FIGURE 1 - THE ARCA REGLER "DROP IN" SEAT DESIGN (METAL TO METAL SEAT SEALING)

In control valve design there are two basic methods to retain the seat ring in the valve body. They are

1) "SCREWED IN" or 2) "DROP IN"

Here is a brief description of both designs and their effects:-

This design is to provide threads on the body web and seat ring so that the seat can be screwed into the body. With this type of design the sealing between valve body and seat is done by a metallic chamfer. The inclination of the two chamfers is slightly different, therefore in theory there is only line contact between the two.

The sealing retaining force induced by the torque applied on the seat depends on the operating conditions in the valve and a few other variables.

The equation below shows the number of variables to effect a reliable seal, the number and type of variables would indicate the possible problems in calculating exact torque requirements.

1. - Quality of Thread
2. - Surface Finish of Thread
3. - Lubrication of the Thread
4. - Material combination of Body and Seat
5. - Process Parameters acting on the valve

$$M_A = F_A \cdot d_2 / 2 \cdot \tan(\varphi + \varphi_G) + \mu_K \cdot \Gamma_A$$

Legend:

M_A = Mounting Torque
F_A = Axial Thrust Load
d_2 = Pitch Diameter
φ = Angle of Climb
φ_G = Friction Angle; tang $\varphi G - \mu G$
μ_K = Friction Factor (μ_G and μ_K depending on material and lubrication)
Γ_A = Friction Effort Arm
μ_G = Friction Factor of Threads

The design of the **"Screwed In"** seat can generally lead to one of two approaches

- **Applying Excessive Torque (The most common approach)**
  Which can result in:
  1. Plastic Deformation of the Sealing Chamfers
  2. Cold Welding
  3. Deformation of the Roundness of the Seat diameter

This approach to "Screwed In" seats to effect a reliable seal carries a heavy penalty in the maintenance area because the seat ring can be almost impossible to remove after being in service for a period of time. Heat, corrosion and contact force tend to **"weld"** the seat ring to the body, requiring excessive torque levels to break it loose. Apart from the time and machining aspect there is also employee safety to consider. i.e. Application of high torque levels can result in an injury-causing energy release if something suddenly breaks loose.

- **Applying Insufficient Torque**

Which can result in:

1. Seat Leakage
2. Bypass Leakage
3. Seat working loose due to vibration or process conditions

The consequences of the above are plain to see.

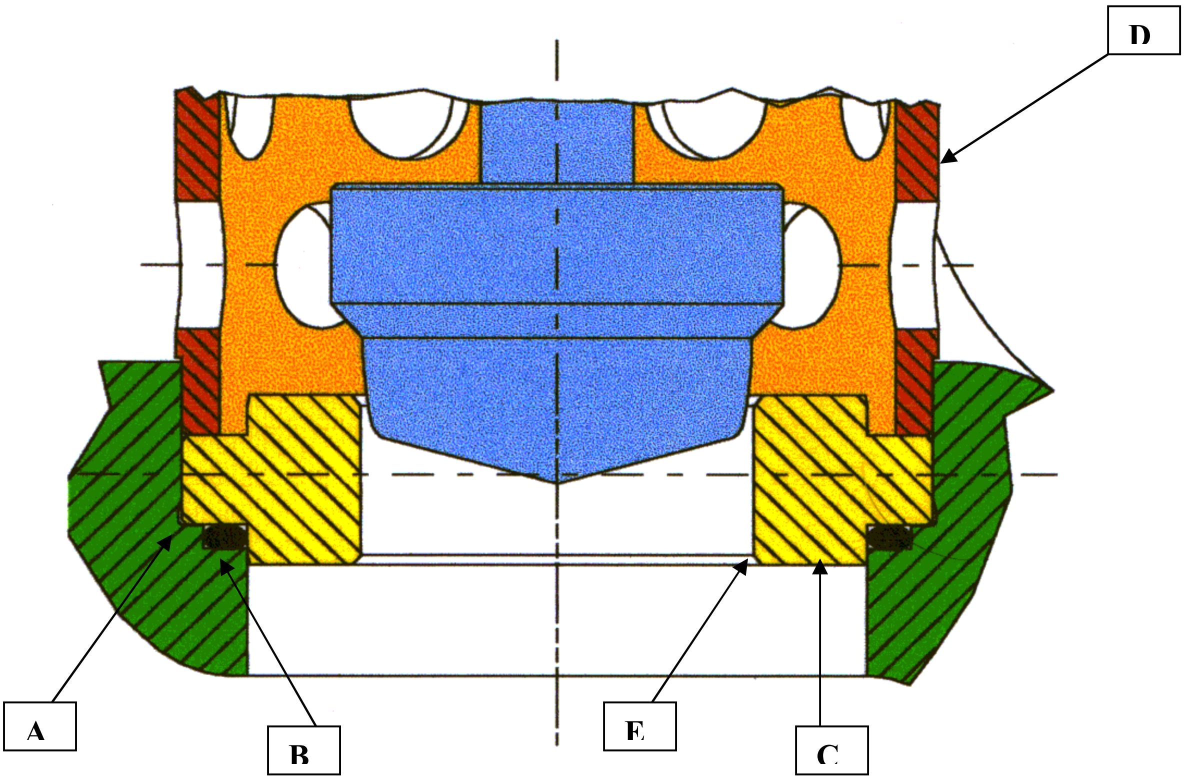
<u>2) "DROP IN" SEAT DESIGN - (Figure 1)</u>

This design provides for a recessed area **(A)** on the body web so that the seat ring **(C)** is retained in the recess. Since it is not mechanically fastened in any way to the body, it is easily removed for maintenance or replacement. It does require some type of seal **(B)** between it and the body to prevent leakage and some method for loading the seal. The seal is typically an **O-Ring** or (for higher temperatures) a **Gasket** and the standard way of loading the seal is to transmit a portion of the bonnet-to-body bolting load through the cage **(D)** (sometimes referred to as the "Seat Ring Retainer") and the seat ring and, in turn, to the seal.

This type of design eliminates all problems associated with "Screwed In" seats and is very simple to assemble and “dis-Assemble.”

<u>LEAKAGE BETWEEN PLUG & SEAT</u>

Apart from the geometry or method of installing the seat and ensuring a seal between body and seat, the other primary consideration is the "Shut-Off", or allowed leakage through the trim. (Excluding valve stem sealing for the moment - Please refer to the **"Maintenance Free Stem Sealing"** article)



<u>THE ARCA REGLER “DROP IN” SEAT DESIGN (METAL TO METAL SEAT SEALING)</u>

The required Seat / Plug sealing thrust force is dependant on **Acceptable Leakage, Geometrical Form** and **Surface Finish, Machining Tolerances** and the **Material Properties** of the **Sealing Chamfer.**

The Sealing Thrust Force (Fs) is determined by,

$$Fs = Cs \cdot \pi \cdot D \ [N]$$

Legend:

1. Fs = Sealing Thrust Force
2. Cs = Sealing Force Factor
3. D = Seat Ring Diameter

The Sealing Thrust Force Factor (Cs) is a factor developed by control valve manufacturers for each valve type based on empirical tests as a function of the leakage. There are industry standards with regard to seat leakage, the most common being ANSI / FCI 70-2, 1991.

Tests on the Arca Regler **"Ecotrol"** valve type, have given the following results:-

Cs factor N / mm	Leakage as a % of Kvs	Comment
2.5	less than 0.01%	Better than ANSI Class IV
15	less than 0.0001%	
25	less than 0.00001%	

The above table would indicate that the more Sealing Thrust Force applied the better the Shut-Off. This increasing of the sealing thrust force will however lead to the Elastic Deformation of plug and seat chamfer. Some manufacturers, due to bad design and / or manufacturing costs, increase the Sealing Thrust Force to overcome "Offsets" between seat and plug or to overcome poor machining tolerances. In spite of all this the thrust forces should be kept to a minimum which means a good design.

Arca Regler have been designing and manufacturing since 1917, taking into account the above criteria and the years of experience, they have designed the **"Doubled Sided"**, **"Quick Change"** and **"Top Entry"** seat.

Double Sided - Due to the complete symmetrical shape of the seat, it is manufactured with a second seating surface on the opposite side of the seat. (See **E** in Figure 1) Other benefits are materials of construction, because of the shape the seat is also manufactured in ceramics, tungsten carbide, or any material required.

Quick Change - As the seat is a "Drop In" design, there is no un-screwing of seats and all the accompanying maintenance problems.

Top Entry - The seat is installed and removed through the top of the valve body, again incorporating ease of maintenance.

There are two basic designs, for control valves, with regard to seat sealing. The first is the metal to metal arrangement (Figure 1), whereby metal to metal contact around the circumference of the seat and plug ensures a Class IV or V leakage. (Arca Regler supply, as a standard, a Class V shut-off for the above design.)

The second basic design is metal to soft seal, the soft seal is usually PTFE inserted into the metal seat. This type of design gives a Class VI leakage rate, which is measured in "Bubbles per Minute". (Please refer to Figure 2). Arca Regler has taken this design one step further. Their design is similar to the **"Fire - Safe"** design used in mechanical **Ball Valves.**

Initially, (Please refer to Figure 2), the plain face of the plug **(A)** comes into contact with the PTFE ring **(B)**, to affect the primary sealing. With additional sealing thrust force the back-up elastomer O-Ring **(C)** becomes compressed until the plug reaches its metallic stop on the seat. In effect a secondary sealing arrangement has come in to play which is the metal to metal arrangement **(D)** as discussed previously.

Arca Regler have used over 50 years of experience in designing a control valve that is "STATE of the ART", it is called the **"ECOTROL"**, and incorporates not just the above seating arrangement, but also:-

1. MAINTENANCE FREE STEM SEALING
2. TUBELESS MOUNTING OF POSITIONER
3. MULTI-SPRING DIAPHRAGM ACTUATOR (Field Reversible)
4. "INTELLIGENT" ELECTRO-PNEUMATIC POSITIONER

FIGURE 2 – THE ARCA REGLER "DROP IN" SEAT DESIGN (SOFT SEAT SEALING)