Aerosol Valves

Aerosol 101

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Corporate Technical Director
Precision Valve Corporation

THE AEROSOL VALVE

BENEFITS OF AEROSOLS

- Convenient
- Easy to Use/Immediate Use
- Controlled Application
- Compact
- Portable
- Long Lasting
- Particle size/pattern control
- Continuous spray
- Recyclable (Regional)

VALVE FUNCTION

- RELEASE THE CONTENTS
- PERMIT FILLING OF PROPELLANT
- ACT AS AN HERMETIC SEAL

HISTORY

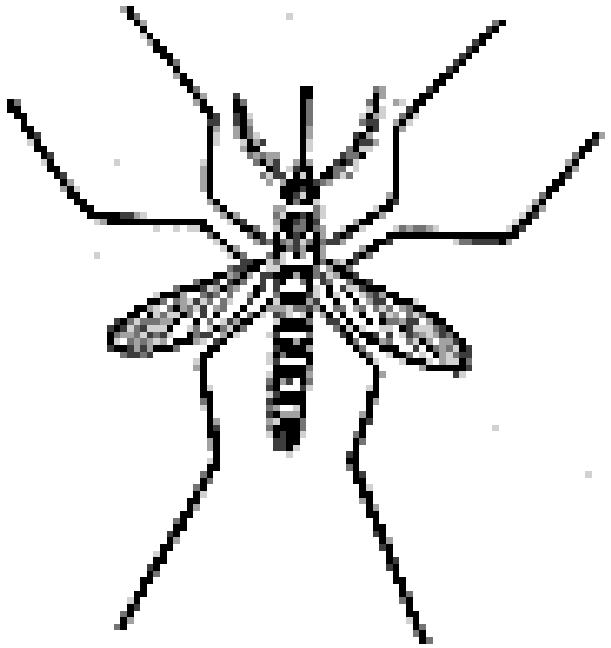
- 1790 France: Self-Pressurized carbonated beverage introduced

HISTORY

- 1927 Norway: Erik Rotheim develops the first aerosol can & valve that holds and dispenses propellant & product.

HISTORY

- 1943 USA: Department Of Agriculture researchers Goodhue & Sullivan develop a small aerosol can pressurized by a liquefied gas. Service men spray malaria infested mosquitoes.



HISTORY

- Post War Commercialization: Valve staked into a “Beer Can”
- 1949: Bob Abplanalp develops the first one inch aerosol valve. Aerosols become inexpensive and practical

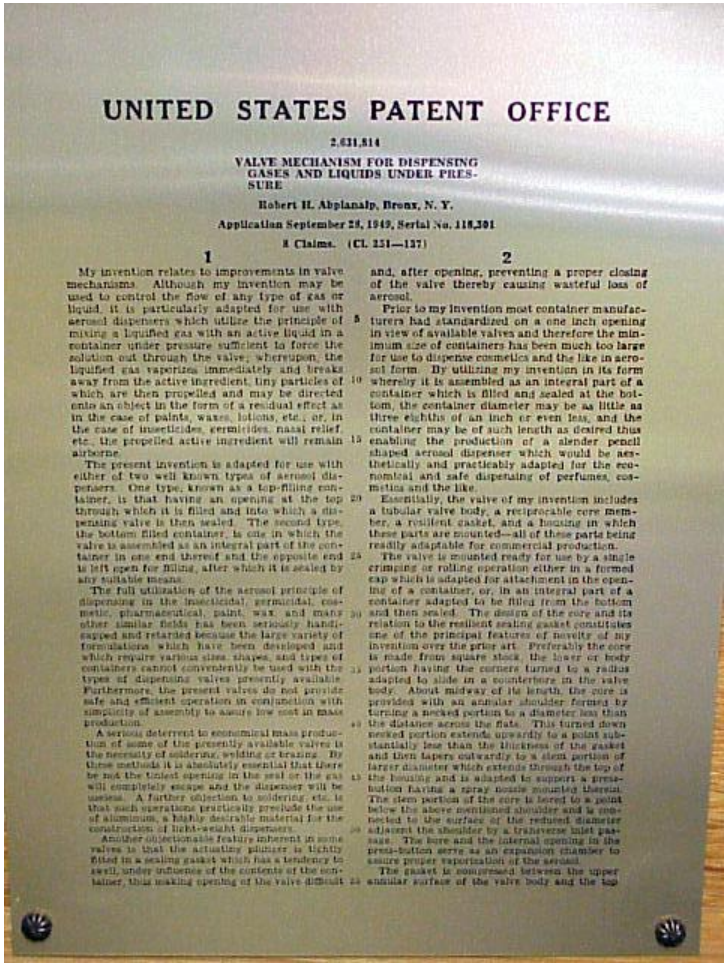
HISTORY


1944
1947
1942
1947
1946
1949
BUG BOMB
AUTOMATIC
Hero
FIRE
EXTINGUISHER
FLY-TOX
AEROSOL
INSECT
BOMB
KILLS
FLIES

HISTORY

- 1953: Robert H Ablanalp patents the aerosol valve as we know it today

HISTORY



UNITED STATES PATENT OFFICE

2,631,814

VALVE MECHANISM FOR DISPENSING GASES AND LIQUIDS UNDER PRESSURE

Robert H. Abplanalp, Bronx, N. Y.

Application September 28, 1949, Serial No. 118,301

8 Claims. (Cl. 251—137)

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My invention relates to improvements in valve mechanisms. Although my invention may be used to control the flow of any type of gas or liquid, it is particularly adapted for use with aerosol dispensers which utilize the principle of mixing a liquified gas with an active liquid in a container under pressure sufficient to force the solution out through the valve; whereupon, the liquified gas vaporizes immediately and breaks away from the active ingredient, tiny particles of which are then propelled and may be directed onto an object in the form of a residual effect as in the case of paints, waxes, lotions, etc.; or, in the case of insecticides, germicides, nasal relief, etc., the propelled active ingredient will remain airborne.

The present invention is adapted for use with either of two well known types of aerosol dispensers. One type, known as a top-filling container, is that having an opening at the top through which it is filled and into which a dispensing valve is then sealed. The second type, the bottom filled container, is one in which the valve is assembled as an integral part of the container in one end thereof and the opposite end is left open for filling, after which it is sealed by any suitable means.

The full utilization of the aerosol principle of dispensing in the insecticidal, germicidal, cosmetic, pharmaceutical, paint, wax and many other similar fields has been seriously handicapped and retarded because the large variety of formulations which have been developed and which require various sizes, shapes, and types of containers cannot conveniently be used with the types of dispensing valves presently available. Furthermore, the present valves do not provide safe and efficient operation in conjunction with simplicity of assembly to assure low cost in mass production.

A serious deterrent to economical mass production of some of the presently available valves is the necessity of soldering, welding or brazing. By these methods it is absolutely essential that there be not the tiniest opening in the seal or the gas will completely escape and the dispenser will be useless. A further objection to soldering, etc. is that such operations practically preclude the use of aluminum, a highly desirable material for the construction of light-weight dispensers.

Another objectionable feature inherent in some valves is that the actuating plunger is tightly fitted in a sealing gasket which has a tendency to swell, under influence of the contents of the container, thus making opening of the valve difficult

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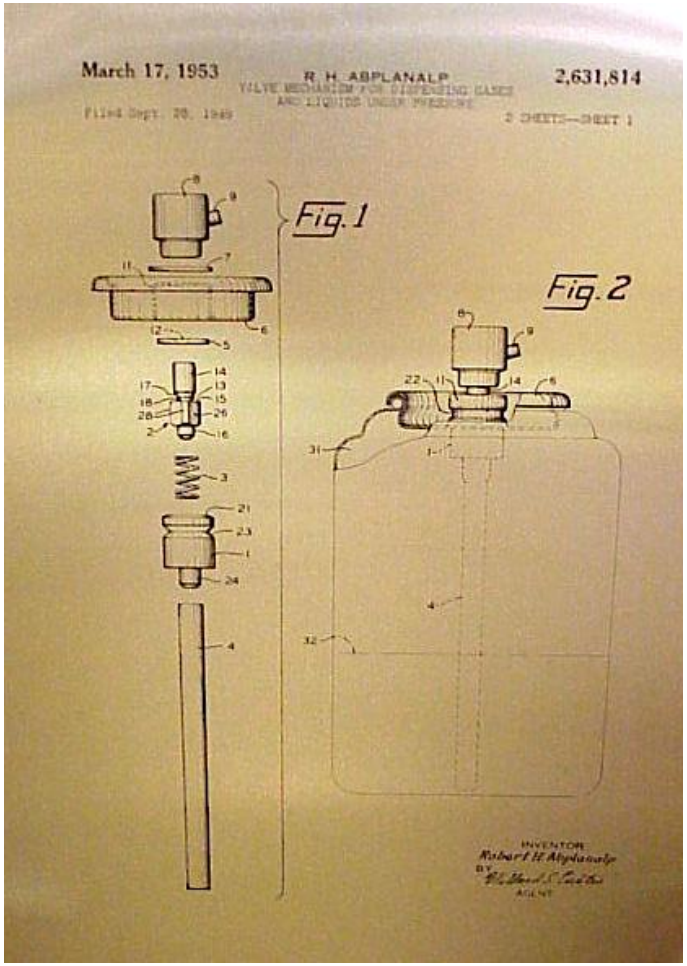
and, after opening, preventing a proper closing of the valve thereby causing wasteful loss of aerosol.

Prior to my invention most container manufacturers had standardized on a one inch opening in view of available valves and therefore the minimum size of containers has been much too large for use to dispense cosmetics and the like in aerosol form. By utilizing my invention in its form whereby it is assembled as an integral part of a container which is filled and sealed at the bottom, the container diameter may be as little as three eighths of an inch or even less, and the container may be of such length as desired thus enabling the production of a slender pencil shaped aerosol dispenser which would be aesthetically and practicably adapted for the economical and safe dispensing of perfumes, cosmetics and the like.

Essentially, the valve of my invention includes a tubular valve body, a reciprocable core member, a resilient gasket, and a housing in which these parts are mounted—all of these parts being readily adaptable for commercial production.

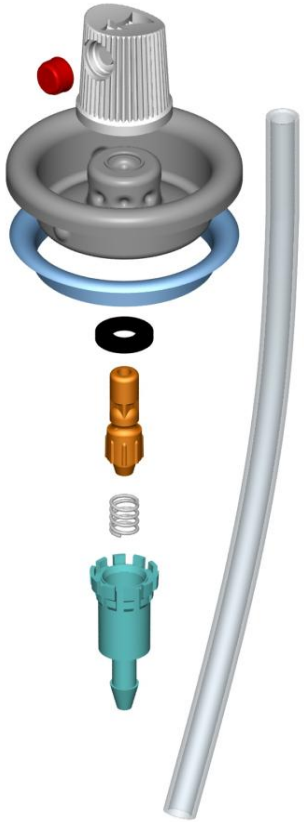
The valve is mounted ready for use by a single crimping or rolling operation either in a formed cap which is adapted for attachment in the opening of a container, or, in an integral part of a container adapted to be filled from the bottom and then sealed. The design of the core and its relation to the resilient sealing gasket constitutes one of the principal features of novelty of my invention over the prior art. Preferably the core is made from square stock, the lower or body portion having the corners turned to a radius adapted to slide in a counterbore in the valve body. About midway of its length, the core is provided with an annular shoulder formed by turning a necked portion to a diameter less than the distance across the flats. This turned down necked portion extends upwardly to a point substantially less than the thickness of the gasket and then tapers outwardly to a stem portion of larger diameter which extends through the top of the housing and is adapted to support a pressure button having a spray nozzle mounted thereon. The stem portion of the core is bored to a point below the above mentioned shoulder and is connected to the surface of the reduced diameter adjacent the shoulder by a transverse inlet passage. The bore and the internal opening in the pressure button serve as an expansion chamber to assure proper vaporization of the aerosol.

The gasket is compressed between the upper annular surface of the valve body and the top

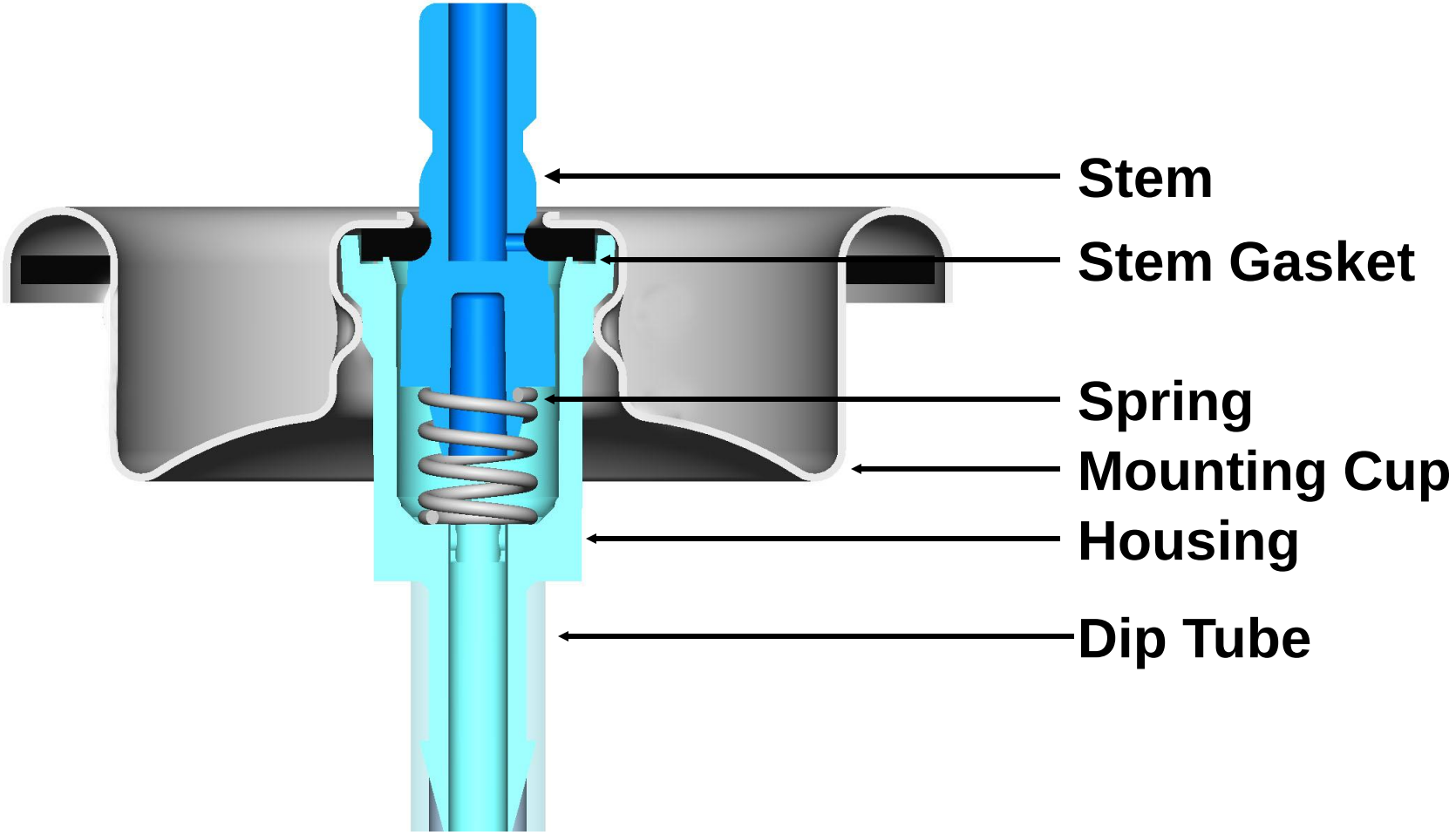


VALVE COMPONENTS

- **7 COMPONENTS**
  - *ACTUATOR*--CONTROLS PATTERN AND FLOW
  - *STEM*--CONTROLS FLOW
  - *STEM GASKET*--THE "ON/OFF" SWITCH
  - *SPRING*-CLOSES THE VALVE
  - *HOUSING (BODY)*--ENCLOSES SPRING/STEM. ALSO CONTROLS FLOW
  - *DIP TUBE*--DRAWS PRODUCT UP INTO THE VALVE
  - *MOUNTING CUP (WITH MOUNTING CUP GASKET)*--THE LINK BETWEEN CAN AND VALVE

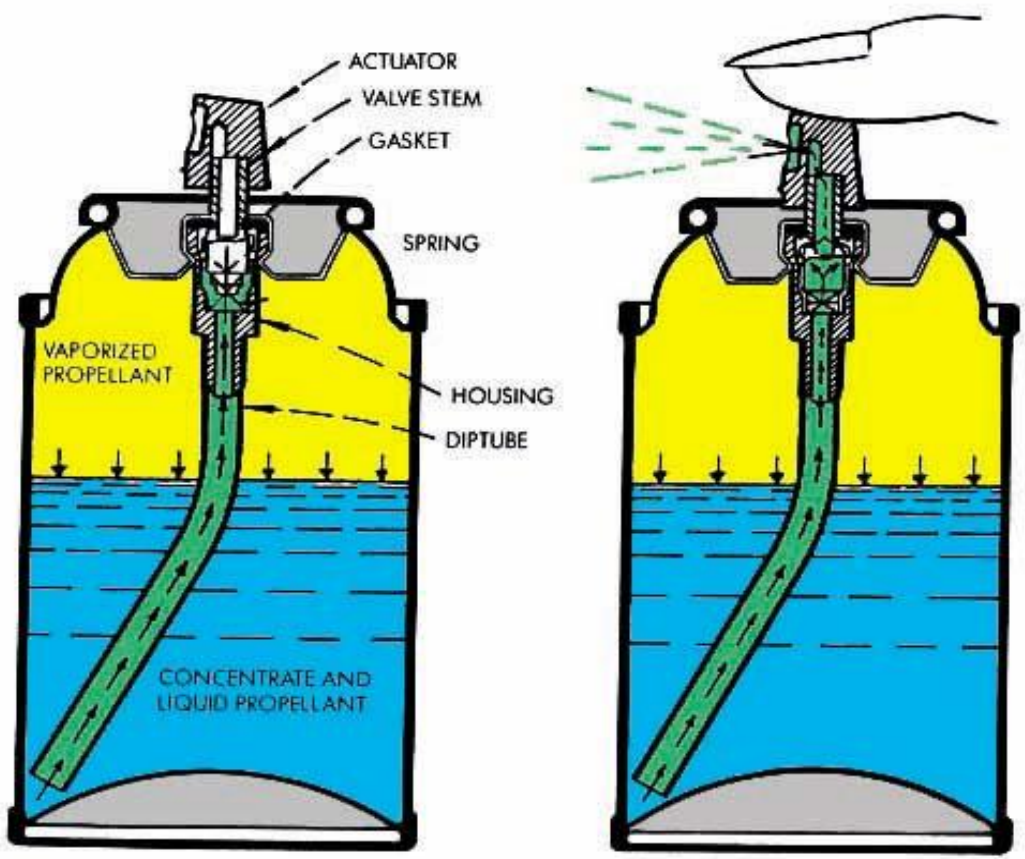


ASSEMBLED VALVE



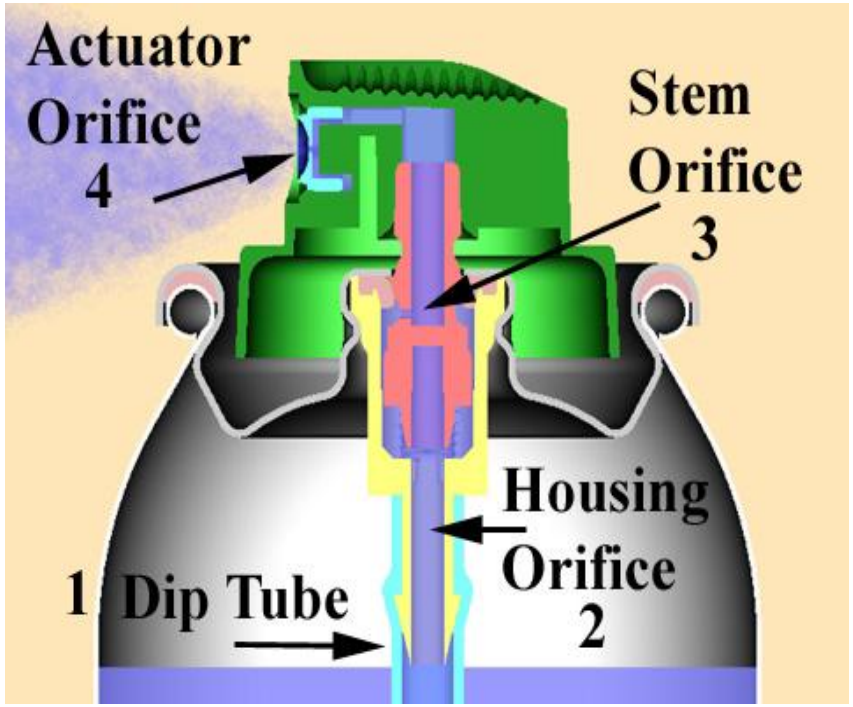
OPERATION

Pressure on the actuator depresses the stem. This movement interrupts the sealing action of the gasket and exposes the stem orifice to the pressurized flow of the product in the container, thereby opening the valve. When the actuator is released, the spring returns the stem orifice to the sealed position, closing the valve.

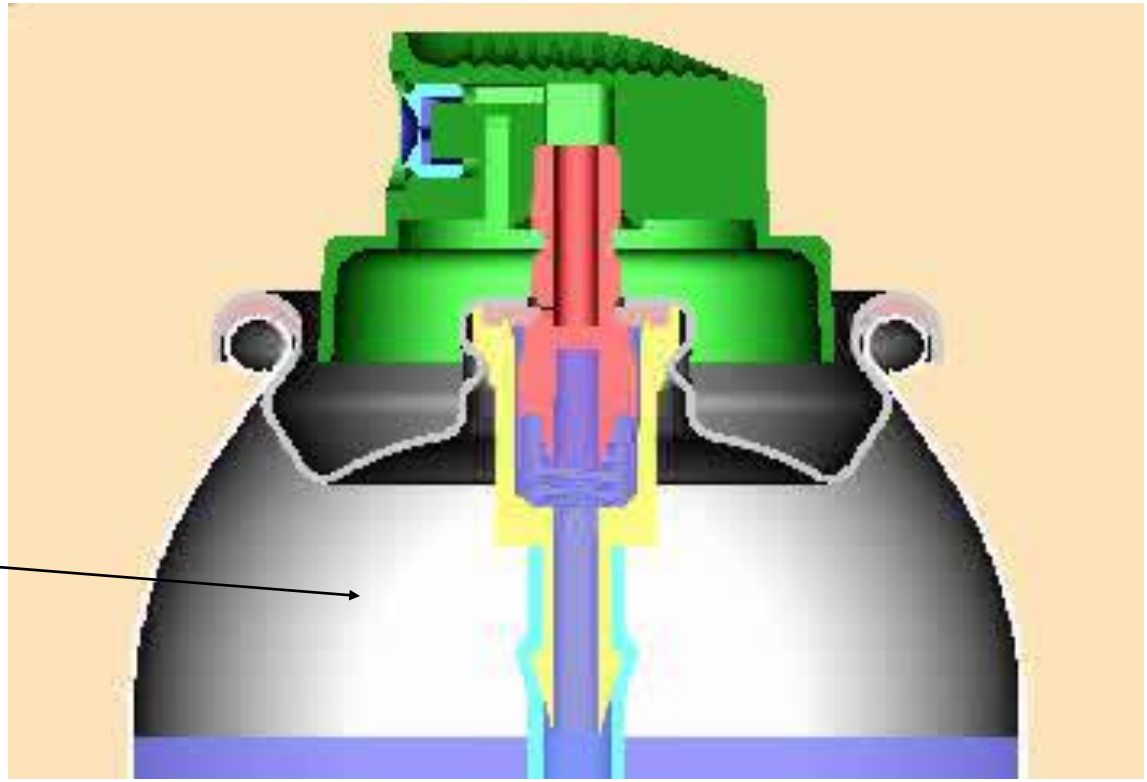


OPERATION

- **Product Flow Through The Valve**
  - 1. Dip Tube
  - 2. Housing
  - 3. Stem
  - 4. Actuator



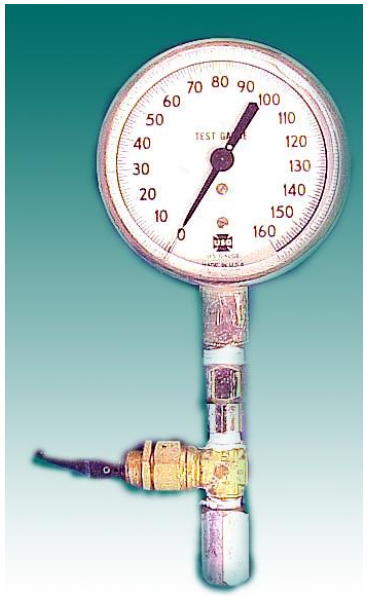
OPERATION



PROPELLANTS

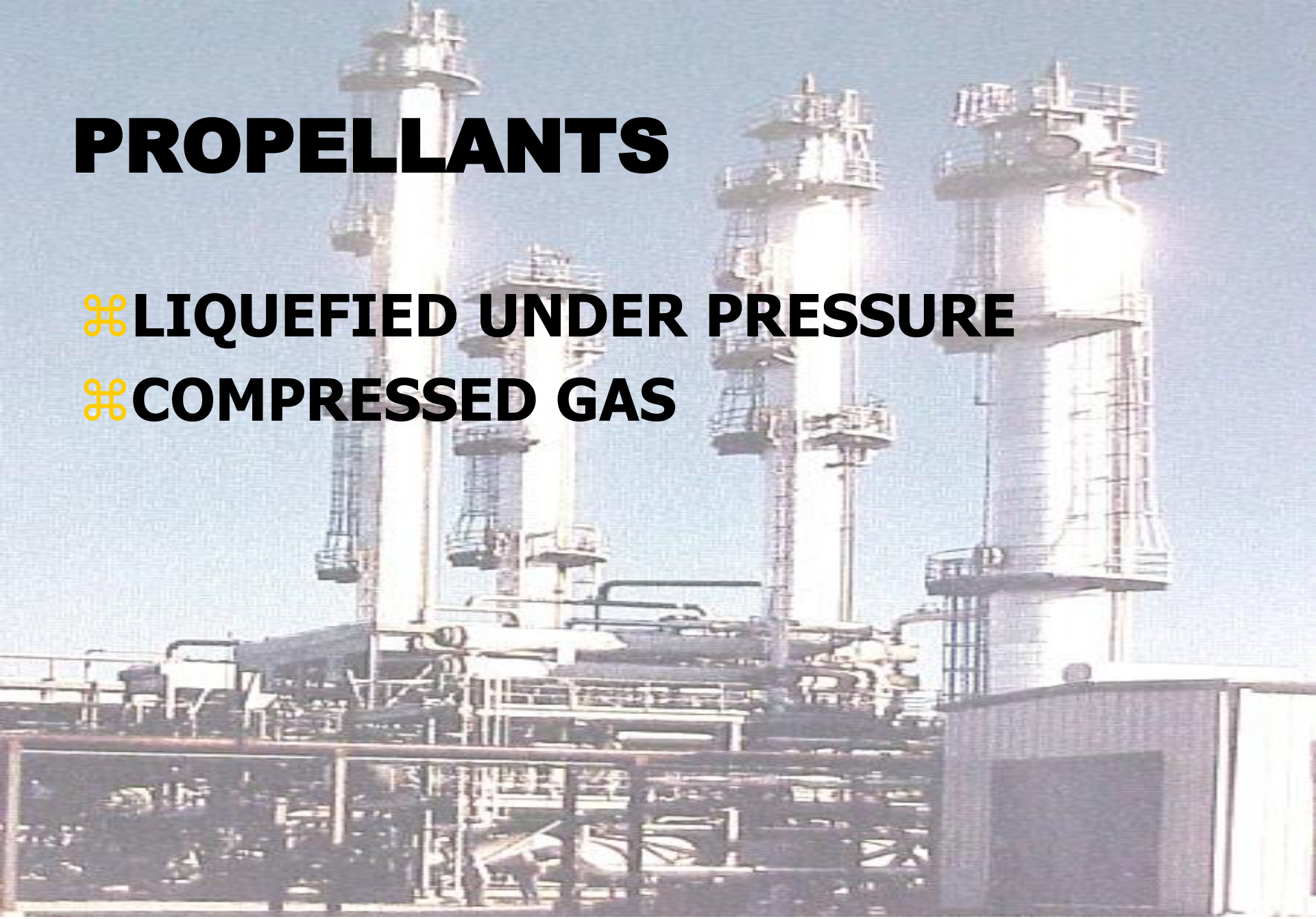
- PROPELLANTS GENERATE PRESSURE INSIDE THE CAN
- WIDE RANGE OF PRESSURES (17 PSIG--140 PSIG)

Pressure Gauge

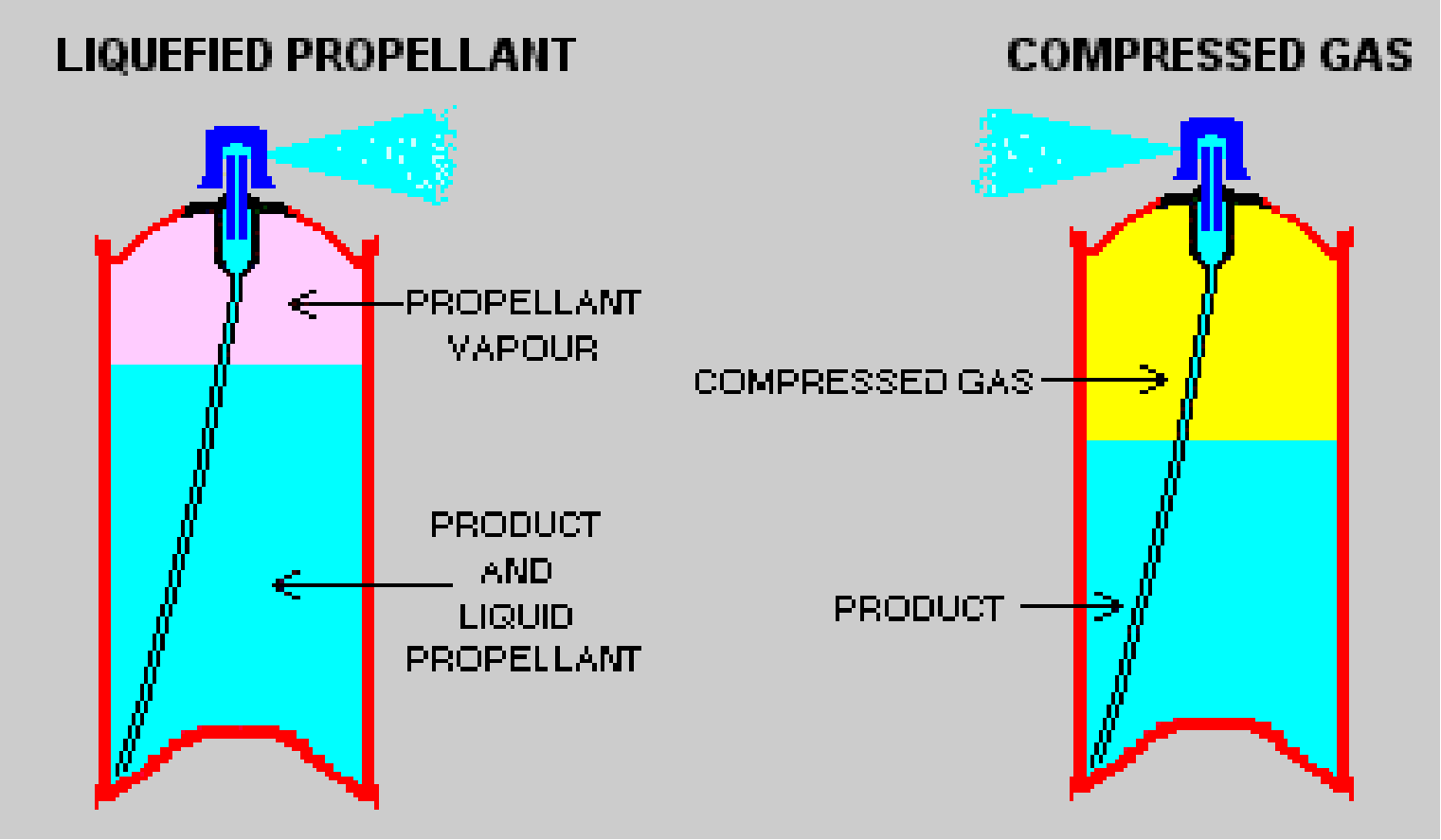


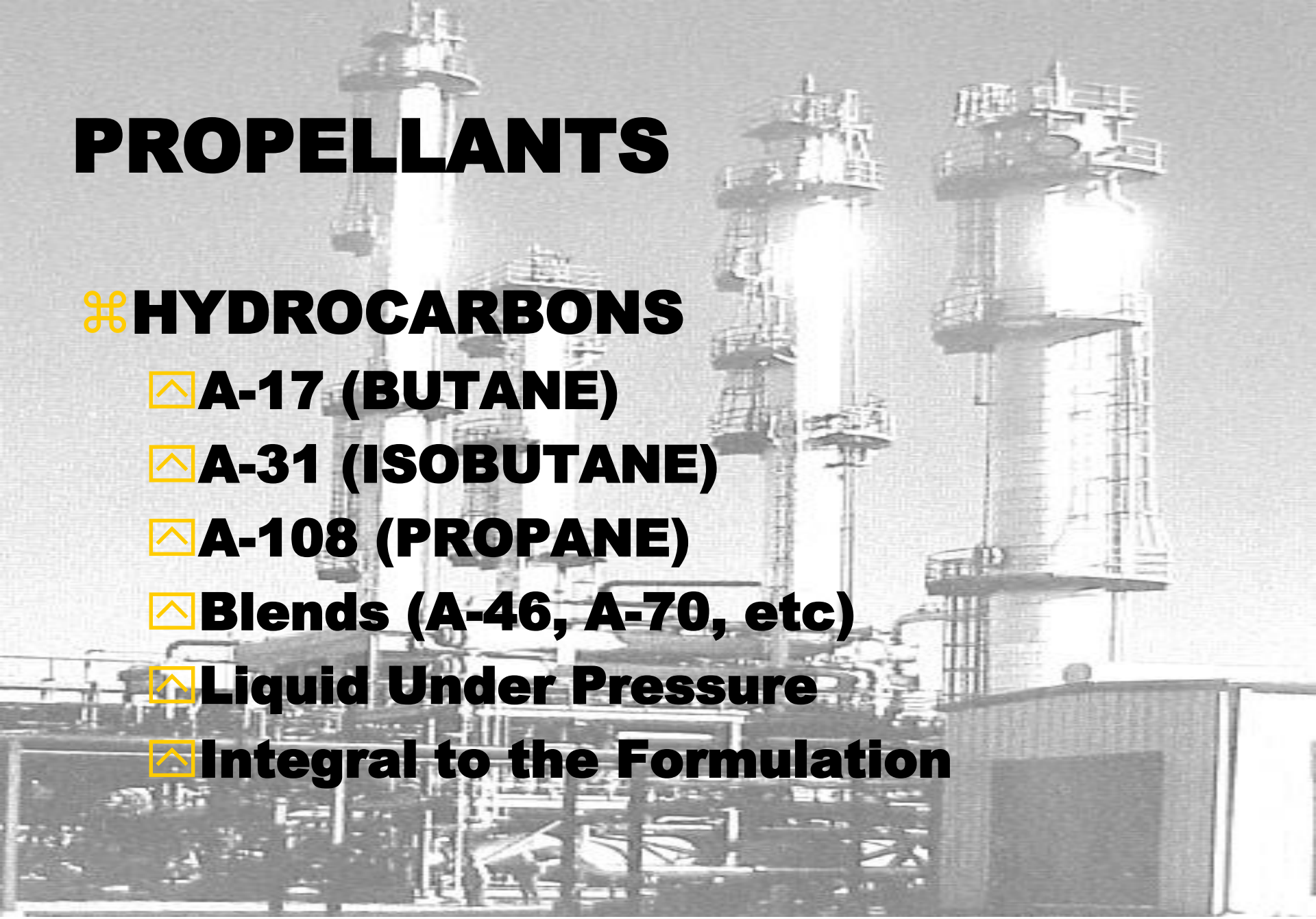
PROPELLANTS

- LIQUEFIED UNDER PRESSURE
- COMPRESSED GAS



PROPELLANTS





PROPELLANTS

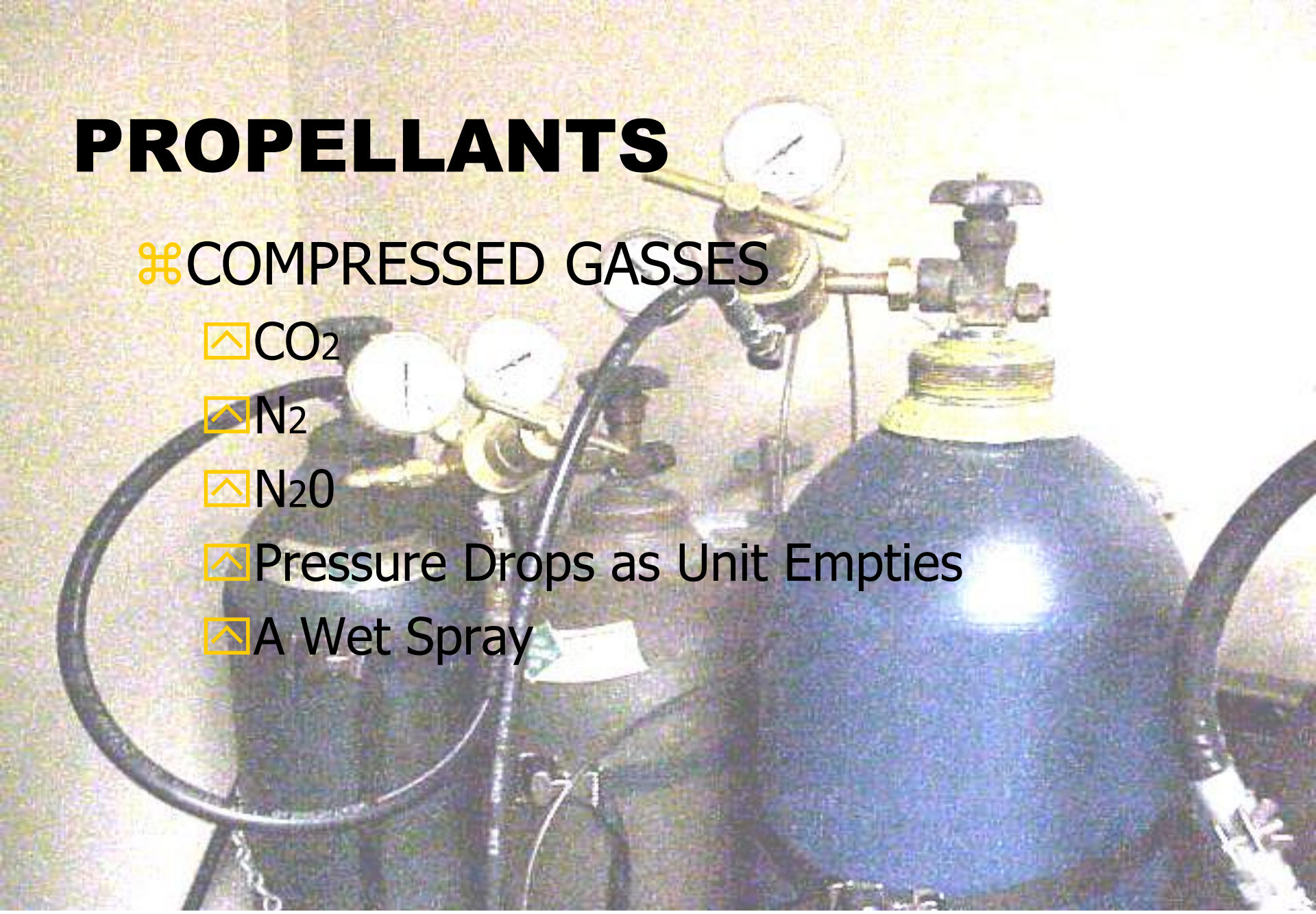
- HYDROCARBONS
  - A-17 (BUTANE)
  - A-31 (ISOBUTANE)
  - A-108 (PROPANE)
  - Blends (A-46, A-70, etc)
  - Liquid Under Pressure
  - Integral to the Formulation

PROPELLANTS

- DME (Dimethyl Ether)
- 152a (1, 1-Difluoroethane)
- 134a (1, 1, 1, 2-Tetrafluoroethane)

PROPELLANTS

- COMPRESSED GASSES
  - CO_2
  - N_2
  - N_20
  - Pressure Drops as Unit Empties
  - A Wet Spray

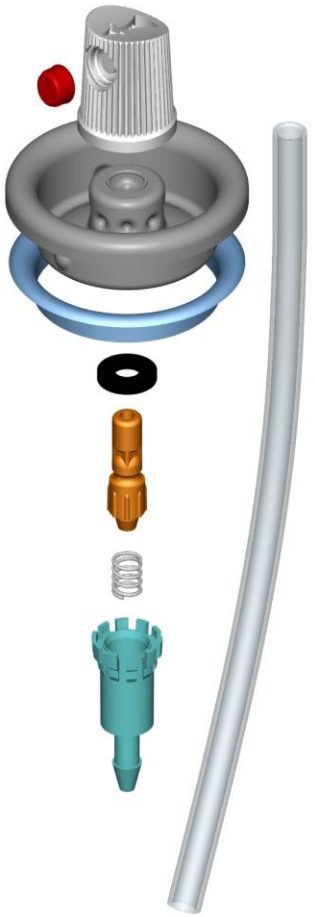


PROPELLANTS

Liquefied	Compressed
An integral part of the formula. Results in smaller, finer particles. Consistent pressure through life of can	Acts like a piston. Large, wet particles. (However, there is some solubility with CO2) Drop in pressure through life of can Caution with CO2 + H2O! Carbonic acid formation.
Large temperature changes effect pressure.	Temperature changes have little effect on pressure. (Good for de-icers, e.g.)
Cost varies	Low cost

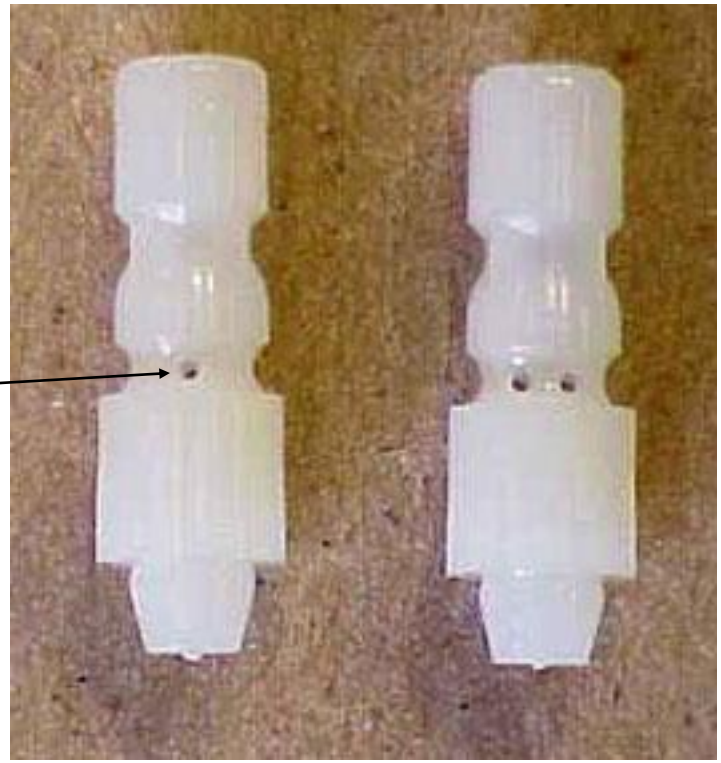
VALVE COMPONENTS

- Functions & Materials of Construction



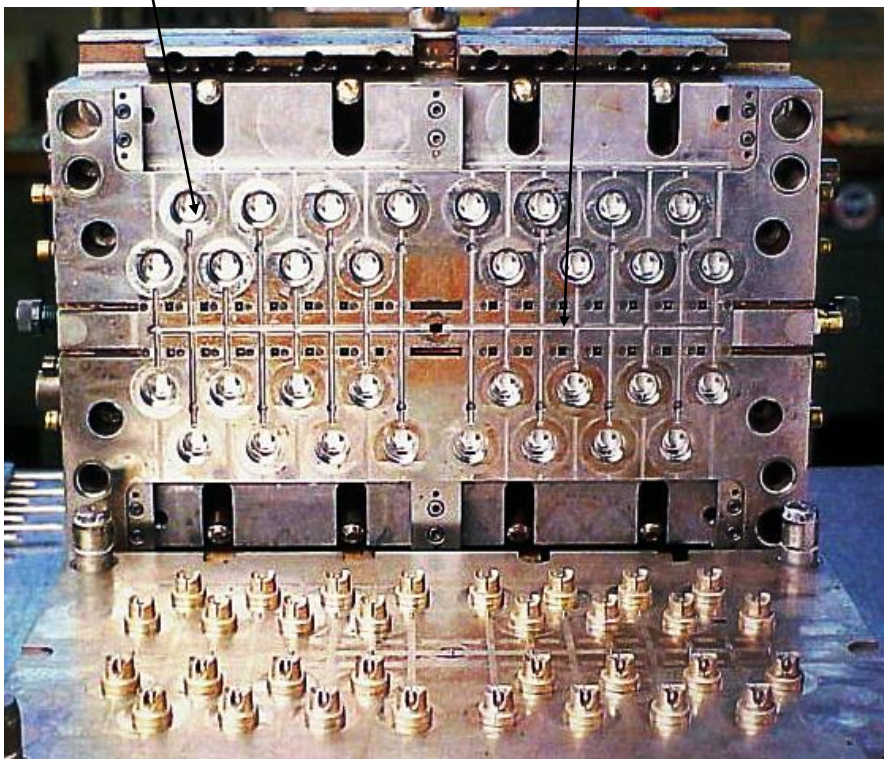
STEMS

- CONTROL THE FLOW
- ORIFICE SIZES: 0.010” TO 4 X 0.027 X 0.045”



INJECTION MOLDING

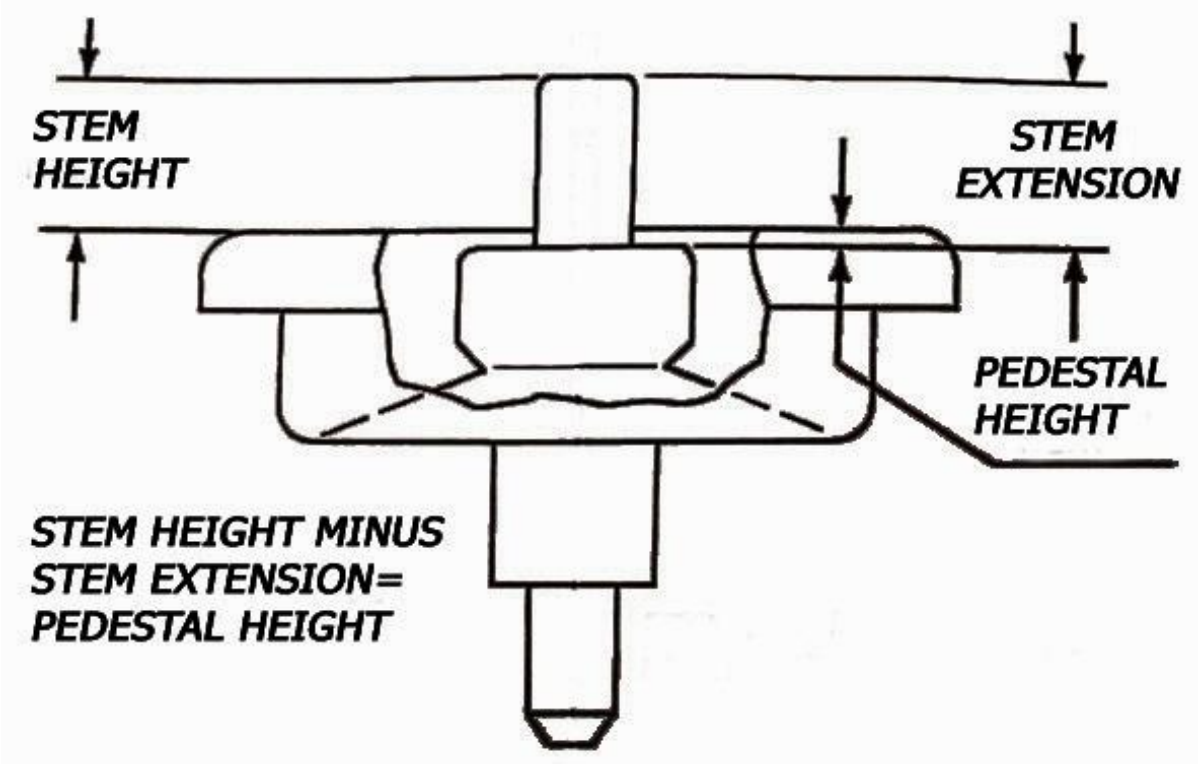
Injection Molding Machines



Two halves of a mold

STEMS

- STEM HEIGHT RELATIONSHIPS



STEMS

Stem height too high causing lifting of the finger pad

STEM GASKETS

- COVERS THE STEM ORIFICE (The on-off switch)
- DIFFERENT MATERIALS AVAILABLE FOR PRODUCT COMPATABILITY
- BUNA N
- NEOPRENE
- BUTYL
- VITON

STEM GASKETS

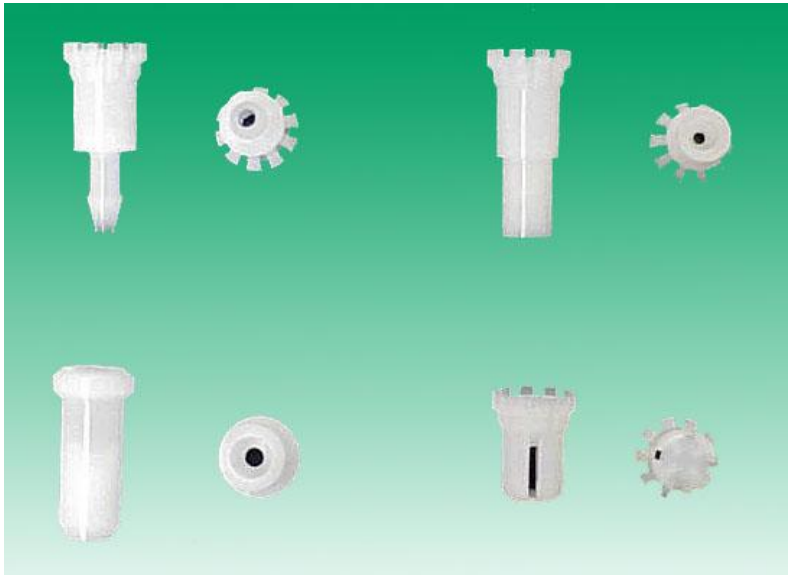
- *Remember*: The stem gasket seals the valve.
- *Remember*: It is made of rubber and will shrink or swell with different formulations.
- *Remember*: There is no universal stem gasket.
- Testing is recommended (more later on)

SPRINGS

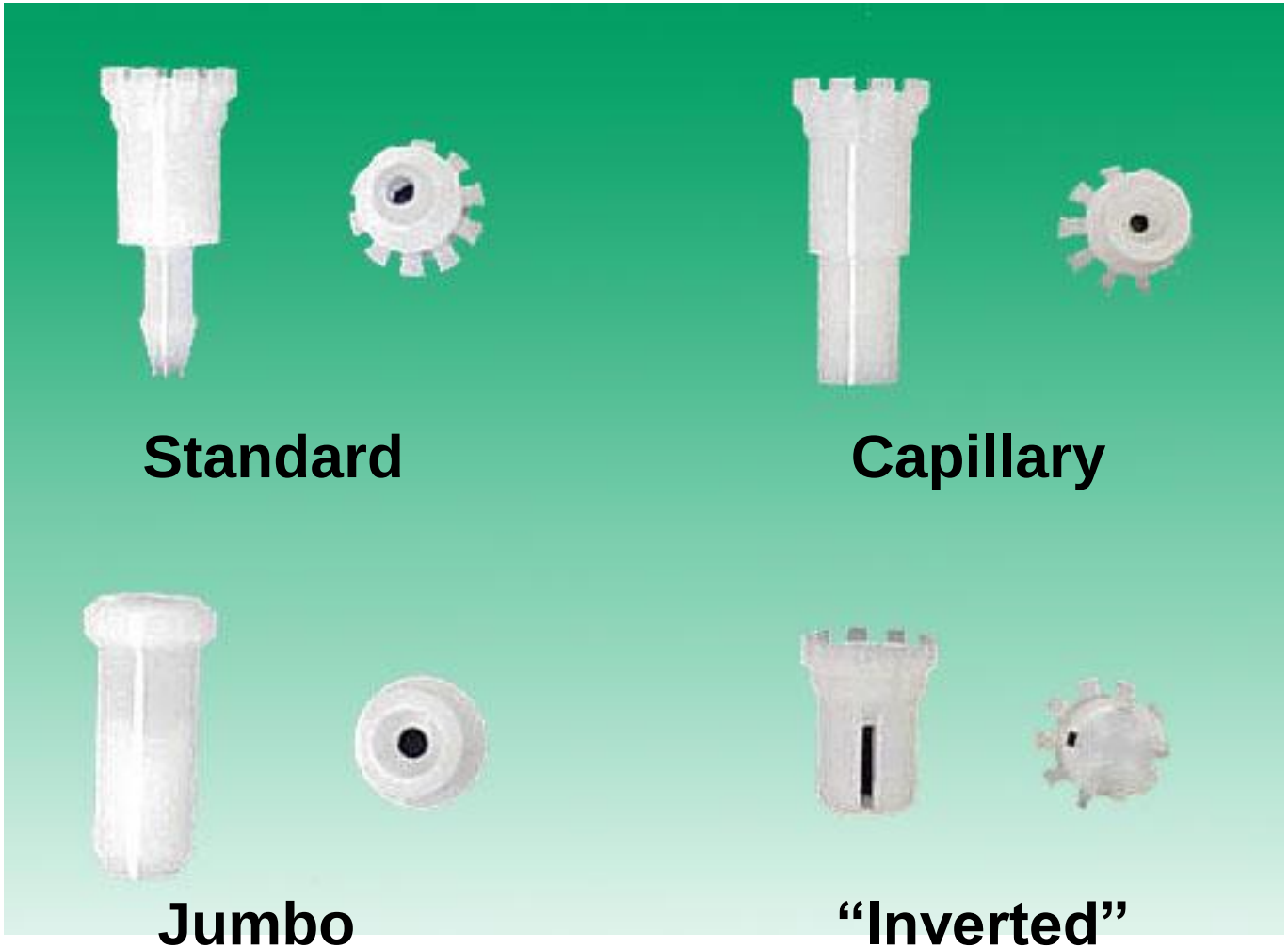
- CAUSES THE VALVE TO CLOSE
- STAINLESS STEEL (302, 316)

HOUSING (BODY)

- ENCLOSES THE SPRING AND STEM
- ACTS AS A SECONDARY METERING ORIFICE
- WIDE RANGE OF ORIFICE SIZES 0.013” TO 0.158”

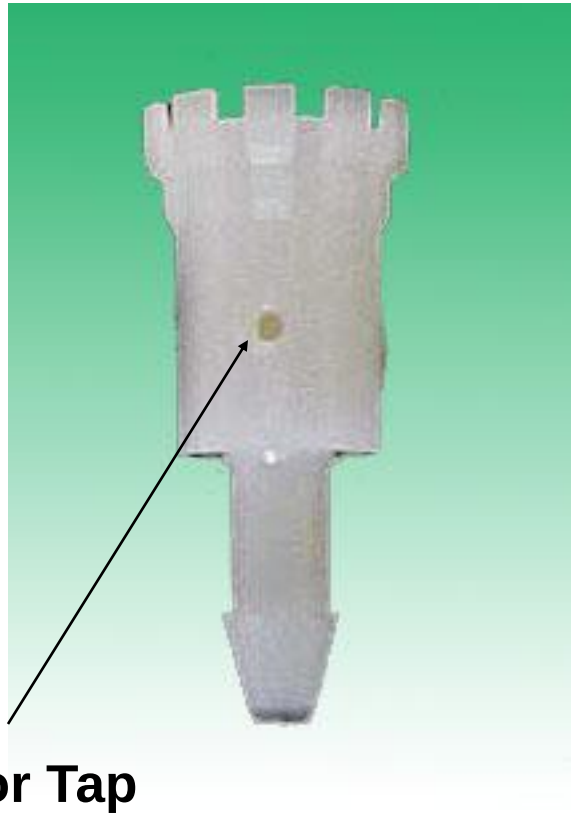


HOUSING



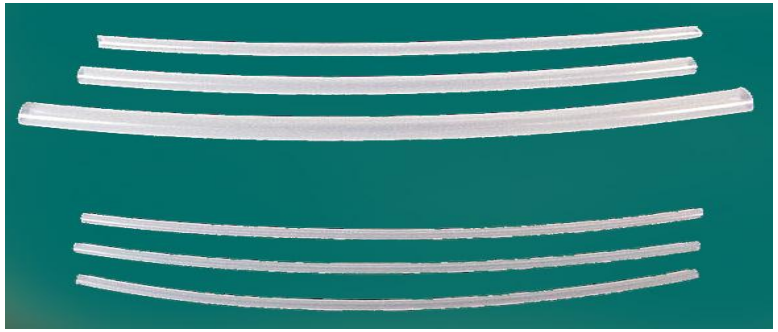
HOUSING (BODY)

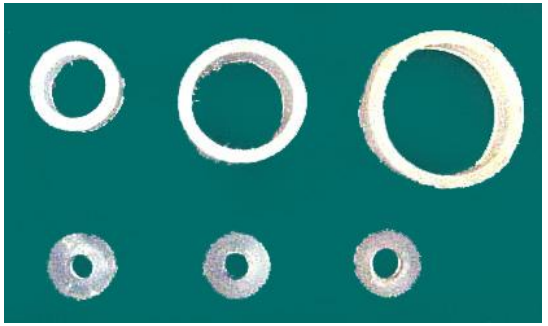
- VAPOR TAP (A HOLE IN THE SIDE OR BOTTOM OF THE HOUSING)
  - --0.005" TO 0.040"
  - --PRODUCES A DRIER AND WARMER SPRAY
  - --REDUCES PARTICLE SIZE
  - --NEEDS SUFFICIENT PROPELLANT TO EVACUATE
  - --DO NOT USE WITH COMPRESSED GAS



DIP TUBES

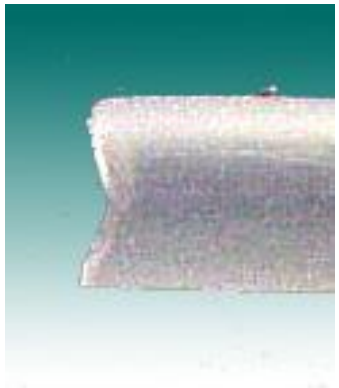
- DRAW PRODUCT UP INTO THE VALVE
- STANDARD: 1/8” (0.122”) INSIDE DIAMETER
- LARGE: 3/16” (0.190”) INSIDE DIAMETER
- JUMBO: OVER 1/4” (0.260”) INSIDE DIAMETER
- CAPILLARY: < 0.060” INSIDE DIAMETER



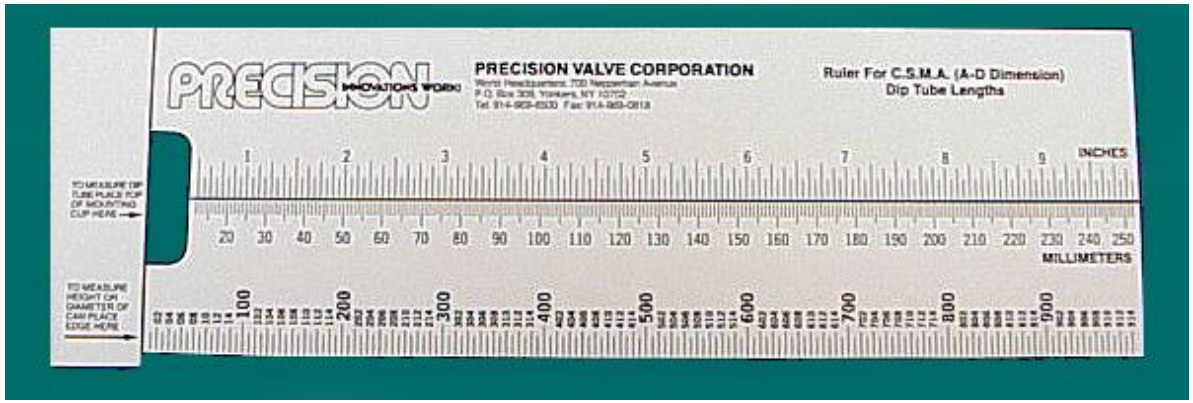


DIP TUBES

- NOTCHED TO PREVENT CLOSING OFF AT BOTTOM OF CAN
- LENGTH MEASURED FROM TOP OF CUP TO END OF TUBE ("CSPA" LENGTH)
- CSPA RULERS AVAILABLE



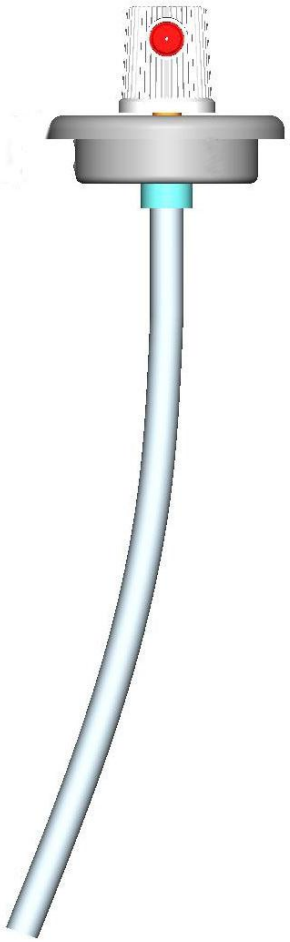
Notch Cut



CSPA Ruler for DT Length Measurement

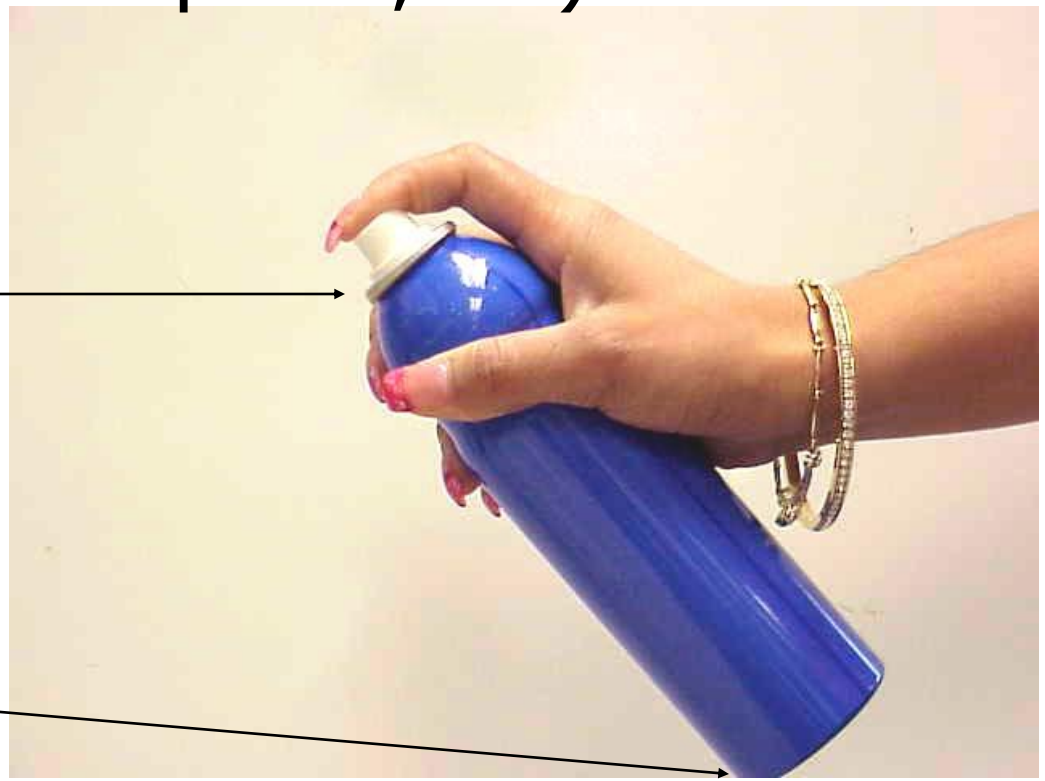
DIP TUBES

- Can use the dip tube curvature to your advantage
- Orient the dip tube for your particular application
- Will ensure complete evacuation



DIP TUBES

- 0 degree orientation for downward spray (starch, furniture polish, etc)



DIP TUBES

- 180 Degree orientation for upward spray (Room fresheners, space sprays, etc.)

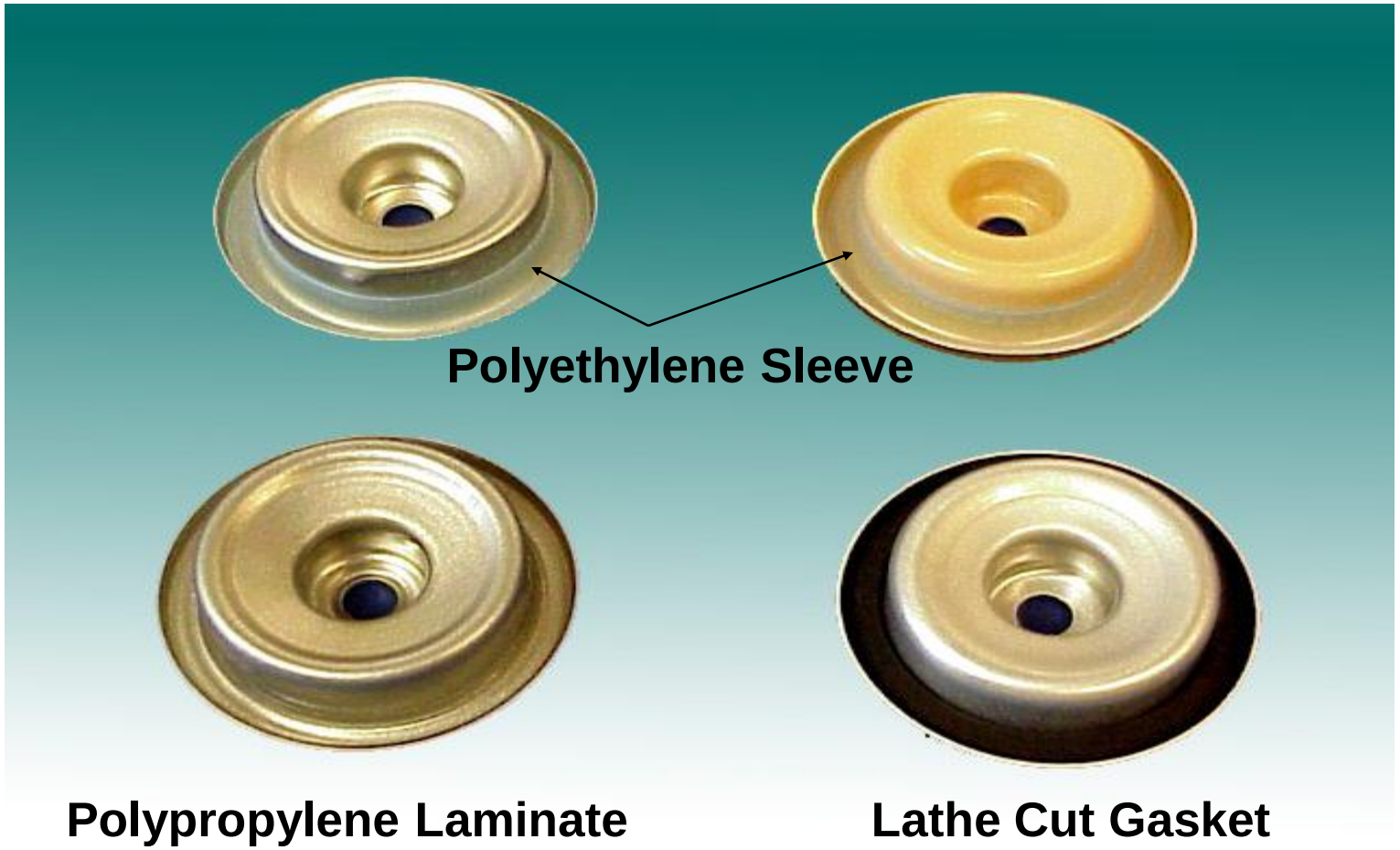
MOUNTING CUPS

- HOLD VALVE PARTS TOGETHER
- ATTACHES VALVE TO CAN
- TINPLATE OR ALUMINUM
- EPON COATED OR UNCOATED

MOUNTING CUPS

- GASKET MATERIALS
- PROVIDES A SEAL BETWEEN CUP AND CAN
- POLYETHYLENE SLEEVE FULLY BONDED TO MOUNTING CUP
- PP LAMINATE (ACTS AS COATING AND SEAL)
- CUT GASKET (AKA LATHE CUT GASKET) BUNA, NEOPRENE OR BUTYL

MOUNTING CUPS



MOUNTING CUPS

- *Which mounting cup gasket do I need?*
  - SLEEVE and LAMINATE
- Sleeve and laminate for general purpose tinplate cans
- Sleeve and laminate for non-milled aluminum cans less than 50mm in diameter

MOUNTING CUPS

- CUT GASKET
- Cut gasket for *any* size milled (machined) aluminum can
- Cut gasket for any aluminum cans 50mm and greater in diameter
- Cut gasket can be used with any can and valve combination…but $$$$$$$$

CRIMP CONSIDERATIONS

- Crimp: The method by which the valve is attached to the can
- Collets move into the mounting cup and spread to a specific diameter and depth

CRIMP CONSIDERATIONS

Closed Collet

Open Collet

CRIMP CONSIDERATIONS

Closed collet

Open collet in cup

CRIMP CONSIDERATIONS

- Crimp dimensions will depend on:
  - Mounting cup material
  - Mounting cup gasket
  - Type of can
- Valve suppliers can give *starting point* dimensions

CRIMP CONSIDERATIONS

- *Gauges and setting block are a must!!!*

ACTUATORS

ACTUATORS

ACTUATORS

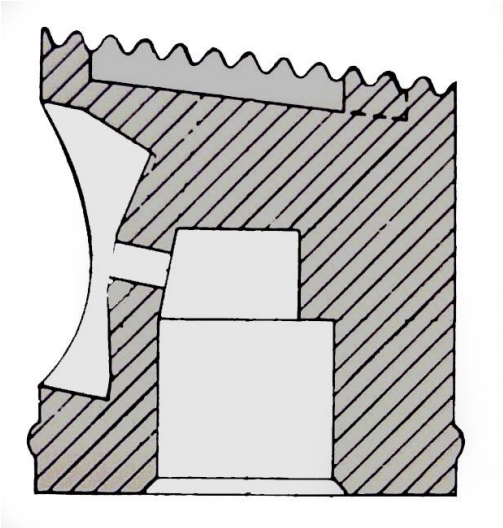






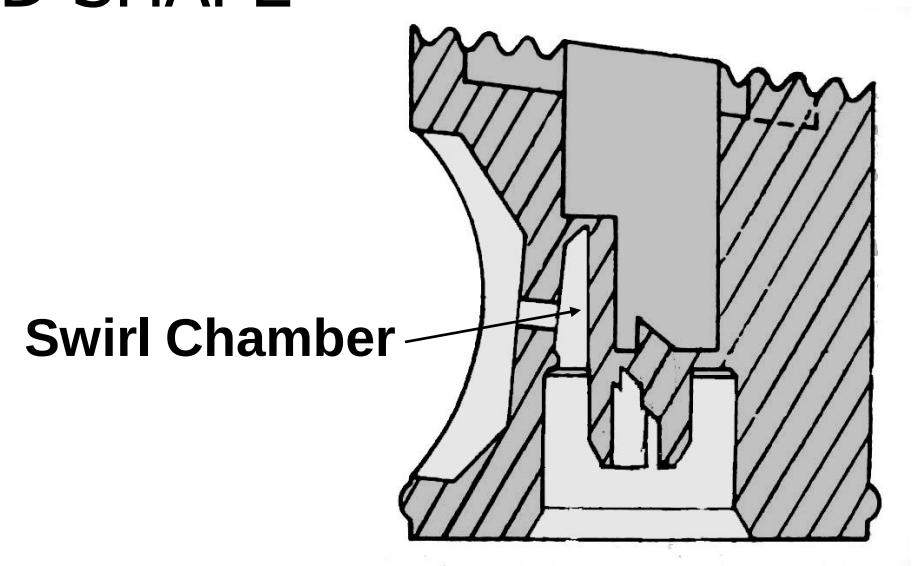
ACTUATORS “Non-MBU”

- NON-MECHANICAL BREAKUP
- A DIRECT FLOW THROUGH THE ACTUATOR
- USUALLY RESULTS IN A STREAM



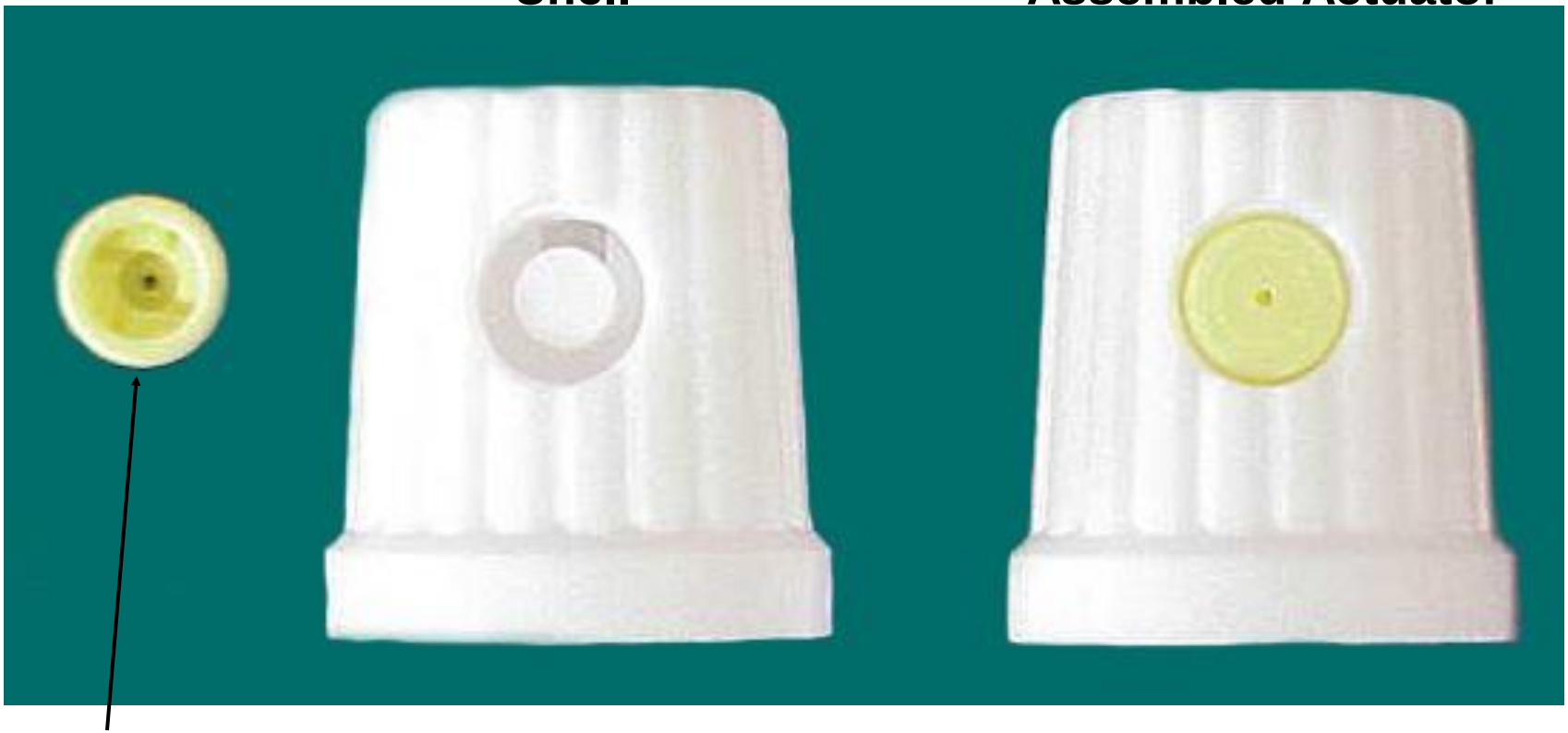
ACTUATORS “MBU”

- MECHANICAL BREAK UP
- INCORPORATES A SWIRL CHAMBER
- RESULTS IN A DISCERNABLE PATTERN SIZE AND SHAPE



ACTUATORS “MBU”

“Shell” Assembled Actuator



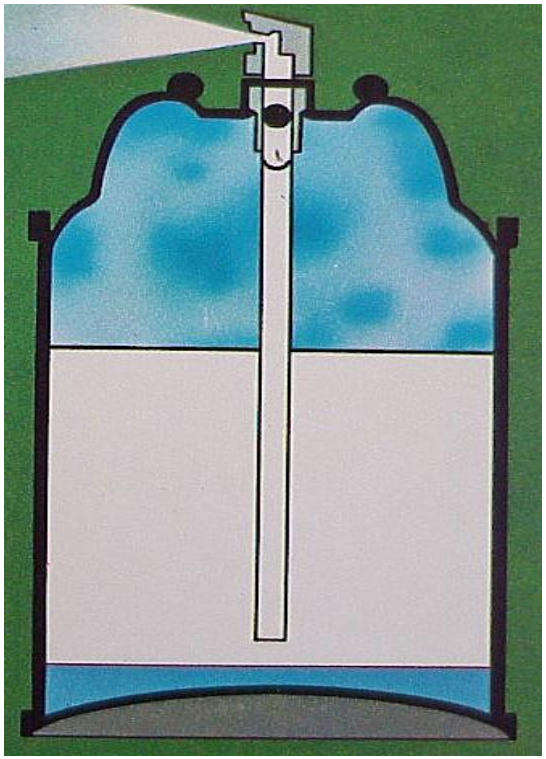
Insert with 4 tangential entry channels

ACTUATORS "MBU"

- Detail of a mechanical break up insert

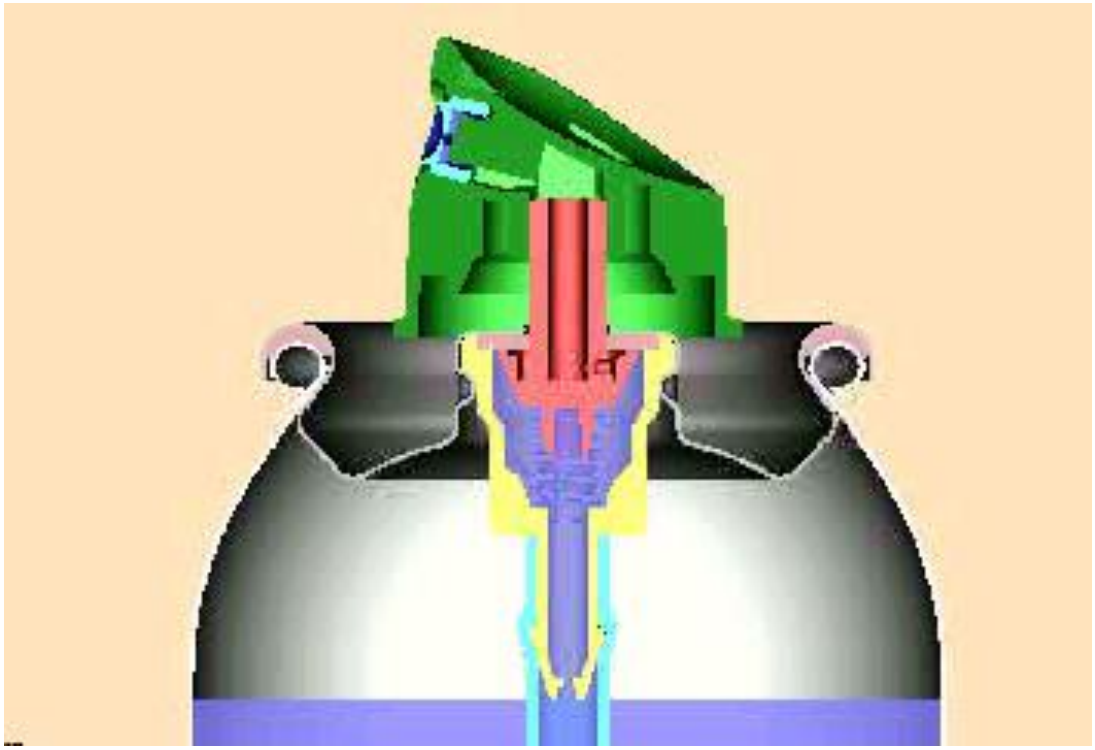
VALVE TYPES

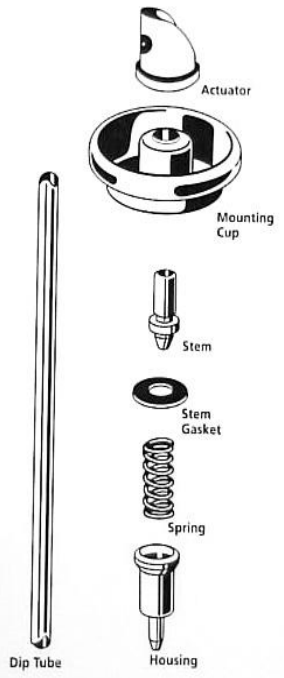
- *VERTICAL VALVE*--VERTICAL PRESSURE ON THE ACTUATOR OPENS THE VALVE.



VALVE TYPES

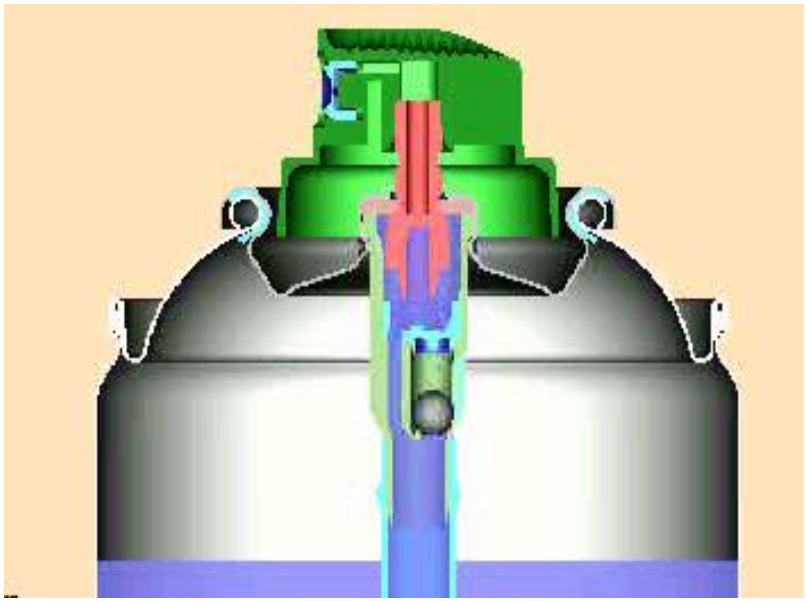
- *TILT VALVE*--FORWARD PRESSURE ON THE ACTUATOR OPENS THE VALVE.



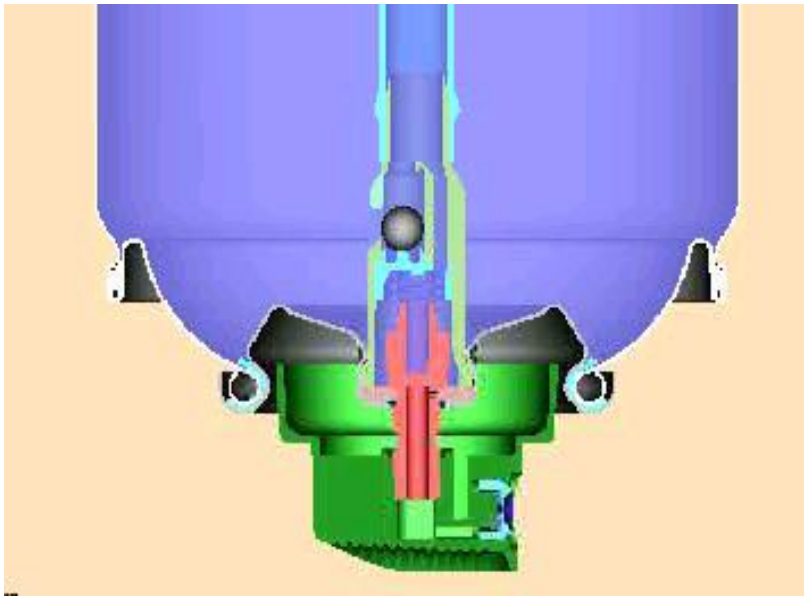


VALVE TYPES

- *UP/DOWN VALVE*--INCORPORATES A SPECIAL HOUSING FOR UPRIGHT OR INVERTED USE



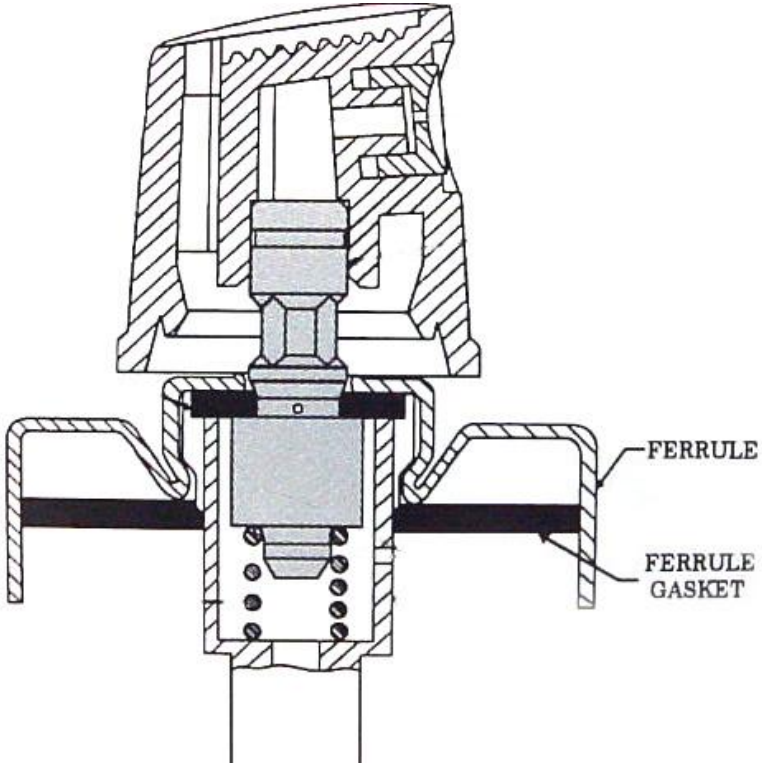
Upright



Inverted

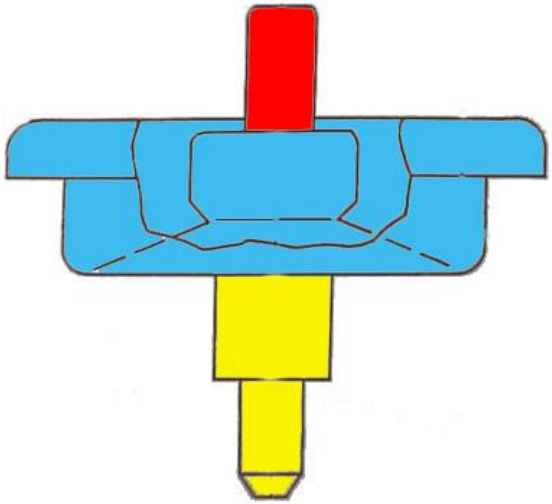
VALVE TYPES

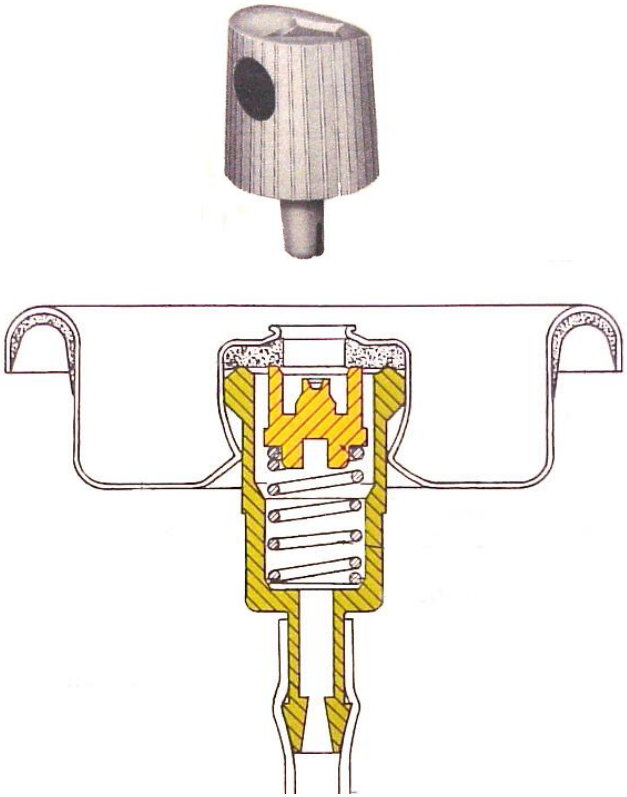
- 20mm VALVE



VALVE TYPES

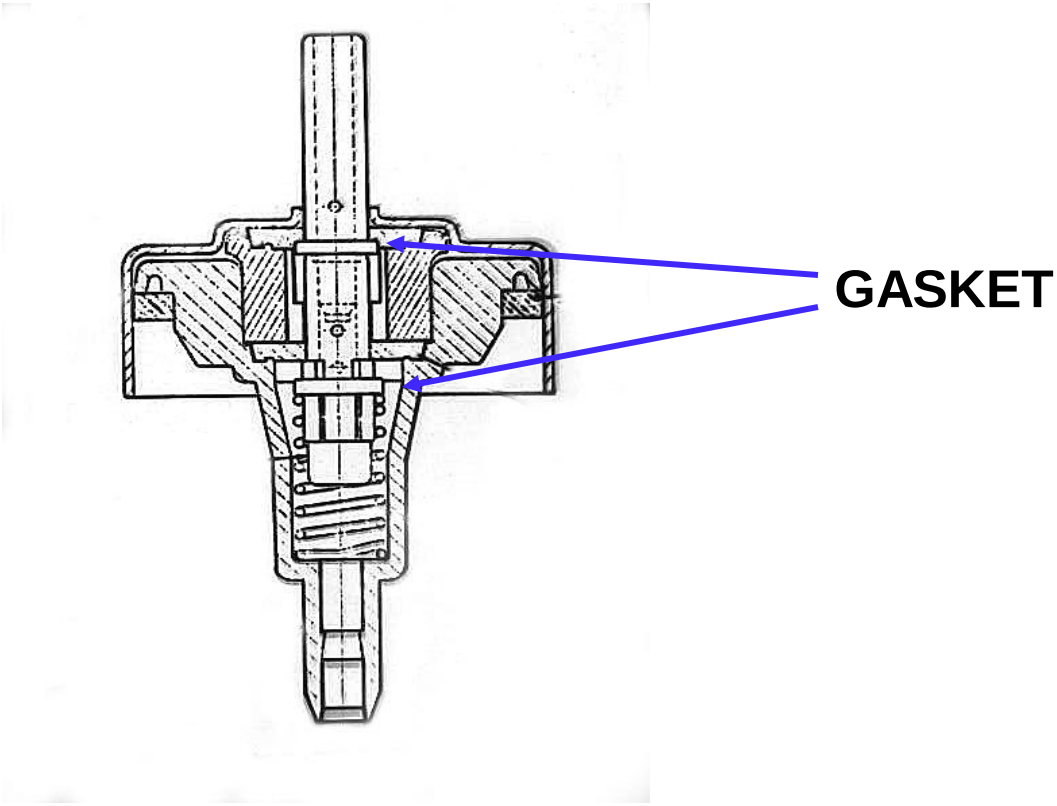
- MALE VALVE
- FEMALE VALVE





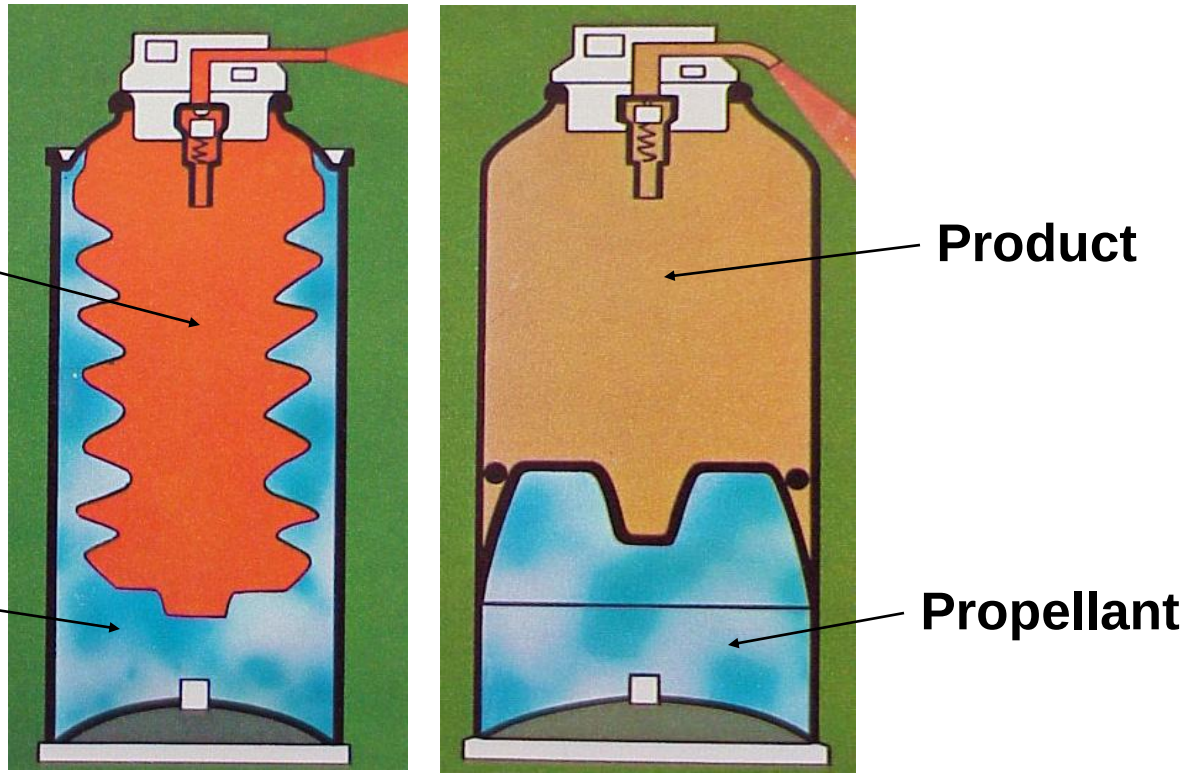
VALVE TYPES

- METERING VALVE



BARRIER/BAG-IN-CAN SYSTEMS

- BAG IN CAN/BAG On VALVE
- PISTON



FILLING METHODS

- How are aerosols filled in production?
  - Cans are "depalletized" and placed on line
  - Liquid is filled into the cans
  - Valves are inserted into cans
  - Propellant is added by
  - One of three methods:

FILLING METHODS

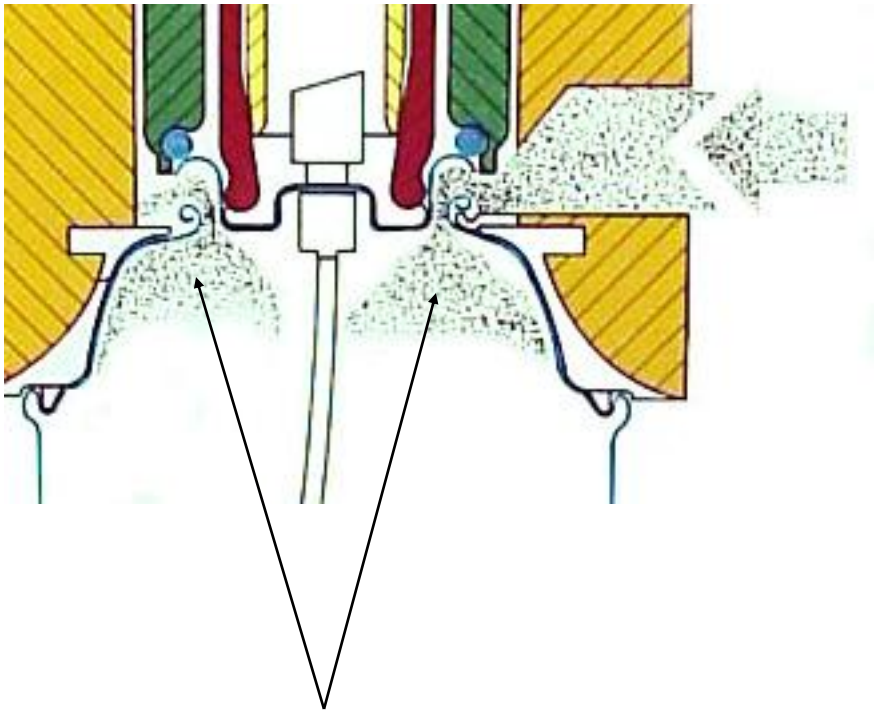
- UTC (UNDER-THE-CUP)
- PRESSURE FILLING
- GASSER SHAKER

FILLING METHODS

- UTC (Under the cap/cup) Operation
- Pulls a vacuum
- Injects propellant into the can
- Crimps valve to the can
- Used by over 50%

FILLING METHODS

- UTC (UNDER THE CUP)



Propellant

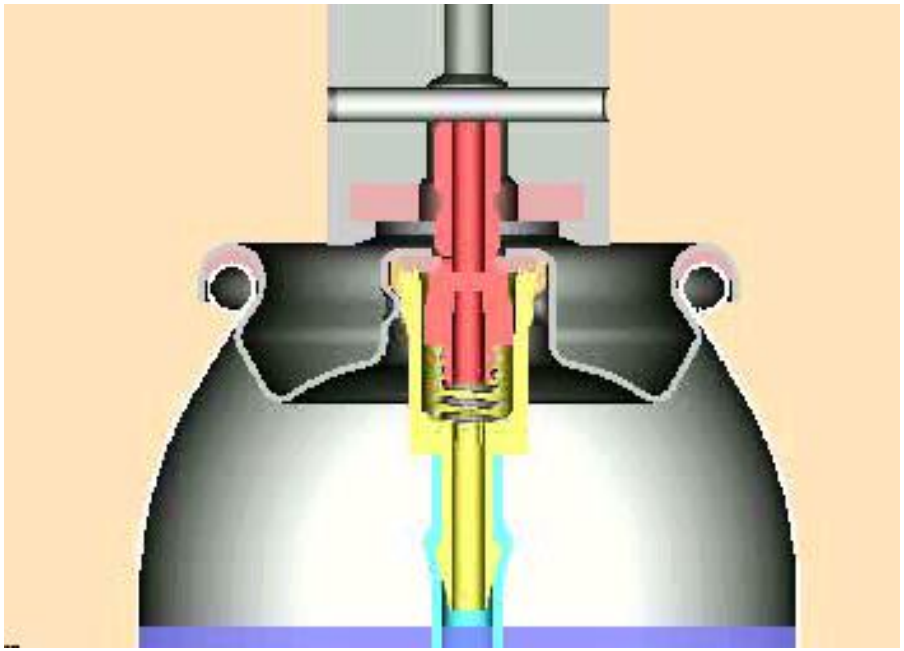
Single Head Under Capper

FILLING METHODS

- Pressure Filling
- Can is vacuumed and valve crimped to can
- Propellant fills through and around the valve
- Can be filled actuator on or off (Limited by actuator size)

FILLING METHODS

- PRESSURE FILL



Pressure Fill Button Off

Single Head Pressure Filler

FILLING METHODS

- Gasser Shaker
- Can is vacuumed and valve crimped to can
- Literally “shakes” the propellant into the can
- Not common
- Used mostly for compressed gas propellants (CO2)

FILLING METHODS

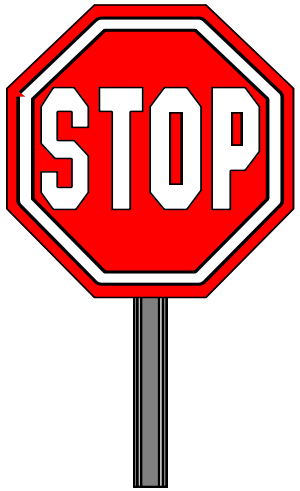
- GASSER SHAKER

FILLING METHODS

- After propellant is added cans are run through a hot water bath
- Internal can pressure must be equal to what the pressure would be at 130 degrees Fahrenheit
- May need to adjust water bath temp and dwell time to accomplish above

VALVE SELECTION

- CONSIDER EVERYTHING!!
- TEST PROGRAM



VALVE SELECTION

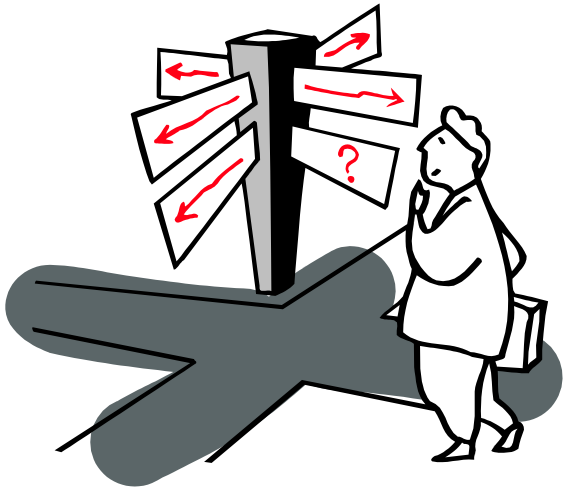
How Many Valve Combinations Are There?

Over 15,000 valve combinations (conservative estimate) not including gaskets and mounting cups

VALVE SELECTION

Where Do I Begin?

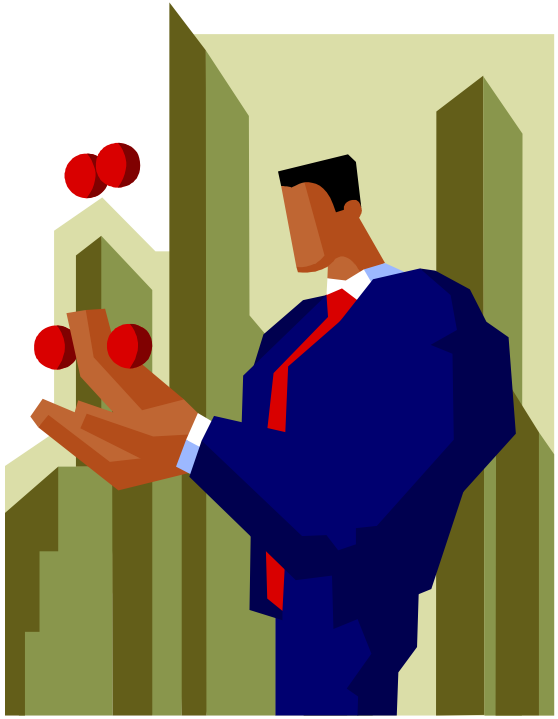
- Gather as much information as possible
  - Type of Propellant
  - Product/Propellant Ratio
  - Production Filling Method
  - Can Size/Material



VALVE SELECTION

Define The Parameters

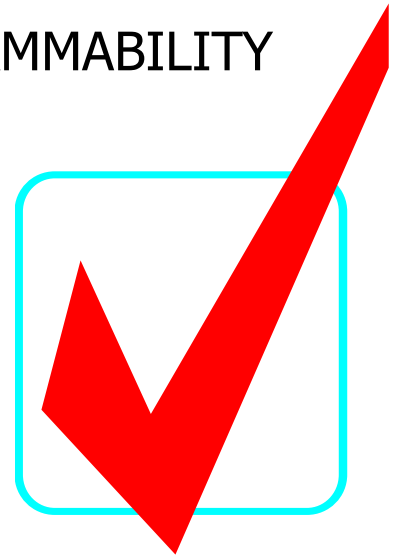
- DRT, Pattern, Particle Size, Flammability
- Which Are Important For Your Product?
- Prioritize



VALVE SELECTION

SOME CONSIDERATIONS

- DELIVERY CHARACTERISTICS
- DELIVERY RATE
- SPRAY PATTERN
- PARTICLE SIZE
- FLAMMABILITY



- WEIGHT LOSS
- CORROSION
- CLOGGING
- OFF ODOR
- APPEARANCE
- LEAKAGE
- LABEL WEIGHT DELIVERY (EVACUATION)

VALVE SELECTION

- Get Valve Samples (free)
  - Valve suppliers can offer starting points for various products
- Determine correct stem gasket

STEM GASKETS

- Importance
  - By choosing the appropriate stem gasket you will avoid:
    - ***High weight loss*** (loss of propellant and/or product) which can result in:
      - Wet cartons in the warehouse
      - Consumer Returns (will consumer buy this again?)
      - Litigation?

STEM GASKETS

How do I select the correct gasket for my product?

- Immersion Test
  - OK for initial screening
- Test in Packed Units
  - More realistic condition. It includes the propellant

STEM GASKETS

- Immersion Test
  - Gaskets in concentrate only, stored at room temperature.
- In Packed Units
  - Test at room temperature and elevated temperature (120 f)

STEM GASKETS

- For either test you want to:
  - Measure the ***Outer Diameter*** of the gasket
  - Measure the ***Thickness*** of the gasket
  - Measure the ***Durometer*** (Hardness) of the gasket if possible. Requires special equipment

STEM GASKETS

- Record measurements at:
  - 2 weeks
  - 1 month
  - 2 months
- Calculate % swell or shrinkage

STEM GASKETS

Interpretation of Results

- Valve gaskets can tolerate up to ~10% swell (check with the individual valve suppliers)
- AVOID SHRINKAGE AT ALL COSTS!!
  - Shrinkage compromises the seal
- Red Flag if there is a big change in durometer

VALVE SELECTION

- Initiate Stability (weight loss) testing
  - Spray Weigh or Dead Storage
  - Test for 30 days to 6 months at Room Temp and Oven (120 F)
  - At end of test check valve parts
  - Check for valve, container corrosion

VALVE SELECTION

- Speak with your filler (What are their requirements/limitations?)
  - How Filled? (Pressure Fill? UTC?)
  - Button-on (Special Adapters Needed?)
  - Button-off (Special Tippers Required?)
    - Hand Tipped (Are Actuators hard to tip?)
  - Covercaps/Shrink wrap (Any Problems?)

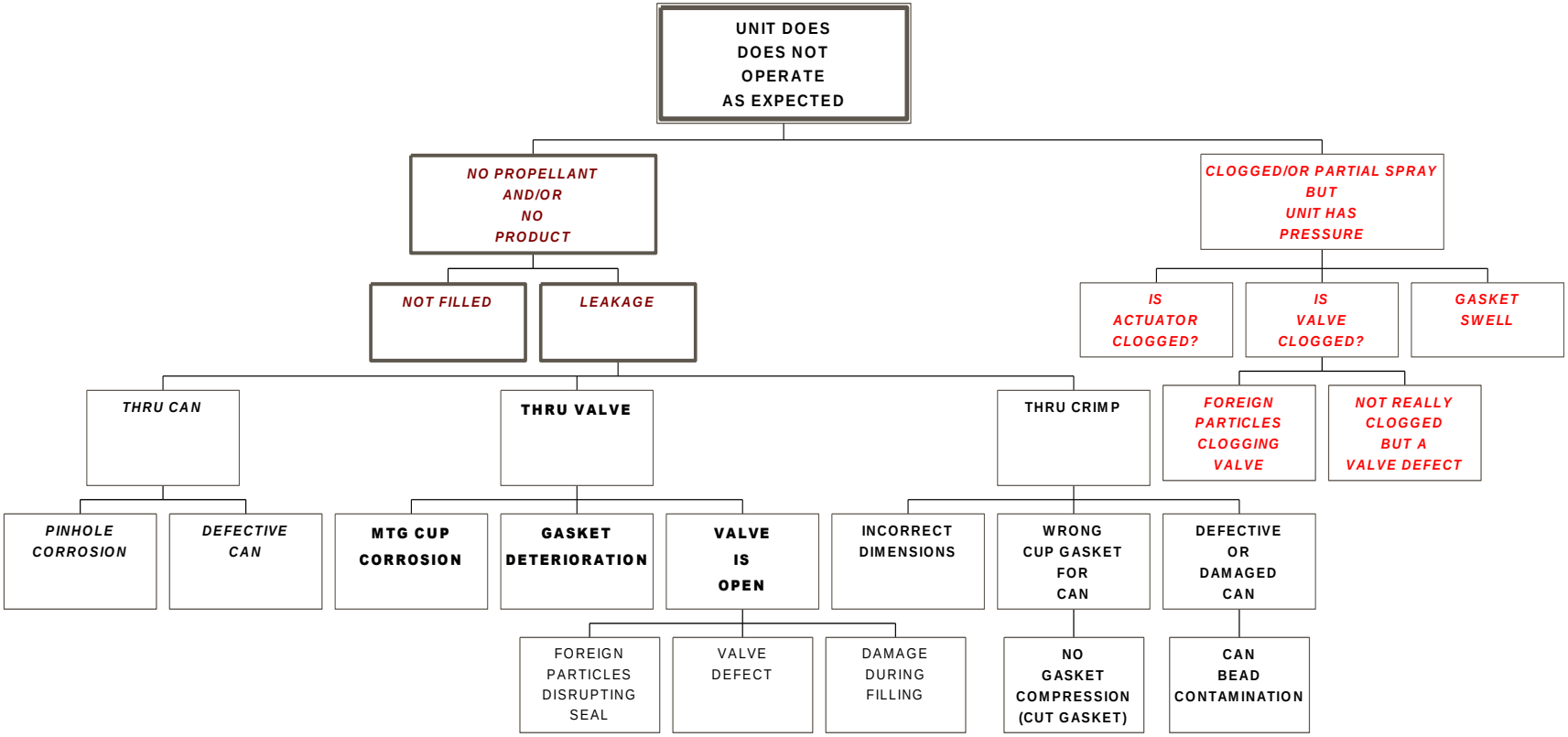
VALVE SELECTION

- Keep an eye out for:
  - Swelling, cracking of the plastic parts (actuators, stem, housing, dip tubing)
  - Coating integrity, pin holing, oxidation, corrosion of metal parts (mounting cups, springs)
  - Impingement using spray thru caps and accessories
  - Clogging with high solid products

VALVE SELECTION

- Don’t assume lab samples will equal production units
- Perform a test run on the production line
  - Reveal equipment issues
  - Reveals bulk handling issues
  - Will show line speed
  - Includes process variations
- Evaluate production filled units

TROUBLESHOOT



CALL US

- For Samples:
  - Clayton Boddie 914-966-4466
- For Technical Assistance:
  - Gioconda LLopis 914-966-4462
  - Serena Zondorak 914-966-4473
  - Mike Zerbe 914-966-4457

THANK YOU

ANY QUESTIONS?