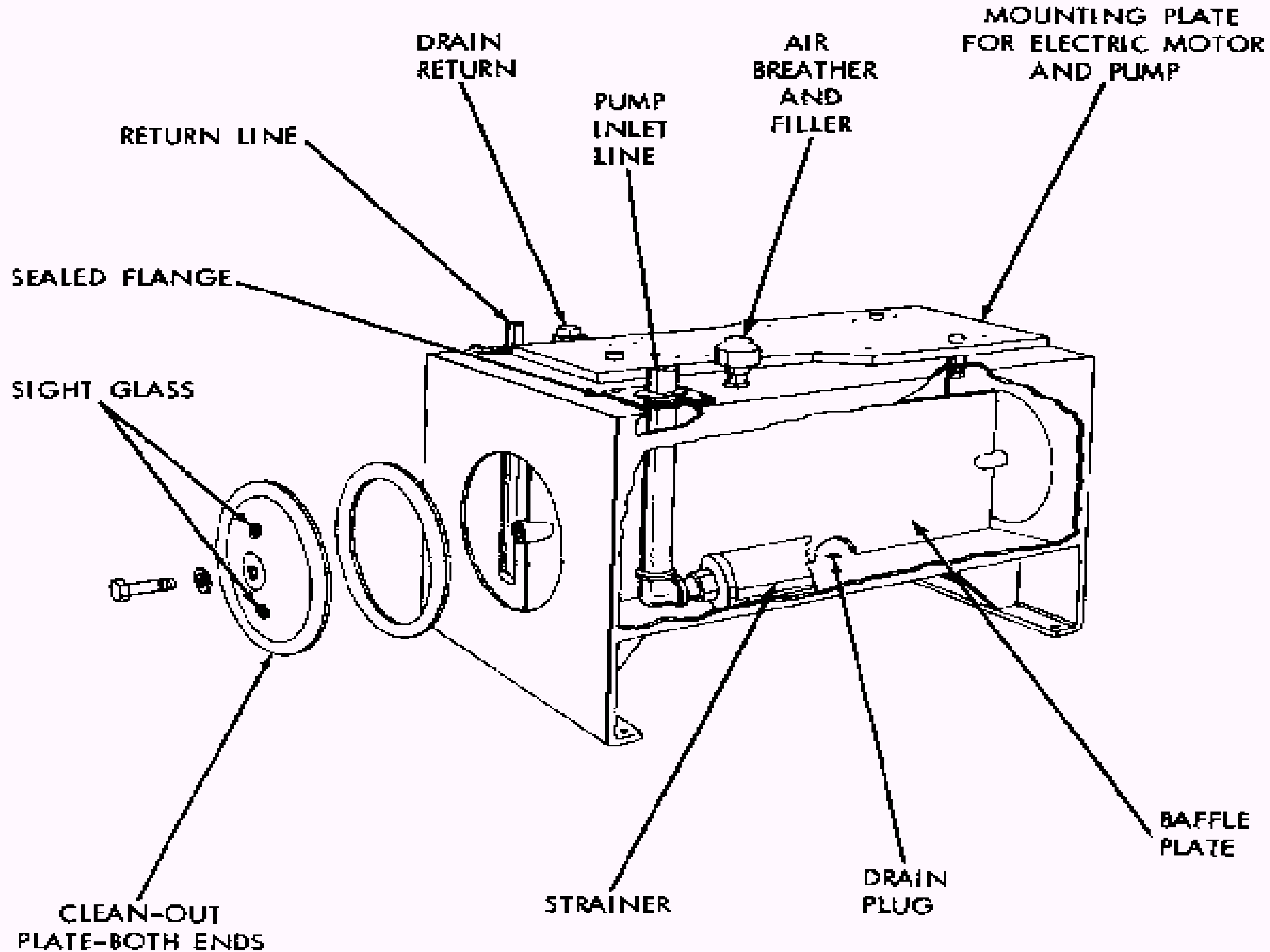
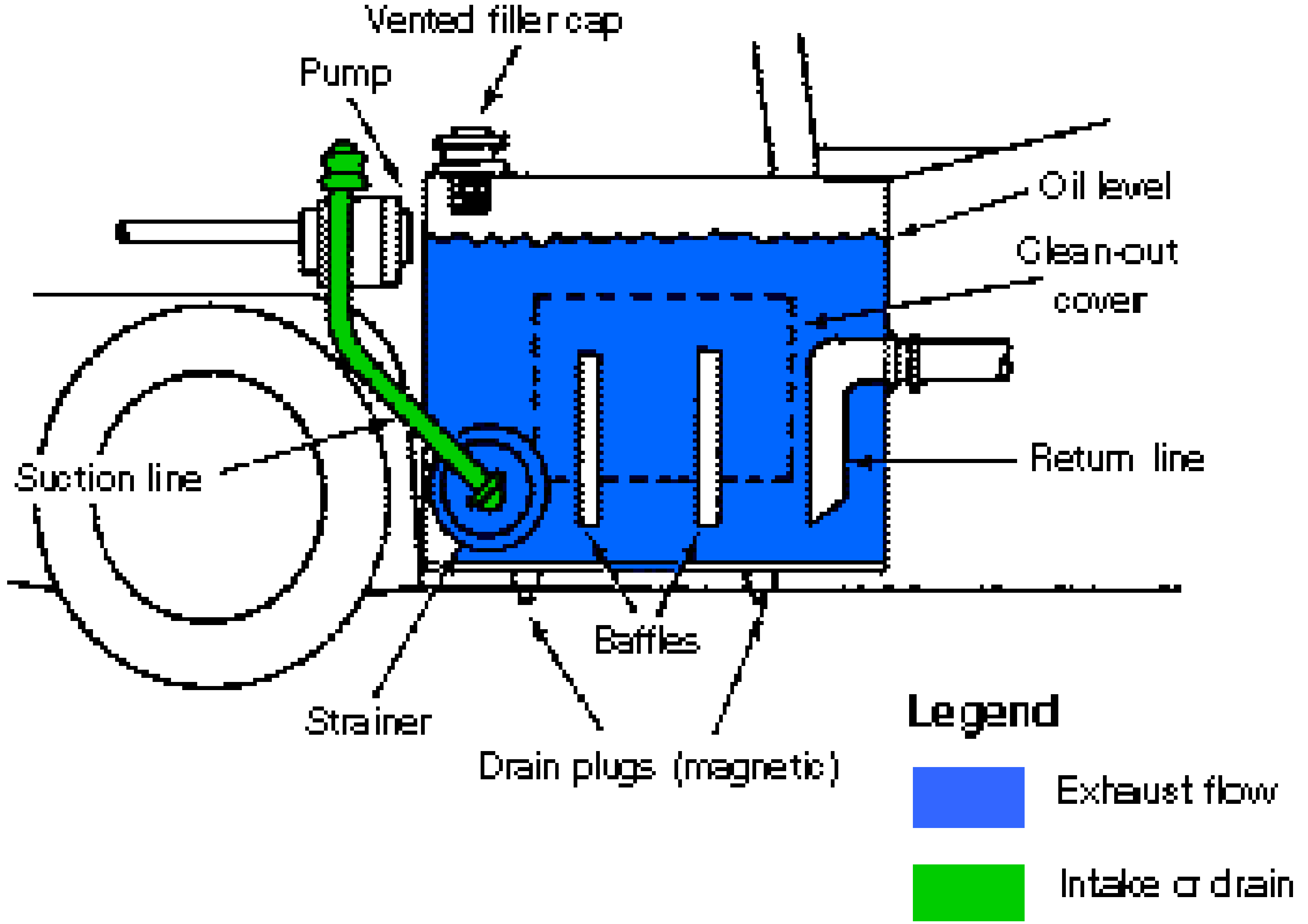



Fig. 1 A Typical Industrial Hydraulic Reservoir Configuration


AIR BREATHER
HYDRAULIC PUMP SUCTION LINE
HYDRAULIC FLUID RETURN LINE
FILLER CAP
DRAIN PLUG
HYDRAULIC FLUID STRAINER
SIGHT GLASS FOR CHECKING FLUID LEVEL
BAFFLE PLACED BETWEEN INTAKE AND DISCHARGE LINES PREVENTS EXCESSIVE TURBULENCE
CLEANOUT PLATE


MOUNTING PLATE FOR ELECTRIC MOTOR AND PUMP
DRAIN RETURN
AIR BREATHER AND FILLER
PUMP INLET LINE
RETURN LINE
SEALED FLANGE
SIGHT GLASS
BAFFLE PLATE
DRAIN PLUG
STRAINER
CLEAN-OUT PLATE-BOTH ENDS



Vented filler cap
Pump
Oil level
Clean-out
cover
Suction line
Return line
Baffles
Strainer
Drain plugs (magnetic)
Legend
Exhaust flow
Intake or drain

# Heat Exchange

**Energy Put** into **Hydraulic Fluid** that
**Do Not Subsequently Remove** in the form of **Useful Work** is
**Manifested** in the **form** of **Heat**
When **We encounter** a **Pressure Drop** across a **Valve** (or any other device)
**We encounter** an **increase in Fluid Temperature**.
**If** we **don't Dissipate** that **Heat** somewhere in the **System**, we end up with
An ever **Increasing Temperature** that will eventually lead to
An **Unacceptable Loss** of **Viscosity**, and eventually to
A **Complete Chemical Breakdown** of the **Fluid**
We could use a **Heat Exchanger** specifically designed for this purpose.
**Another Way** to **get rid of Unwanted Heat** is **through** the **Reservoir Walls**
The **System** should be **Designed** to **Prevent** the **Losses** that lead to
**Temperature Rise**, **But Some Losses** are **inevitable**, and we must
**Design** our **Systems** to deal with the **Resultant Temperature Rises**.
The **Dissipation** of **Heat** from the **Fluid** in the **Reservoir** results

**All 3 Heat Exchanger Mechanisms:** **Convection**,
**Conduction**,
**Radiation**.

**Heat Exchanger** by Convection **requires** a **Significant Circulation** or **Movement** of the **Liquid** through the **Regions** of **Different Temperatures**.

**Convection** may be **Natural** or **Forced**.

**Natural Convection** occurs because **Warmer Fluid** is **Less Dense** and **Rises** and is **Replaced** by **Cooler Fluid** next to the **Wall**.

**Forced Circulation** results when a **Pump** (or **Fan** or **Blower** in case of **Air**) is used to **Move** the **Fluid**.

**Conduction** is a **Heat Exchanger Mechanism** that occurs on A **Molecular Level** within the **Liquid** or **Gas**

It is the result of **Collisions** or **Intimate Contact** between the **Molecules**.

**Thermal Radiation** is the **Transfer** of **Heat** by means of **Electromagnetic Radiation**.

The **Amount** of **Heat Radiated** depends on

The **Configuration** of the **Surface**,

The **Surface Temperature**, and

The **Material** and **Finish** of the **Surface**

By a **Combination** of **These Mechanisms**, **Heat passes**

From the **Fluid** into the **Tank Walls** and then into the **Atmosphere**

The **Efficiency** of this **Operation** depends on:

The **Total Surface Area** exposed to the **Atmosphere**

and The **Length** of **Time** that the **Fluid Remains** in the **Reservoir**.

The **Rate** at which **Heat** is **transferred** from a surface is measured in

**B**ritish **T**hermal **U**nits per square foot per hour,

or **Watts** per square meter (**W/m$^2$**).

The **Larger** the **Reservoir**,

The **More** square feet of **Surface Area** there are for **Heat Dissipation**.

The **Effectiveness** of the **Heat Transfer** is also enhanced by

**Direct Contact** of the **Fluid** with the **Walls** of the **Tank**.

The **Transfer** of **Heat** from the **Fluid** to the **Dissipating Surfaces** is

**Not Instantaneous**.

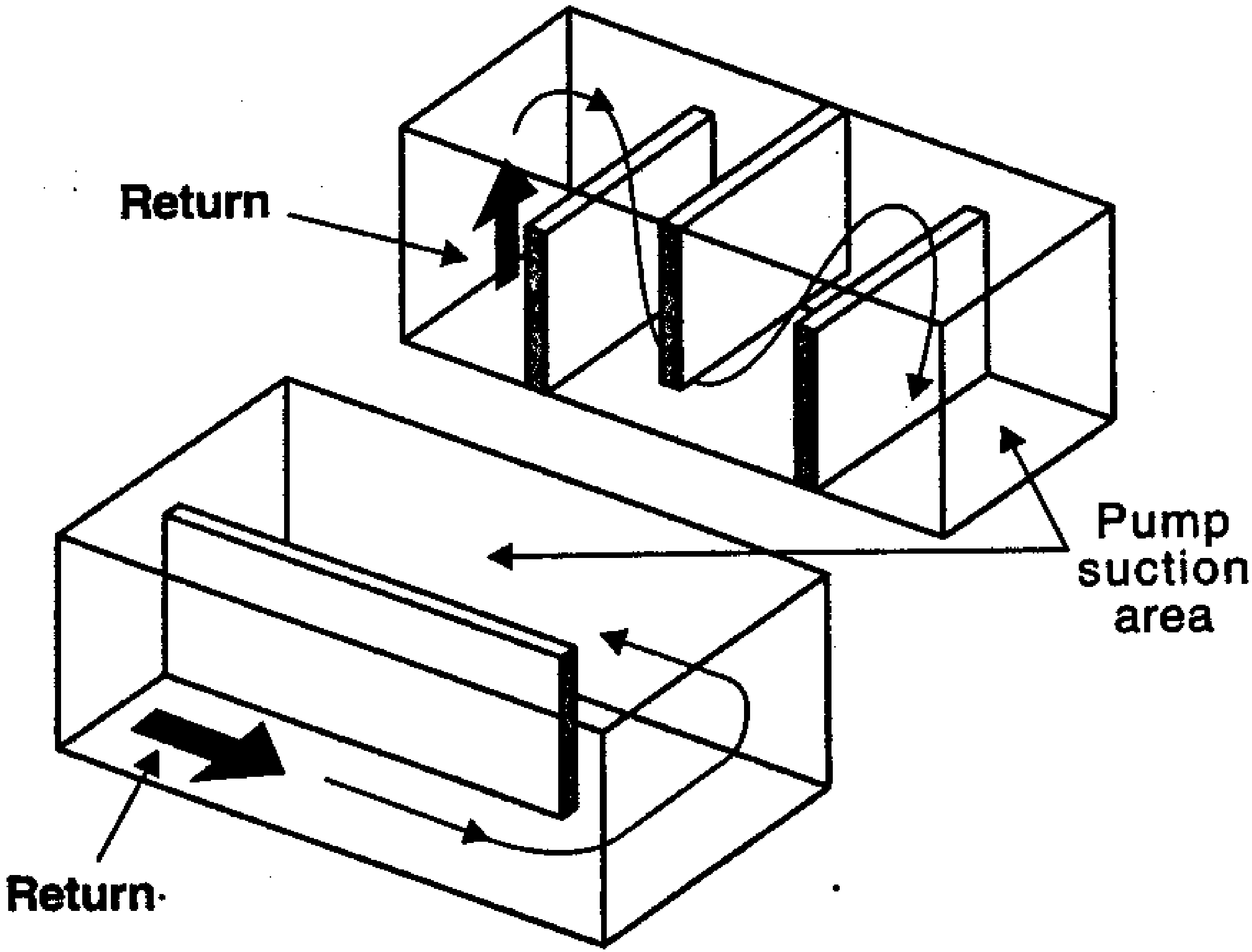
The **Fluid** must be allowed to **Remain** in **contact** with the **Walls**
For as long as **Possible**

This is a **Function** of the **Length** of **Time** the fluid **remains** in the **Reservoir**
Termed **Dwell** or **Residence Time**

**In order to Increase Dwell Time**, many **Reservoirs** are **Built** with
A **Series** of **Baffles** around which the **Fluid** must **Travel**.

The **Tortuous Path** provided by these **Baffles Prevents** the **Fluid**
From **Traveling Directly** from the **Return Line** to the **Pump Inlet Line**.

**It Also Promotes Mixing** of the **Fluid**, which **Improves**
The **Heat Transfer Situation**.




# Fig. 2 Baffles increase Dwell Time.

An **Oversized Reservoir** offers another **Advantage** in that
There is simply **Much More Fluid**, so that
The **Average Bulk Fluid Temperature increases** at a much **Lower Rate**
than it would with a **Smaller Quantity** of **Fluid**.
**This**, coupled with the **Increased Surface Area**
and the **Lower Turnover Rate** of the **Fluid** leads to
**Much Lower Overall Temperatures**
What constitutes this –**Oversized- Reservoir**.
Most **System Specifications** call for the **Reservoir to contain**
**Three Times** the **Pump Flow Rate**.
The **Mobile Equipment Industry** tends to use a **1 to 1 Ratio.**
**Other Requirements Vary** according to **Application**.
An **Oversized Reservoir** might be on the order of **10 to 1**
**10 gallons** of **Fluid** for **Each gpm** of **Output**.
**To Determine Whether** the **Reservoir** has **Sufficient Surface Area** to
**Dissipate** the **Heat** generated by the **System Operations**

We can **Compare** The **Heat Generation Rate** of the **System** to
The **Heat Dissipation Rate** of the **Reservoir**.
**Otherwise**, you **Lose Twice:**
**You pay** for the **Wasted Energy** to **Put** the **Heat in**, and
**You pay** for the **Heat Exchanger** and its **Operation** to **Take the Heat O**ut.
**Another Heat Exchange Function** that might take place in the **Reservoir** is
The **Reverse** of what we have just been discussing.
That is, we might want to **Heat** the **Fluid** rather than **Cool it**.
**This Situation** could arise **During** the **Startup** of a **System** that has been
exposed to **Low Temperatures** for an **Extended Time**.
The **Cold Fluid** may **Not** be **Pumpable**, so
**It** may be necessary to **Heat it** to **Lower** its **Viscosity**.
This is usually **Accomplished** By
**Electrical Heating Elements immersed** in the **Fluid**,
**In** some **Very Large Plant Installations**, **Steam** or **Hot Water Pipes** are
sometimes **Run through** the **Tank**.

.

**If Electric Heaters** are **Used**, **Care** must be taken **Not** to "**Cook**" the **Fluid** that **contacts** the **Heating Elements**.

This **Results in** **Degradation** of the **Fluid** and The **Creation** of a **Coating** of **Burned Fluid** on the **Elements** that **Severely Reduces** their **Heating Efficiency**.

As a **Rule** of **Thumb**,

The **Heat Output** of in **Tank Heating Elements** should **Not Exceed 3 watts** per **square inch** of **Heating Element Surface**.

## Sedimentation

A **Reservoir** acts as a **Filter** when **Solid Particles** are allowed to **Settle** to the **Bottom** as the fluid passes through.

**Not All** of the **Particles** will **Settle Out** of the **Fluid**, even if **It remains** at **Rest** over very long periods of time.

**For Settling** to **Occur**, the **Force** of **Gravity** must **Overcome Buoyant Forces** and **Viscous Drag**

**Relatively Large**, **Dense Particles** will tend to **Settle Out Rapidly**, **While Small Particles (**Smaller than **10 microns**) may **Never Settle Out**, especially in a high-viscosity fluid.

The **Longer** the **Dwell Time** of the **Fluid** in the **Reservoir**,
The **More Opportunity** there is for **Particle Drop-Out**.

This constitutes another factor **Favoring Oversized Reservoirs**.

**Good Filtration** (internal and external) should **Remove** the **Large Particles** Before they **get** to the **Reservoir**

An **Off-Line Filter Loop** will do far more to **Clean** the **Fluid** in the **Reservoir** than **Sedimentation** could ever do.

## Deaeration

**Reservoirs** that are at **Atmospheric Pressure** provide an opportunity for **Deaeration**, the **Release** of **Air** that may have been **Trapped** in the **Fluid**.

**Air** in **Fluids** may take **Three Different Forms**: **Dissolved**
**Entrained**
**Free**

Most **Hydraulic Oils** will **contain** about **10% Air** by **Volume**
Under **Atmospheric Pressure**

This **Dissolved Air** is **Contained** in the **"Empty Spaces"** between
The **Fluid Molecules**,
and **Does Not increase** the **Volume** of the **Fluid**.

As we **Exceed** the **Amount** of **Air** that can be **Dissolved** in a **Fluid**,
We begin to **Encounter Entrained Air**.

We see this in the form of **Bubbles** which are
**0.001** to **0.030 in (25** to **750 μm)** in **Diameter**.

**Fluids** with **Entrained Air** tend to **Look Cloudy** or **Foamy**.

**Generally,** **Entrained Air** is **Attempting** to **Get Out** of the **Fluid**.
**If** the **Fluid** is allowed to **Sit Undisturbed** for a **Time**, the **Bubbles**
Will usually **Agglomerate** into **Larger Bubbles** of **Free Air,**
**Rise** to the **Surface** and **Escape**.
Most modern **Hydraulic Fluids** contain **Antifoaming Additives**
To **help** in **Releasing** the **Air** from the **Fluid**.
The **Smaller** the **Bubble**, the **Longer** it **takes** to **Rise** to the **Surface**
in any given **Fluid**.
The **Rise Rate** is also **Inversely Proportional** to the **Viscosity** of the **Fluid**;
The **More Viscous** the **Fluid**, the **Longer** it will take any given **Bubble**
to **Rise** to the **Surface**.
Some **Finite Amount** of **Time** is **Required** to **Allow Air Bubbles**
to **Escape** from the **Oil**.
A **More Efficient Deaeration Process** will be realized
**If** the **Fluid Flows** through the **Reservoir Slowly**.
In an **Undersized Reservoir**, or in one that is **Not Adequately Baffled** .

**Bubbles** in the **Oil** can be **Swept Back** into the **Pump inlet line** before **They** can **Rise** to the **Surface**.

This can lead to **Pump Damage** and eventual **Failure** due to **Pseudo-Cavitation**-a **Process** in which **Collapsing Air Bubbles** Allow **High-Velocity Fluid** to **impinge** on **Pump Surfaces**.

The **Result** is that **Metal Particles** are **Dislodged**, **Contaminating** the **Fluid** and **Destroying Critical Pump Clearances**.

**Free Air** is seen as **Large** "**Globs**" of **Air** in the **System**.

This **Condition** is most commonly found in **Cylinders, Accumulators**, and **Elevated Points** in the **System** where the **Fluid Velocity** is **Low** enough for **Entrained Air Bubbles** to **Agglomerate** and form **Large Air Pockets**.

While **Dissolved Air** is **Expected** and generally **Acceptable**, **in any form** can have **Detrimental Effects** in the **System**.

**Fluid Oxidation phenomenon requires Oxygen**- The **presence** of **Air** in any form will **suffice**.

The **Advantages** of **Using Liquids instead** of **Gases:**

**Incompressibility** of **Liquids** is **Lost** with **Highly Aerated Fluids**.
**Fluid Column Stiffness** is **lost** because **Air** in the **Fluid** is **Compressible** and **Must** be **Compressed** before **Any Other Work** can be **Done**.
This **Causes System Response** to be **Slow**.
**Aerated Fluid causes Pseudo-Cavitation** in **Pumps, Valves**.
This can **Cause Severe Damage** and **Rapidly Degrade** the **Components** to **Absolute Uselessness**.
**In** a **Reservoir** that is **Open** to **Atmospheric Pressure**,
We can **Remove** **Only** the **Entrained** and **Free Air**.
**If** the **Reservoir** is **Pressurized**, the **release** of **Air** will be restricted by
The **Henry-Dalton Law**:
***"The Amount of Air that can be Dissolved in a Fluid is***
***Directly Proportional to the Air Pressure above the Fluid*"**
**Creating a Vacuum** in the **Reservoir** will **Significantly Accelerate** the **Release** of **Free** and **Entrained Air** and **Promote** the **Dissolution** of the **Dissolved Air.**

An **Advantage** of this **practice** is that the **Fluid** can act as an **Air "Sponge"**

Readily **Absorbing Any Air** that might be **Bleeding** into the **System**

or **Introduced** by **Bad Maintenance Practices**.

**Reservoir Vacuum** is **seldom** seen in other than **Laboratory Situations**,

**It** is more **Expensive** and **Troublesome** than **Breathing Reservoirs**.

**Reservoir Vacuum** could also be **Detrimental**

and could lead to **Pump Cavitation**.

A **Design** that is sometimes seen, is a **Reservoir** **Containing**
A **Sloped Screen** through which the **Fluid Flows** as it **Moves**
from the **Return** **Line** to the **Pump** **Inlet** **Line**.
**Bubbles** tend to **Adhere** to the **Screen** and thus
be **Removed** from the **Flow** **Stream**.
**Eventually**, **They** **Agglomerate**, **Forming** **Large** **Bubbles** that
**Rise** to the **Surface** and **Dissipate**.
The **Most** **Effective** **Arrangement** seems to be
**Number 100** to **Number 400** **Wire** **Mesh**
**Inclined** about **20** **degrees** to the **Horizontal**.
**Removal** **Efficiencies** in **excess** of **95%** have been **Experienced**,
But again, **Dwell** **Time** is **Very** **Important**.

# Dehydration

During **Periods** of **System Downtime**,

When the **Fluid** is standing in the **Reservoir**, **Water** in **Fluids** that are **Less Dense** than **Water** will tend to **Separate** from the **Oil** and **Settle** to the **Bottom** where it can be **Drained off**.

This **Separation** will **Occur only if**

The **Water** and **Oil** have **Not** been **Emulsified**.

**As** with the **Separation** of **Air** from the **Oil**,

The **Separation** of **Water is Not Instantaneous.**

**Little Separation** is likely to **Occur** as long as the **Fluid** is **moving** through the **Reservoir** unless very **Large amounts** of **Water** are **Present**.

# Alternative Devices

Some of the **Functions** discussed are **Performed Efficiently**
by the **Reservoir**.

The **Large Surface Area** of **the Reservoir Walls** (especially one that is
**Intentionally Oversized**) **Dissipate Heat Efficiently**,
Although the **Efficiency** is **Severely Reduced** on **Hot, Still Days**

**Deaeration** is also **Accomplished fairly Efficiently**, especially in
**Large Reservoirs** with **Long Fluid Dwell Times**.

This **Function** is normally **Restricted** by the fact that
The **Reservoir** is usually at **Atmospheric Pressure**, or **Higher**,
so that **None** of the **Dissolved Air** is **Removed**.

The **Percentage** of **Free** and **Entrained Air Removed** is
A **Strong Function** of the **Fluid Dwell Time**.

**Other Devices** can **Perform** these **Functions**
More **Efficiently** than The **Reservoir**.

A great deal of **Dirt** ends up upon the **Bottom** of the **Tank**
**Good Filters** perform this **Function** far **More Efficiently**.

**Water Removal** is another **function** that can be performed **More Efficiently** by **Devices Specifically Designed** for that **Purpose**.

**Water Separator** **Removes Water** from the **Oil Continuously**, while the **System** is **Operating**.

**It** does **Not Require Quiescent Fluid** to be **Effective**, and the **Water** is **Removed** in an **Active** rather than **Passive Operation**

**Heat Exchangers**, while viewed by some as **Unnecessary** when **Large Reservoirs** are **Used**, can be **Utilized Very Effectively**.

Sometimes, the **Bulk** or **Weight** of an **Oversized Reservoir** is **Undesirable**.

The **Thermal Demands** of the **System** may **Require** a **Heat Exchanger** in **Some Cases**

**Air-Oil Separators**, or **Deaerators**, offer some **Advantages** **Over Reservoirs** in the **Removal** of **Air** from the **Fluid .**

One such **Device** the **Separate Air Utilizes** a **Vacuum Arrangement**

To **Remove** a **Significant Amount** of **Dissolved Air**

From **Operating Fluid Systems**

While this may **Not** be **Necessary** in **Normal Industrial Systems**,

**It** can be **Very Important** in **Applications** such as

**Aircraft Flight Control Systems**, where

**Sluggish** or **Spongy Operation** could **Mean Disaster**

# Reservoir Construction

**Figure 1** depicts a **Standard Industrial Reservoir** along
The **Lines Recommended** by the **Joint Industrial Conference (JIC)**.

Some of the **Features** we have already mentioned can be seen in this drawing; for instance, the **Baffle Plate**.

In this **Design**, a **Single Plate** runs the **Length** of the **Tank.**

There is a **Drain Plug** in the **Bottom** that can be used
To **Drain off Settled Water**
as well as To **Empty** the **entire Reservoir**.

**Both Ends contain Plates** that can be **Removed**
to **Facilitate Cleaning** the **entire Tank**.

Notice that the **Tank is Standing well Clear of** the **Floor**
to **allow Air Circulation** to **Enhance Heat Transfer**

# Breathers

A **Breather Reservoir** is **intended** for **Industrial Applications** and **operates** at **Atmospheric Pressure**.

It gets its **Name** from the fact that It **Inhales** and **Exhales** the **Fluid level changes** due to **System Operation**.

**Atmospheric Dirt** is one of the **Major Sources** of **Fluid Contamination**.

**Good Filtration** should be **Provided** to **Clean** the **Incoming Air**.

In addition to the **Removal** of **Airborne Dirt**, some **Breathers** are **Designed** to **Remove** the **Moisture** from **Incoming Air**.

These **Desiccant Breathers** contain both a **Particulate Filter** and a **Water-Absorbent Agent** that **Extracts Water Vapor** from **Air** as it is drawn into the unit.

**An Alternative Method** of **Preventing** the **Ingression** of **Dirt** and **Moisture** is to **Prevent** the **inhaling** of **Atmospheric Air**.

This can be done with a so-called **Pressurized Breather**, which contains A **Vacuum Breaker** to **allow** an **initial influx** of **Air** When the **System** is **First Started up** and **Fluid** is **Pulled** from the **Reservoir**.

In subsequent operation, as **Fluid Returns** to the **Tank**, A **Relief Valve prevents** the **Air** from being **Expelled** from the **Tank**.

**Rather**, it is **Compressed** and will be **Exhausted Only If** The **Relief Valve Setting** (from **3** to as much as **25 psig**) is **Exceeded**.

**Caution** must be used **When Adding** a **Pressurized Breather** To an **Existing Reservoir** to ensure that The **Tank Structure** can **Withstand** the **Internal Pressure**.

**The Ideal Situation**, would be to **use** a **Completely Sealed Reservoir** that has **No Communication** with the **Environment**.

**Unfortunately**, this is **Seldom Done** because of the **Expense** and **Weight** involved in **Providing Sufficient Strength** To **withstand** the **Internal Pressures** that might result.

# Fig. 3 This De-Aerator utilizes a Vacuum Arrangement to Remove Air

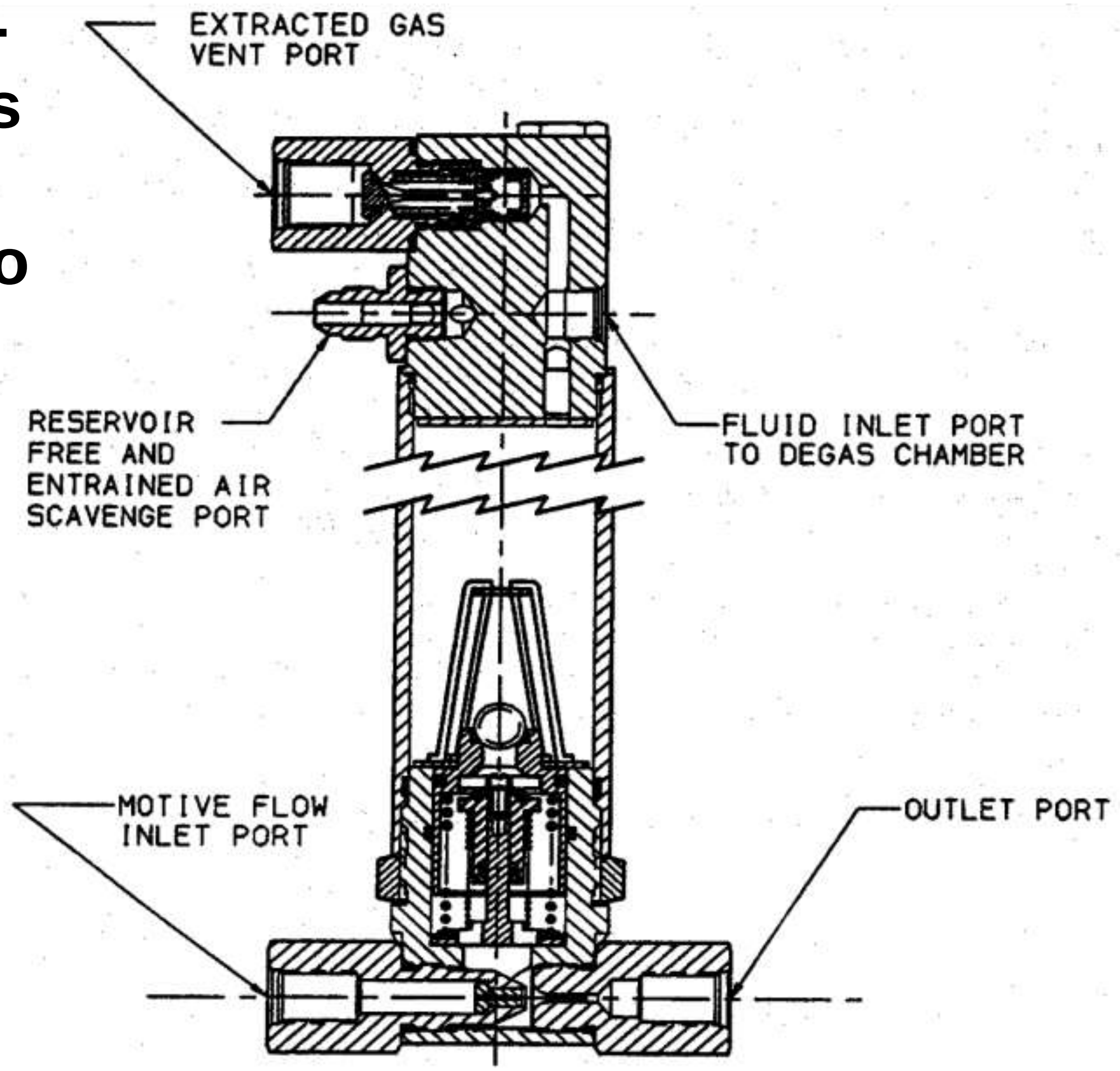
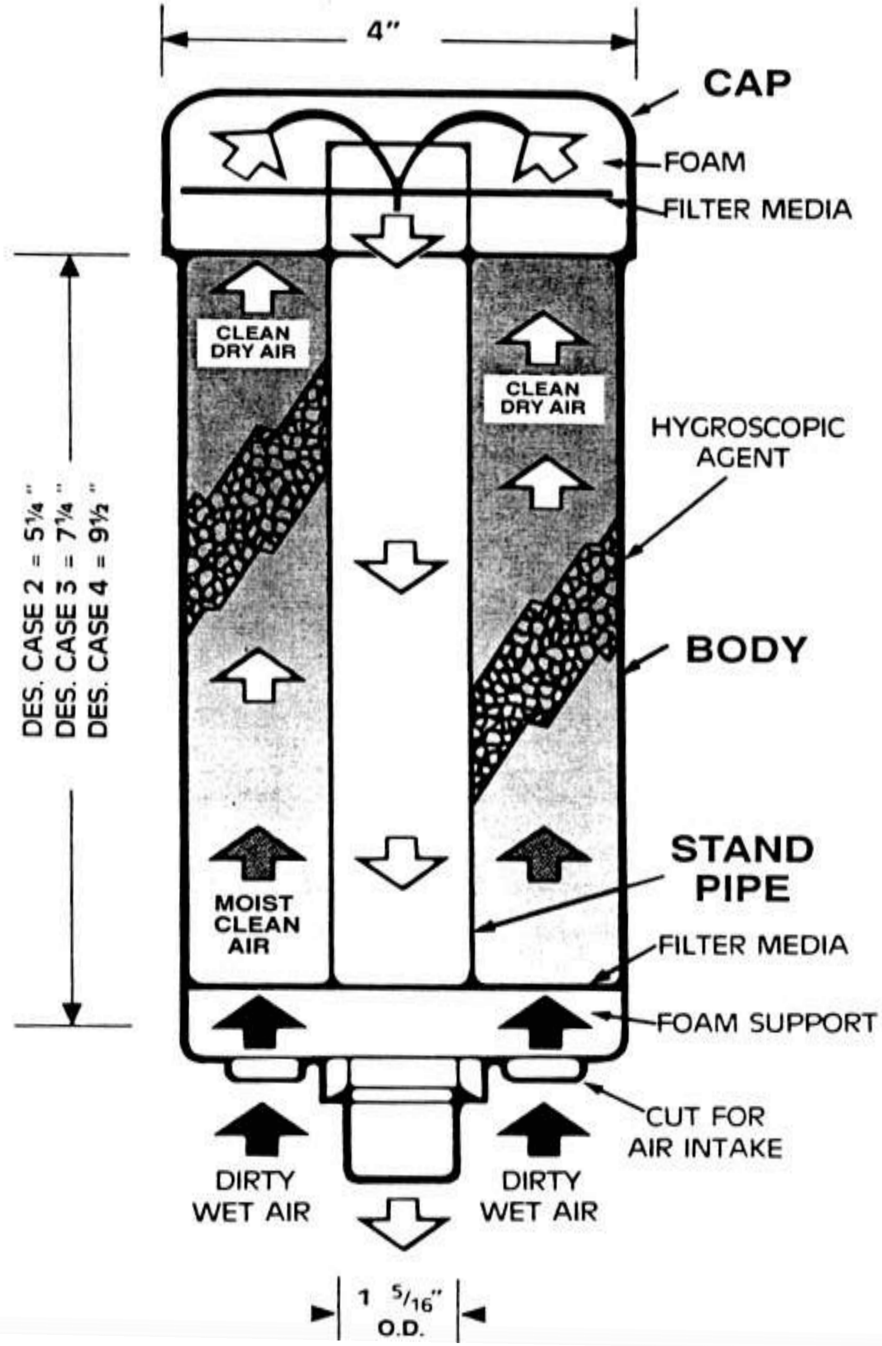


**Fig. 4 A Dessicant Breather Removes Moisture**

as well as **Dirt** from **Incoming Air**



# Strainers

A **Strainer** is often **attached to** the **Pump Inlet Line**.
These are necessarily **very Coarse Elements**,
**Seldom providing** better than **150 micron Filtration**
**Their Main Purpose** is to
**Prevent Trash** in the **Reservoir** from **Finding** its **Way** into the **Pump**.
**Two Very Important Points** must be **Remembered**:
**First**, the **Strainer** should always be **Covered** by at least **3 inches** of **fluid**.
A **Vortex** could form that would **allow Air** to be **pulled** into the pump.
**Second**, these **Strainers** must be **Changed Periodically**.
**If** they are allowed to **Clog up**, they can **Severely Restrict**
The **Fluid Flow** to the **Pump**, resulting in **Pump Cavitation**.
The **Reservoir Design** must **accommodate** the **Maintenance Task**
of **Changing** the **Strainer**.

# Pump Inlet

and

# Return Lines

The **Locations** of the **Pump Inlet Line** and the **system Return Line** (and any other lines bringing fluid into the tank) can be **Critical** in the **Ability** of the **Tank** to **Perform All** the **Jobs** that are thrust upon it.

The **Fluid Dwell Time** is **Very Important**.

We should **Arrange** the **Inlet** and **Return Lines** to provide The **Longest** and **Most** tortuous **Path Possible**.

**They** should be at **Opposite Ends** of the **Tank** or On The **Same End** But on the **Opposite Sides** of a **Longitudinal Baffle**.

The **Pump Inlet Line** must be **Near**, But **Never On** the **Bottom** of the **Tank**.

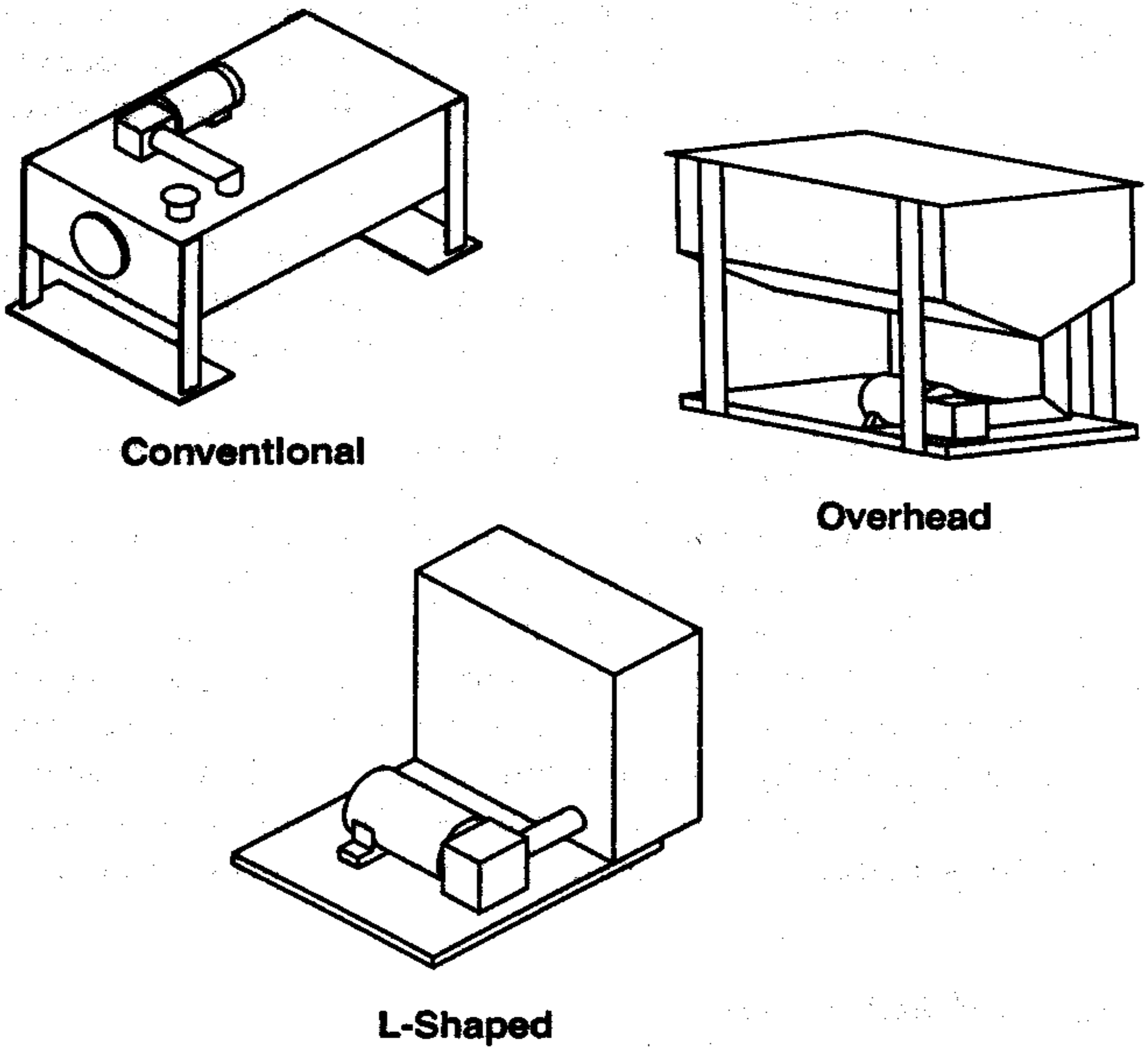
**If it were on the Bottom**, **Dirt** that has **Settled Out** of the fluid might be **Picked Up** when the **Pump Starts**.

**Return Lines** must always be **Below** the **Surface** of the **Fluid**,

**Preferably Extending** to **Near** the **Bottom** of the **Tank**.
A **Diffuser** on the **End** of the **Return Line** will **Promote** the **Release** of **Air** and **Generate** **Mixing** of the **Returning** **Fluid** with that in the **Tank** To **aid** in **Heat** **Transfer**
Very often (but not always), the **Top** of the **Reservoir** will be a **Heavy** **Cover** That is **Bolted** to the **Side** **Walls** is very common for The **Pump** and **Drive** **Motor**, **Some** **Valves**, the **Filters**, and so on, to be **mounted** on this **Cover**.
A **Good** **Gasket** provided for the **Cover** to **Prevent** the **Entrance** of **Atmospheric** **Air**.
The **Cover** kept on the **Reservoir** and **Bolted** down **Securely** to **Maintain** the **Integrity** of that **Gasket**.
The **Door** is **Opened** for **Major** **Contamination** **Problems**.
**Reservoir** shown in **Fig. 1** is **Only** **One** of a **Multitude** of **Possible** **Designs**

**Figure 5** shows other designs commonly found in **Industrial Applications**.
There is **No** such thing as a **common Reservoir Design** for

**Mobile Applications**.
In **Aircraft, Tractors**, and **Other Mobile Equipment**, **Reservoirs** are **Put Wherever They** can be **Fit** in **Conveniently** and the **Space Available dictates** the **Shape**




# Fig. 5 Industrial Reservoir Configurations

# Tanks
of
# Mobile Hydraulic Equipment

The **Hydraulic Oil tank Main Function** is **To Store Oil**,
However, it has **some Other Functions** as well.

The **Tank** must: **Remove Heat**
**Separate Air** from the **Oil**.

**Tanks** must have: **Sufficient Strength**,
**Adequate Capacity**
**Keep Dirt Out**.

**Hydraulic Tanks** are usually but not always **Sealed**.

**Tank Components are:**

**Fill Cap:** **Keeps Contaminants Out** of the **Opening** that's **Used** to **Fill** and **Add Oil** to the **Tank** and **Seals Pressurized Tanks**.

**Sight Glass:** Used to **Check** the **Oil Level**.

The **Oil Level** should be **Checked** When the **Oil** is **Cold**.

The **Oil Level** is usually **Correct** When the **Oil** is in The **Middle** of the **Sight Glass**.

**Supply and Return Lines:**

The **Supply Line** allows **Oil** to flow from the **Tank** to the **System**.

The **Return Line** allows **Oil** to flow from the **System** to the **Tank**.

**Drain:** **Located** at the **Lowest Point** in the **Tank**,

The **Drain** is used to **Remove Old Oil** from the **Tank**.

The **Drain** also allows for the **Removal** of **Water** and **Sediment** from the **Oil**

# Pressurized Tank

The **Two Main Types** of **Hydraulic Tanks** are **Pressurized** and **Vented** (**Unpressurized**).

The **Pressurized Tank** is **Completely Sealed**.

**Atmospheric Pressure** does **Not Effect** the **Pressure** in the **Tank.**

When the **Oil** is sent through the **System**, it **absorbs Heat** and **Expands**.

The **Expanding Oil Compresses** the **Air** in the **Tank.**

The **Compressed Air Forces** the **oil** out of the **Tank** and into the **System**.

The **Vacuum Relief Valve** serves **Two Purposes**.

**It Prevents** a **Vacuum** and **Limits** the **Maximum Pressure** in the **Tank**.

The **Vacuum Relief Valve** **Prevents** a **Vacuum** by **Opening** and **Allowing air** to enter the **Tank** When the **Tank Pressure** drops to **3.45 kPa (0.5psi)**

**When Pressure** in the **Tank reaches** the **Vacuum Relief Valve Pressure setting**, The **Valve Opens** and **Vents compressed Air** to the **Atmosphere**.

The **Vacuum Relief Valve Setting** may **Vary** from **70 kPa (10 psi)** to **207 kPa (30 psi).**

## Other Tank Components are:

**Filler Screen: Keeps Large Contaminants** from **Entering** the **Tank** When the **Fill Cap** is **Removed**.

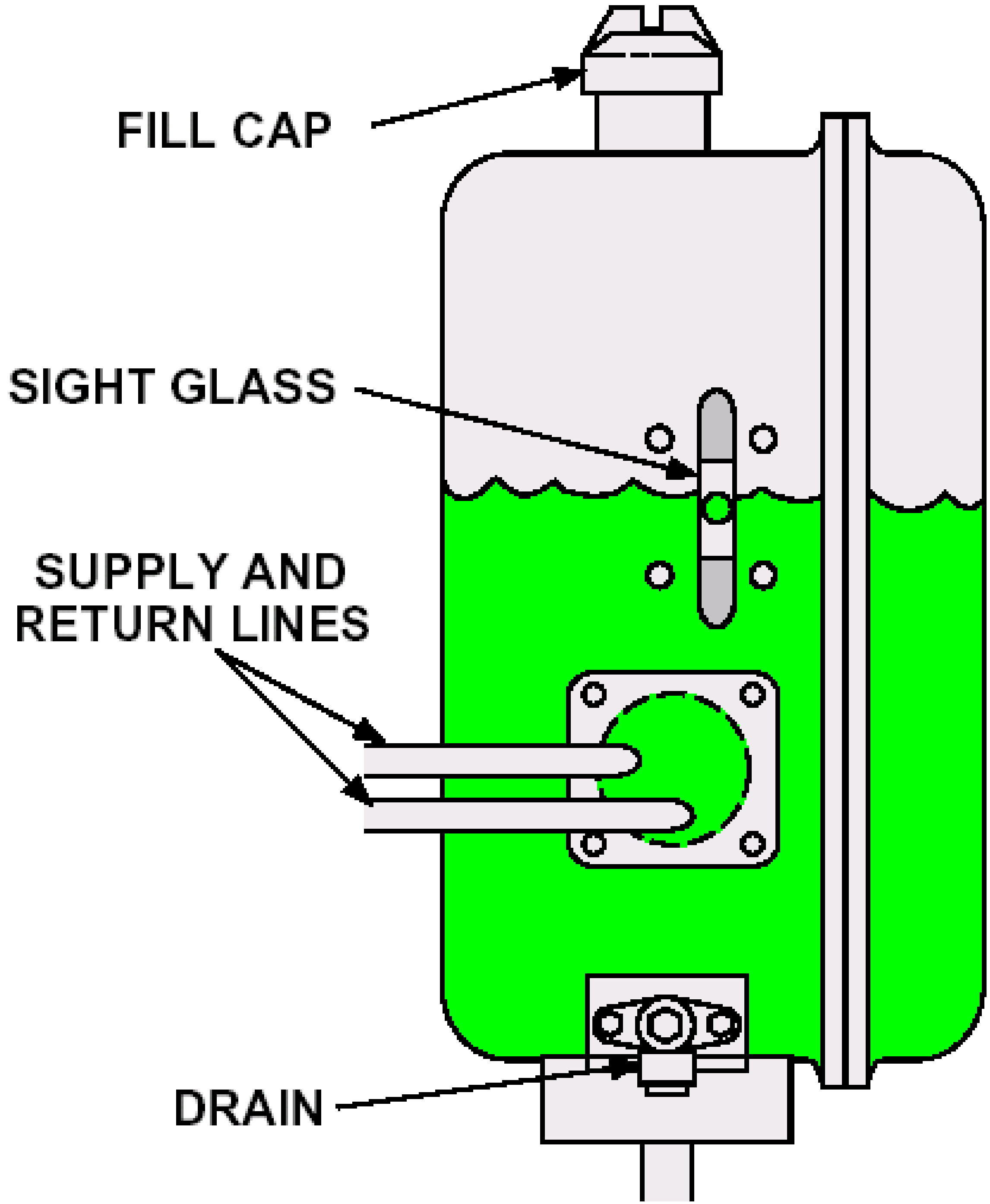
**Filler Tube: Allows** the **Tank** to be **Filled** to the **Correct Level**, But **Not Over Filled**.

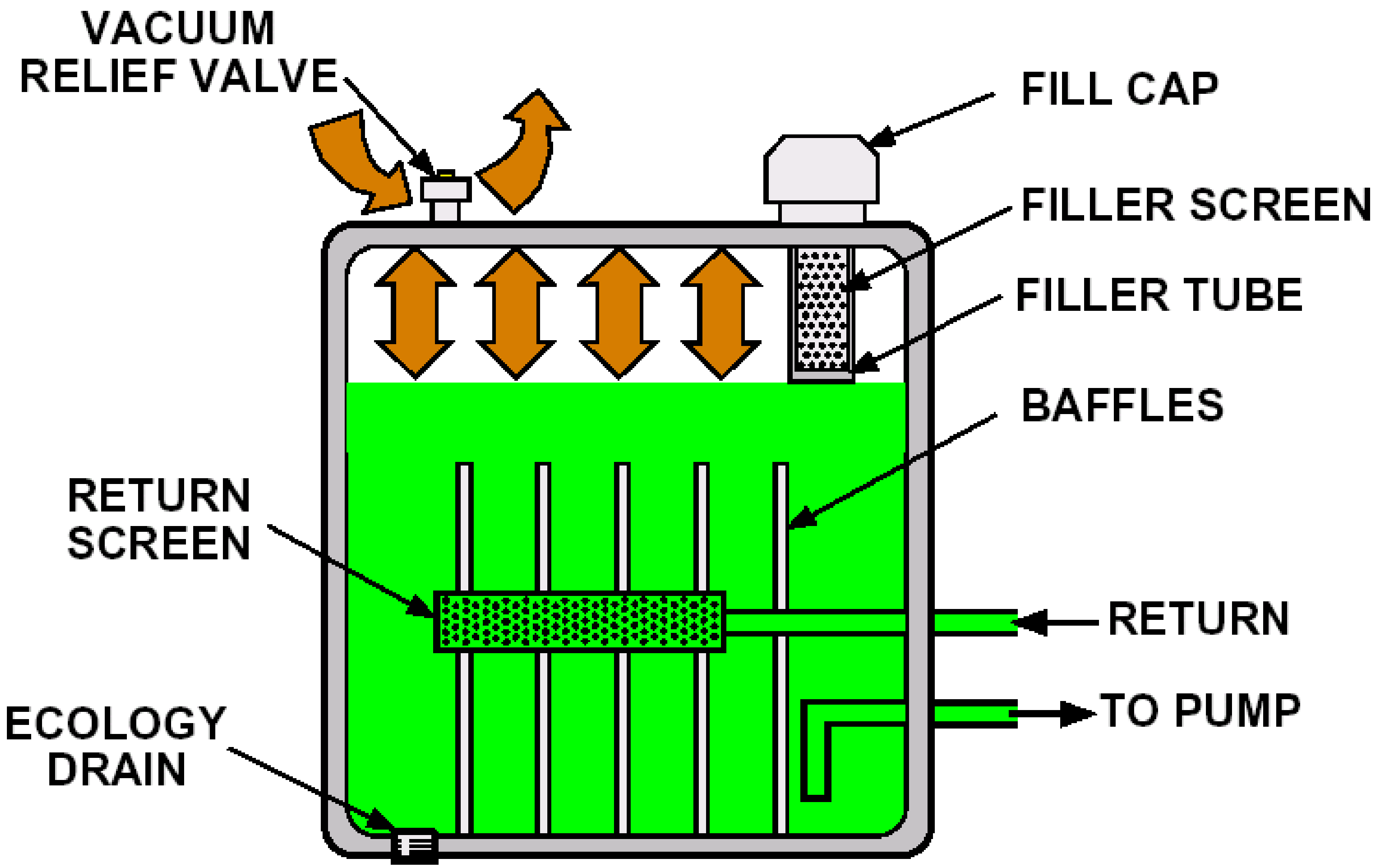
**Baffles: Prevents** the **Return Oil** from flowing **Directly** to the **Tank Outlet** **Allowing Time** for **Bubbles** in the **Return Oil** to **Rise** to the **Top**.

Also, **Prevents** the **oil** from sloshing which helps **reduce Forming** of the **oil**.

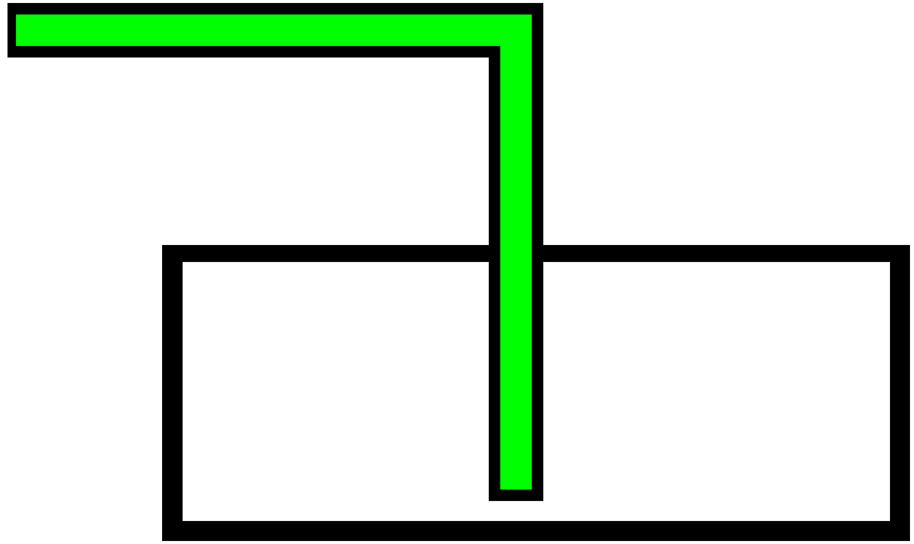
**Ecology Drain**: Used to **Prevent Accidental Spills** when **Removing Water** and **Sediment** from the **Tank**.

**Return Screen: Prevents Larger Particles** from **Entering** the **Tank**, But does **Not Provide Fine Filtering**

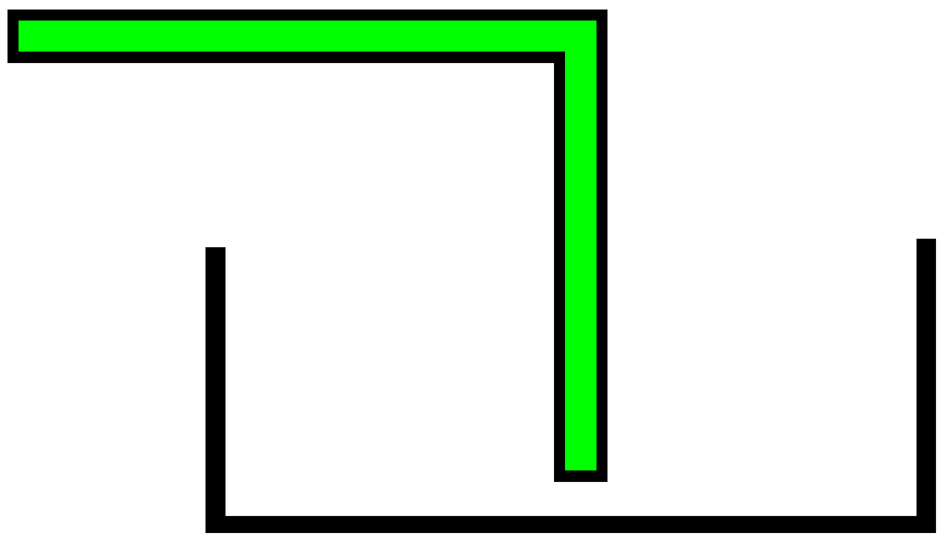

FILL CAP
SIGHT GLASS
SUPPLY AND
RETURN LINES
DRAIN




PRESSURIZED TANK



Pressurized Tank

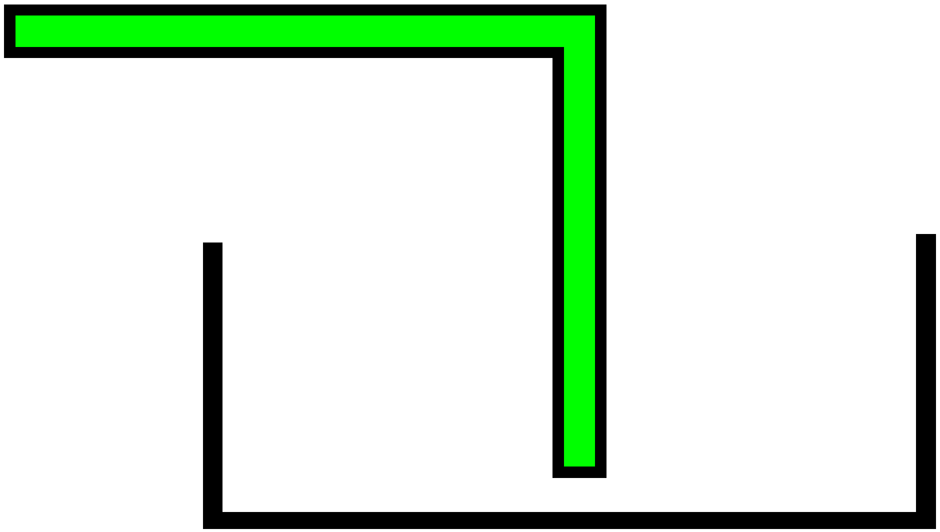


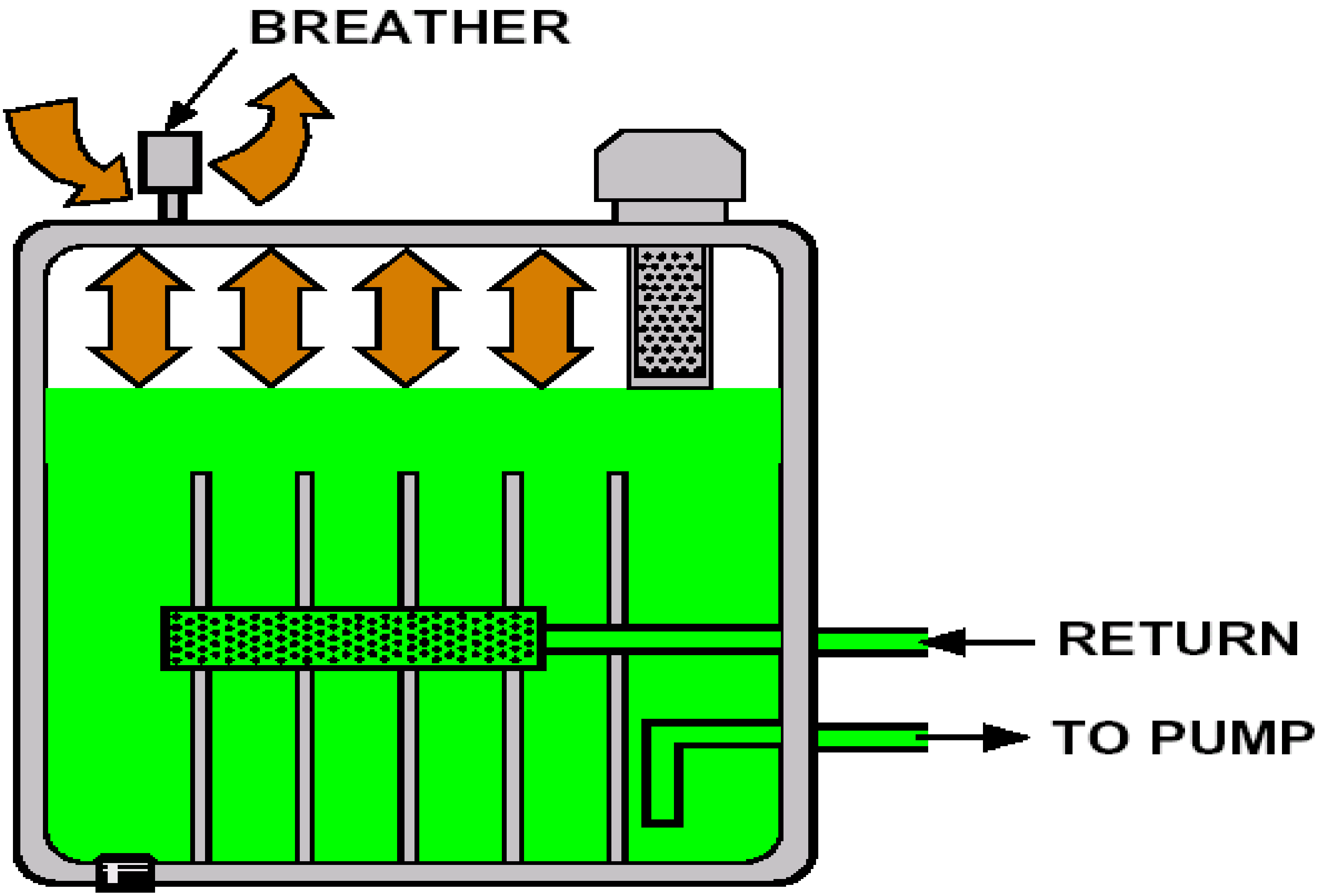
Vented Tank

# Vented Tank

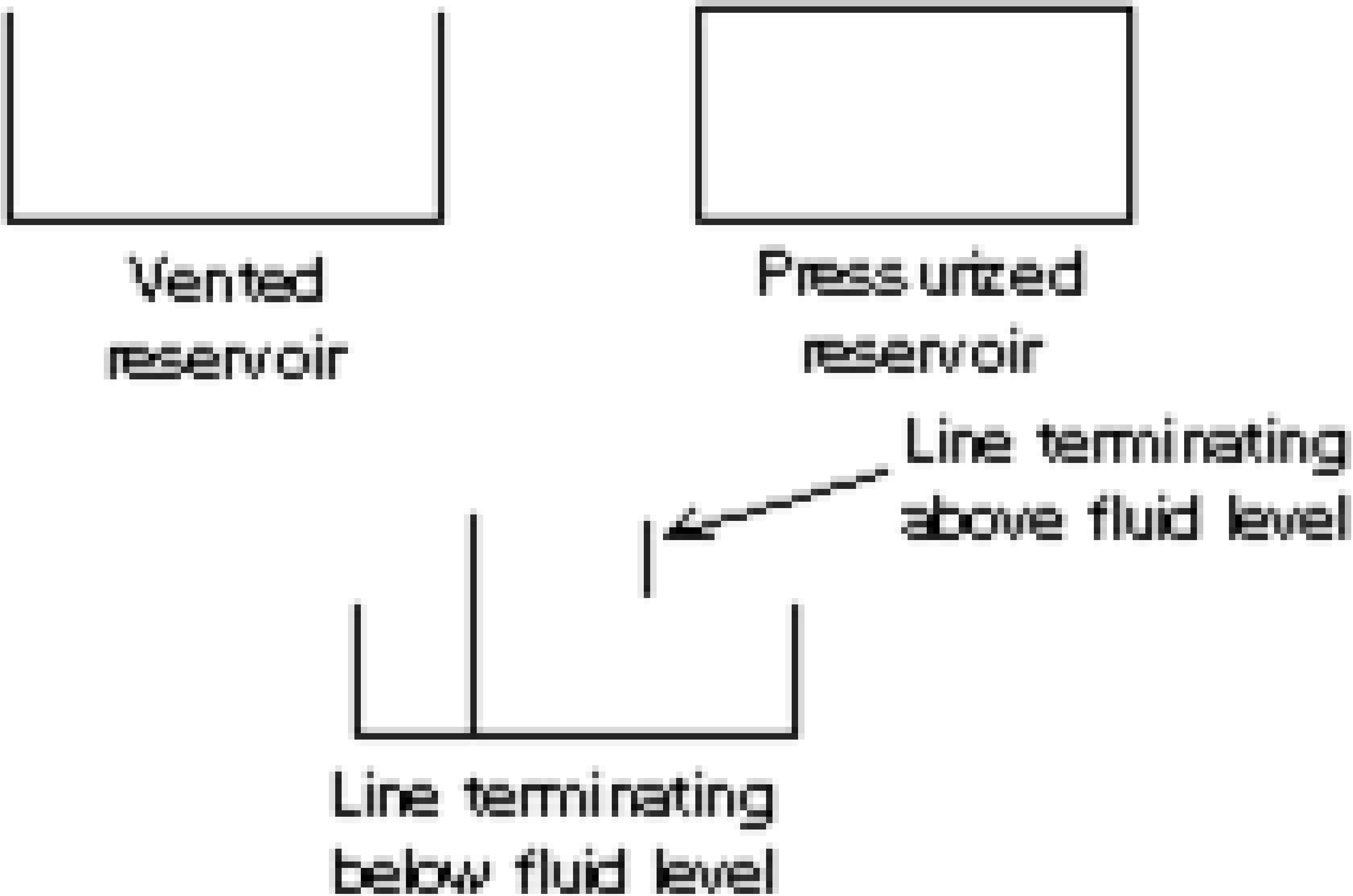
The **Vented** or **Un-Pressurized Tank**
Differs from the **Pressurized Tank**
in that the **Vented Tank** has a **Breather**.
The **Breather allows Air** to **Enter** and **Exit Freely**.
**Atmospheric Pressure** on the **Top** of the **Oil**
**Forces** the **Oil Out** of the **Tank** and into the **System**
The **Breather** has a **Screen** that **Prevents Dirt** from **Entering** the **Tank**.

## Vented Tank

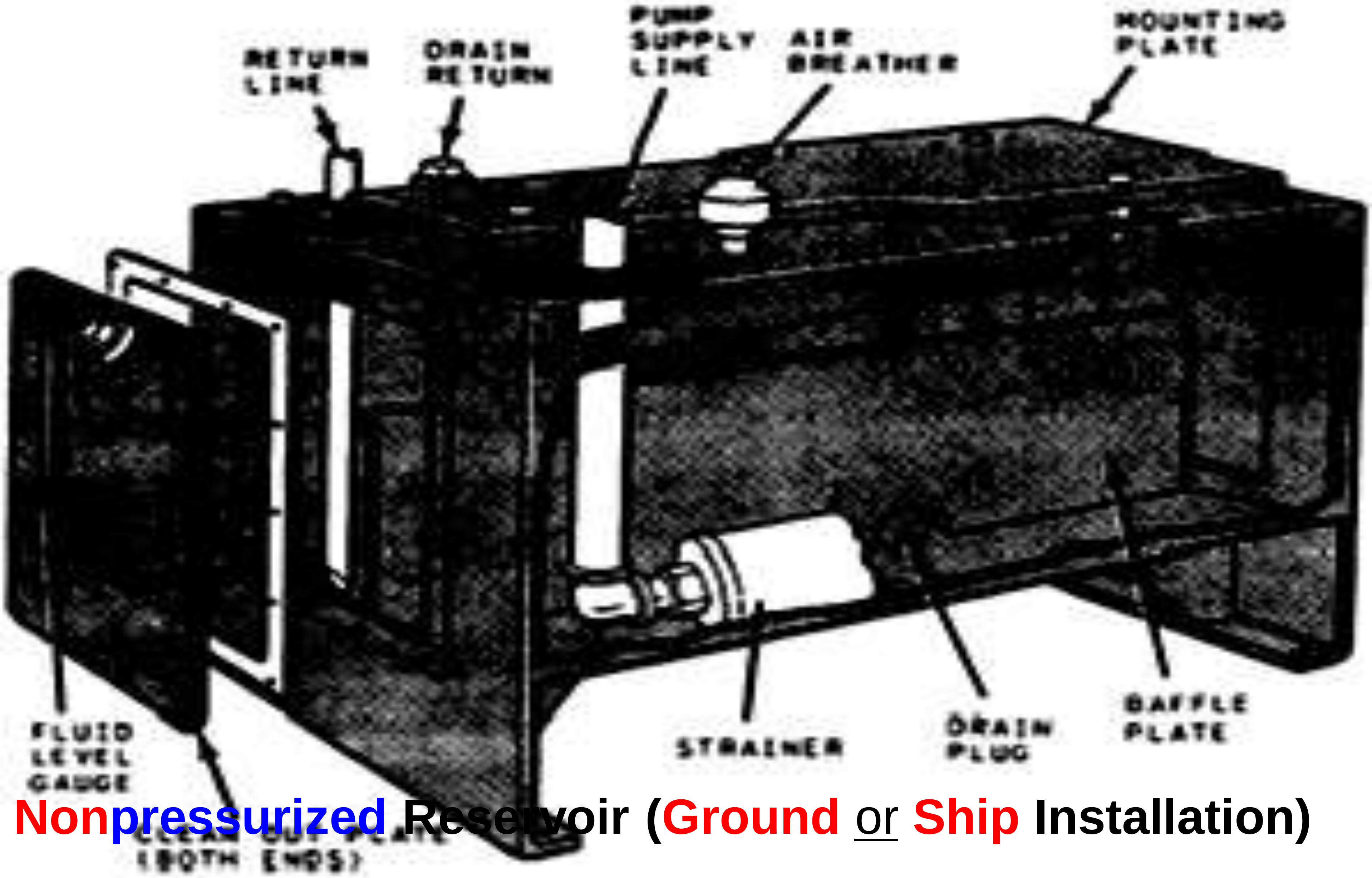




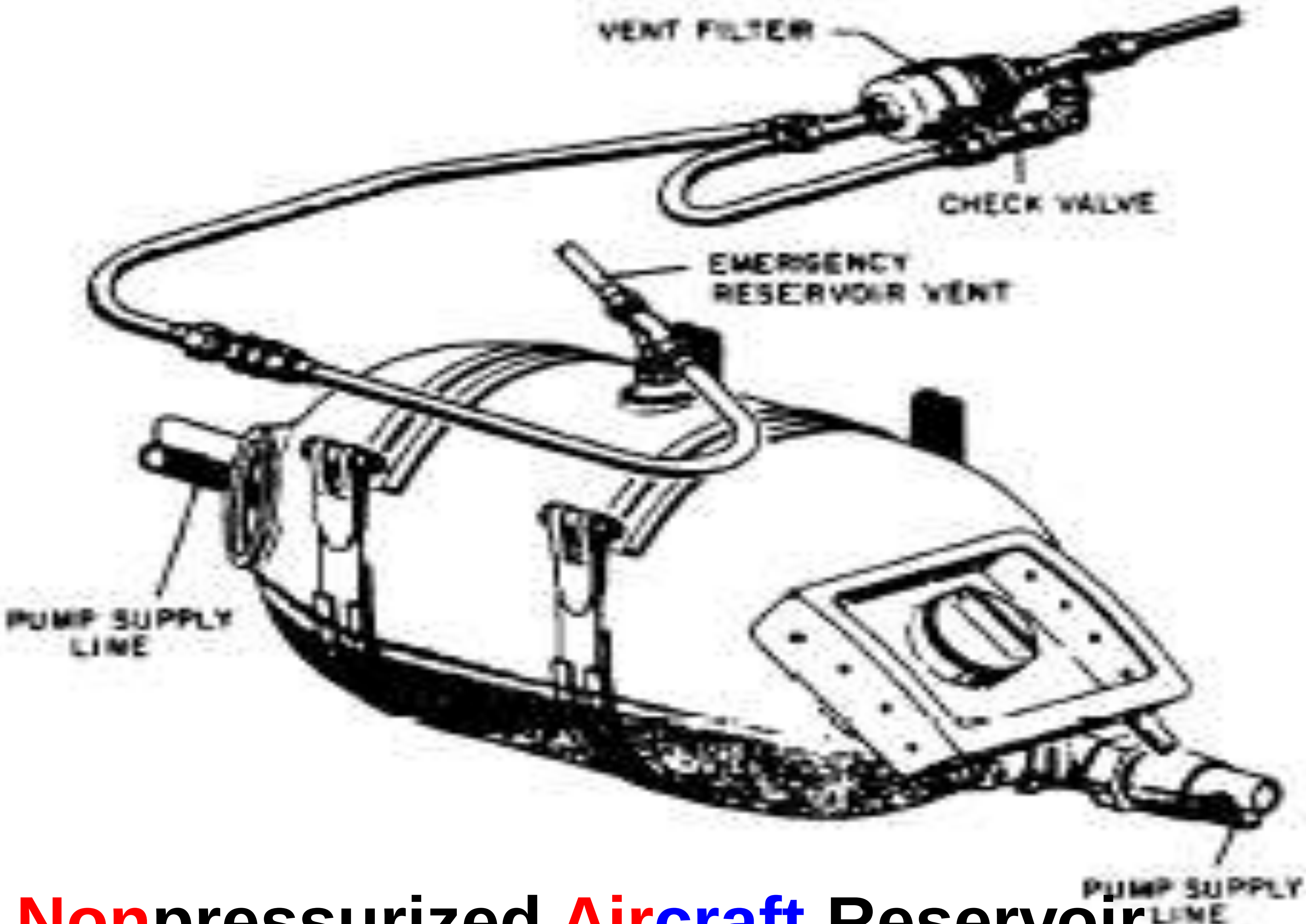

VENTED TANK



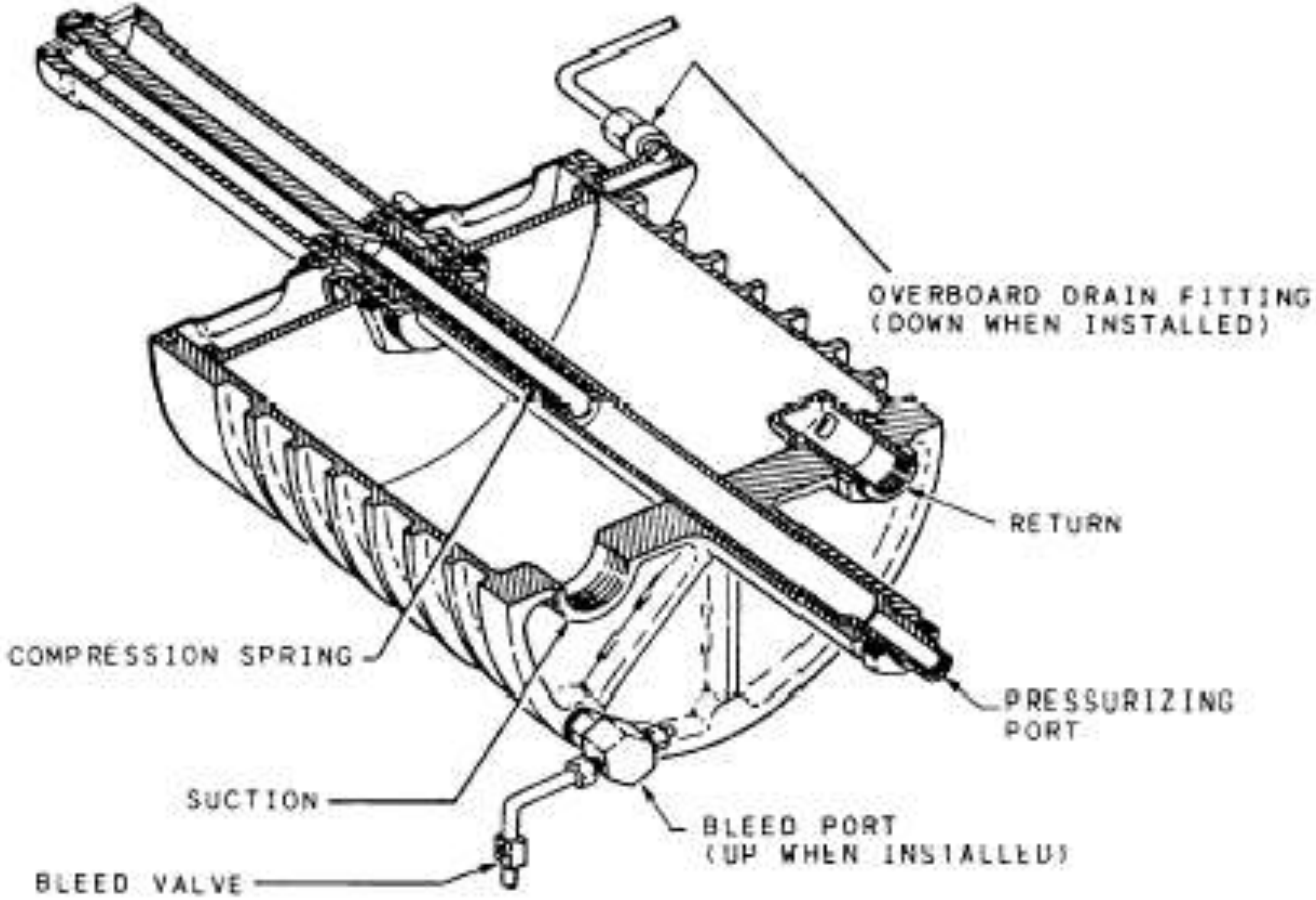

**Reservoir Symbols**



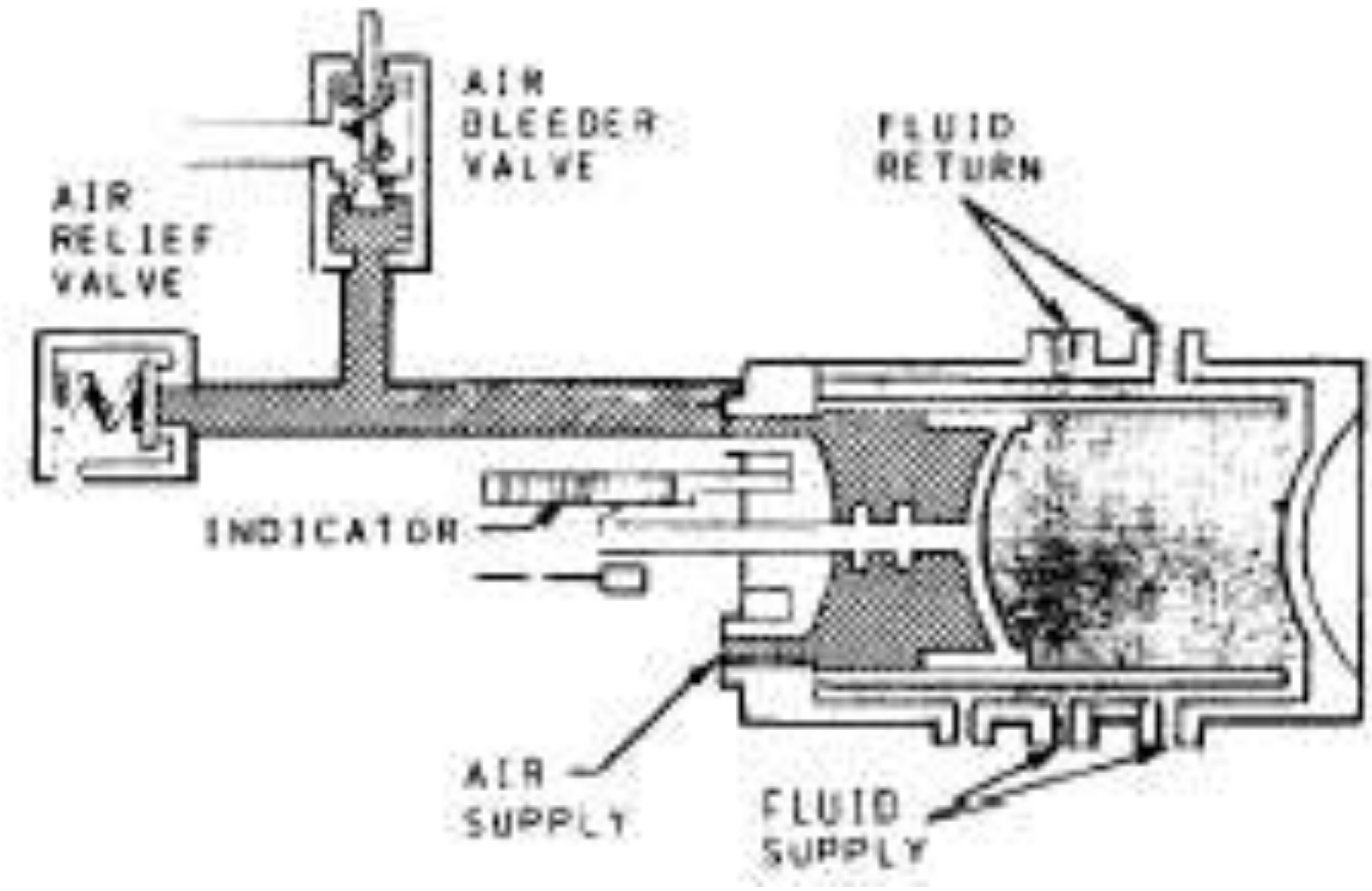

**Nonpressurized Reservoir (Ground or Ship Installation)**




# Nonpressurized Aircraft Reservoir




# Typical Fluid-Pressurized Reservoir




# Air-Pressurized Reservoir