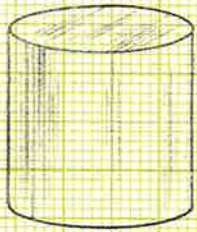


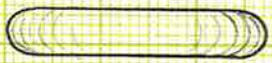
RING FORGINGS

FORGING MANUFACTURERS
GAIN FOUR IMPORTANT
BENEFITS WHEN THEY
USE GROTNES EXPANDING
MANDREL MACHINE TOOLS:

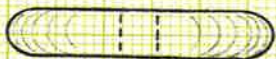
RECOMMENDED
PROCESS



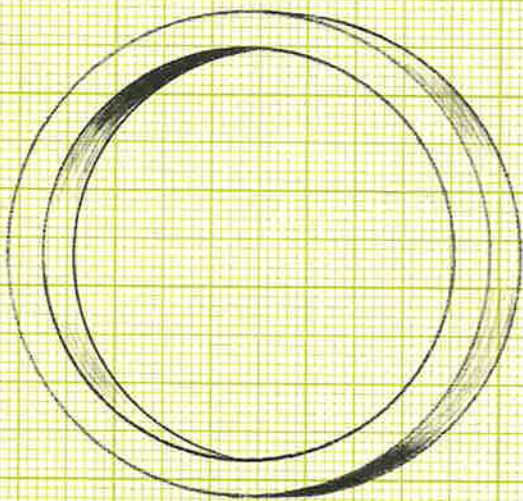
1. BILLET



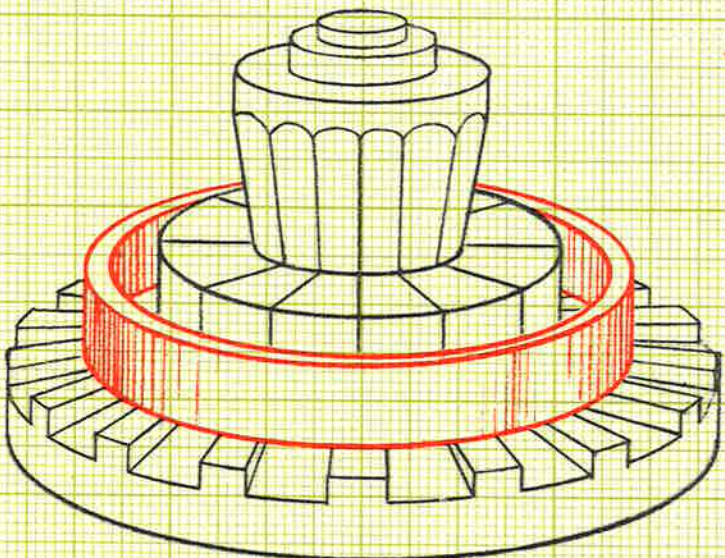
2. FLATTENED



3. PIERCED

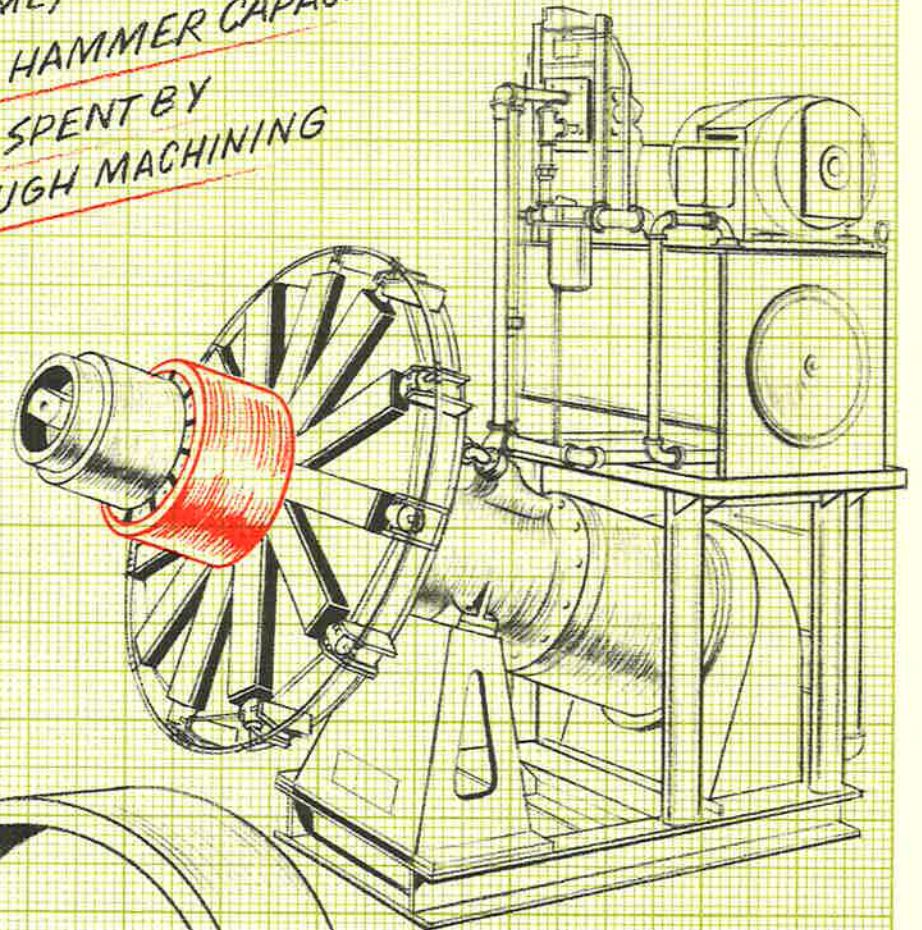


4. HEATED AND HAMMERED
TO 80% OF FINAL SHAPE



5. HEAT AND EXPAND
LAST 20% ON A GROTNES
EXPANDER IN A 15 SECOND
MACHINE CYCLE

- 1. BETTER PARTS (QUALITY)
- 2. LOWER MANUFACTURING COSTS
(MATERIAL and TIME)
- 3. DOUBLED FORGING HAMMER CAPACITY
- 4. ELIMINATE TIME SPENT BY
CUSTOMER IN ROUGH MACHINING



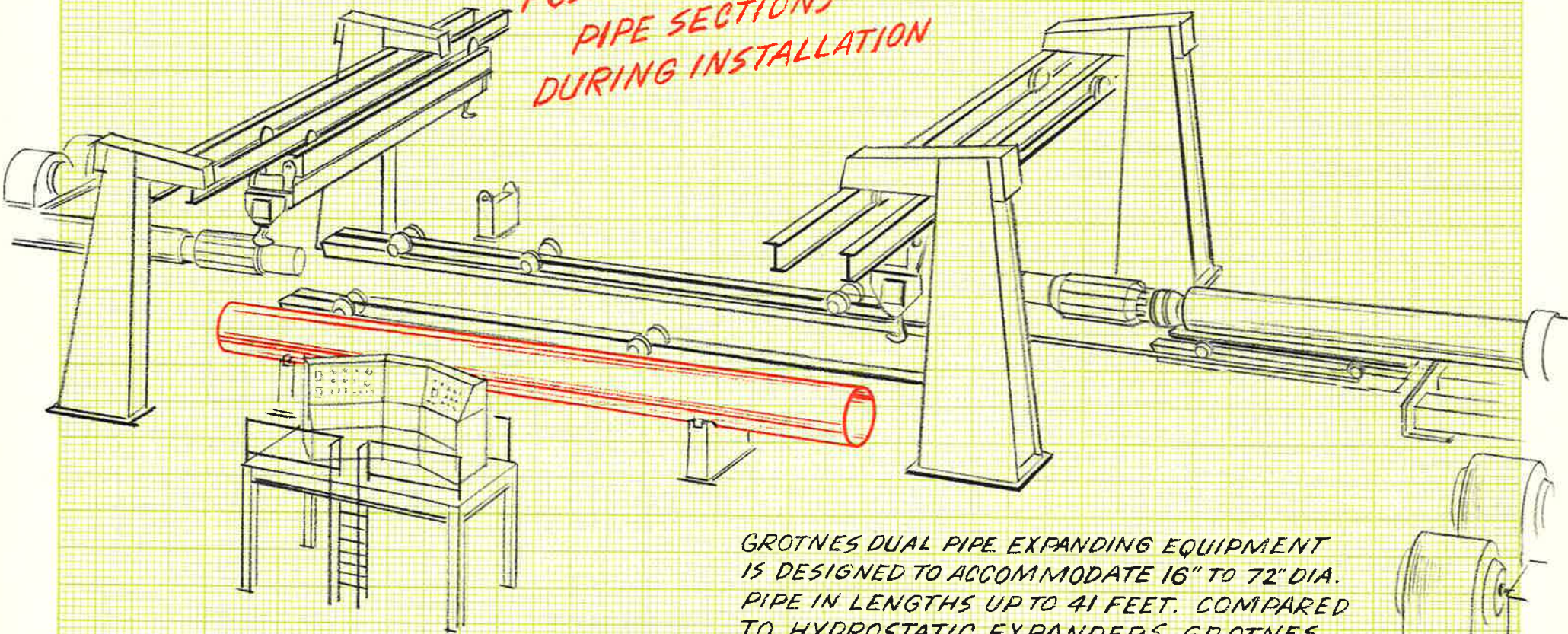
GROTNES HYDRAULIC
EXPANDER FOR
HOT RING FORGINGS

RESULTS! A BETTER PRODUCT!

A FINISHED PART TO A TOLERANCE
OF $\pm .005$ ", ELIMINATING EXCESS
MATERIAL FORMERLY REQUIRED FOR
MACHINING TO CONCENTRIC SHAPE.
AN EXPANDED FORGING ALSO HAS
CONSISTENT HOOP STRESS RATHER
THAN UNDESIRABLE RANDOM STRESSES
INDUCED BY THE FORGE. HAMMER
MARKS ARE GREATLY REDUCED.

Subject:
**CONCRETE
and METAL
PIPE**

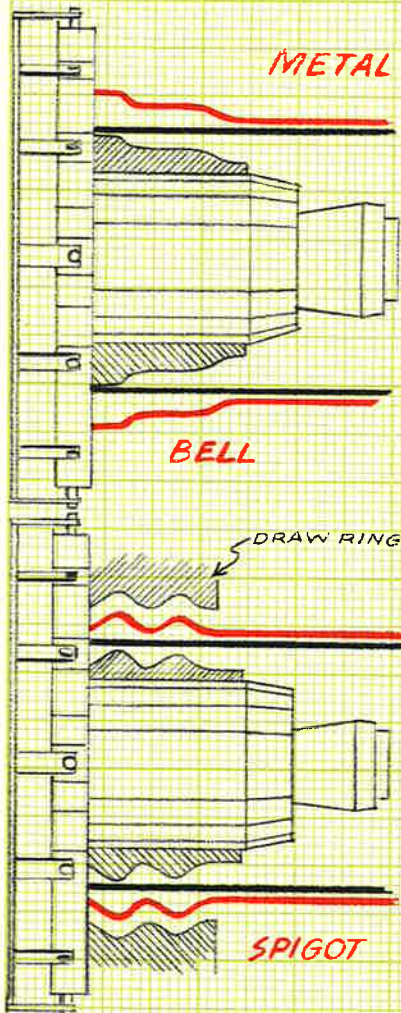
**RADIAL STRETCH FORMING
OF PIPE AND PIPE JOINTS
IMPROVES PRODUCT
QUALITY AND INSURES
POSITIVE MATING OF
PIPE SECTIONS
DURING INSTALLATION**



GROTNES DUAL PIPE EXPANDING EQUIPMENT IS DESIGNED TO ACCOMMODATE 16" TO 72" DIA. PIPE IN LENGTHS UP TO 41 FEET. COMPARED TO HYDROSTATIC EXPANDERS GROTNES DELIVERS THE FOLLOWING DISTINCT ADVANTAGES:

1. EXTREME ACCURACY OF I.D.
2. TENSILE STRENGTH AND MECHANICAL PROPERTIES IMPROVED BY COLD WORKING
3. CHANGE OVER TIME FROM SIZE TO SIZE REDUCED BY APPROX. 10 TO 1
4. MINIMUM DIE COSTS
5. COMPARATIVELY LITTLE MAINTENANCE
6. PIPE USERS BENEFIT FROM LOWER COST OF INSTALLATION

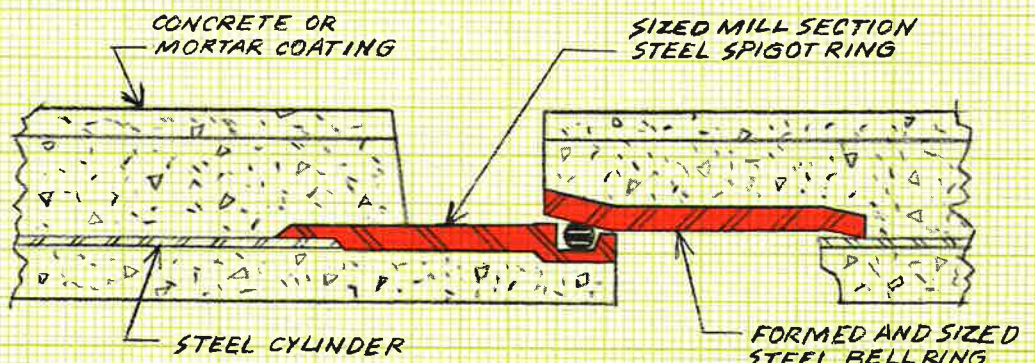
METAL PIPE JOINTS



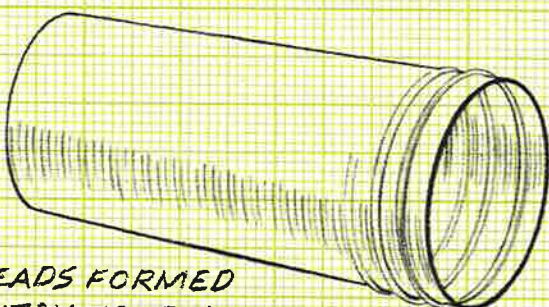
BELL AND SPIGOT JOINTS ARE FORMED DIRECTLY FROM THE STRAIGHT WALL CYLINDER OF THE PIPE. TOLERANCE IS CONTROLLED FOR PERFECT FIT AND SEAL OF JOINT.

RED LINE INDICATES FINAL EXPANDED SHAPE OF PIPE JOINT. ORIGINAL SHAPE SHOWN IN HEAVY BLACK

STEEL JOINT RINGS FOR USE IN CONCRETE PRESSURE PIPE



IRRIGATION PIPE

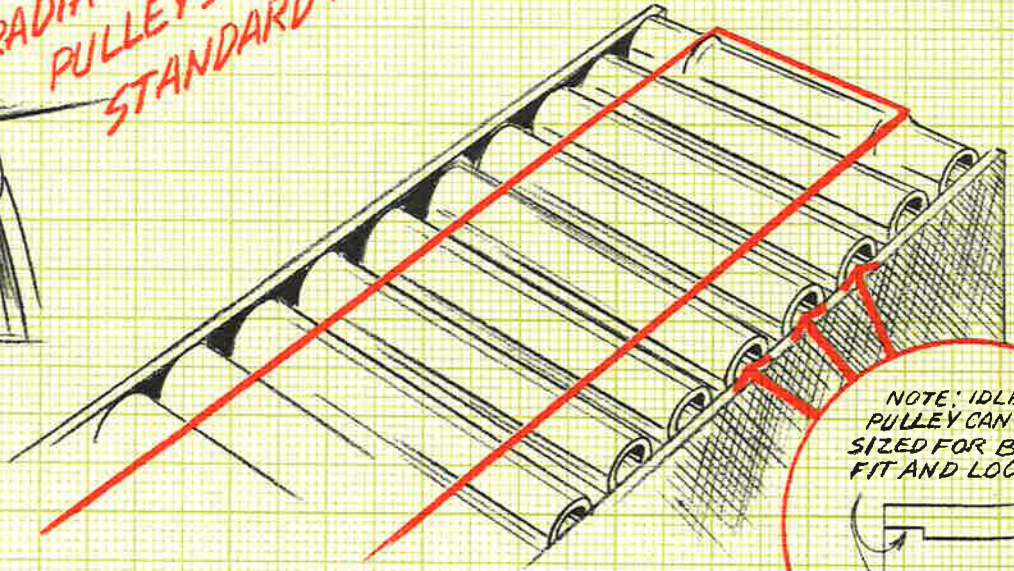
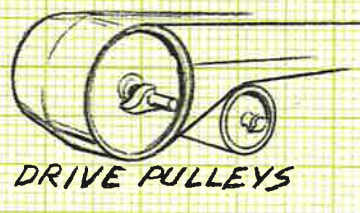
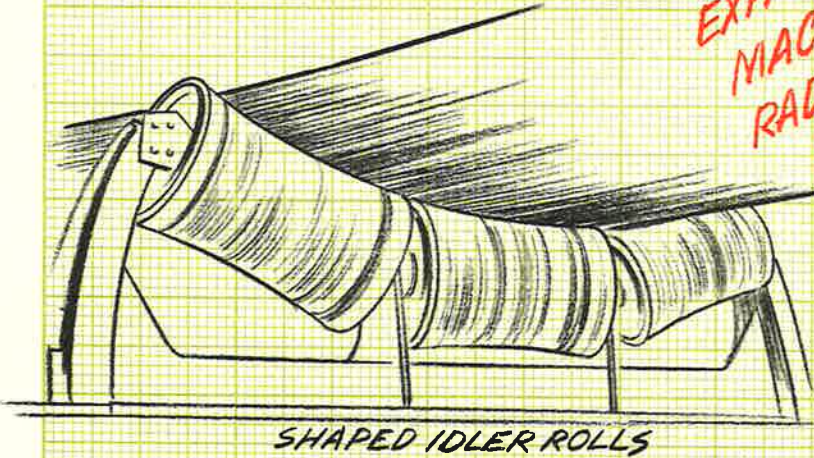


THREADS FORMED
- 1" PITCH - 10" DIA.

RADIAL STRETCH FORMING HAS GREATLY SIMPLIFIED THE MANUFACTURING PROCESS. PARTS ARE PRODUCED TO EXTREMELY CLOSE TOLERANCE AND ENHANCE THE QUALITY WITHOUT MACHINING

Subject:
**CONVEYOR
PULLEY
FABRICATION**

**LABOR COSTS CAN
BE CUT AS MUCH AS
90% USING GROTNES
EXPANDING MANDREL
MACHINE TOOLS TO
RADIAL STRETCH FORM
PULLEY'S FROM
STANDARD TUBING**

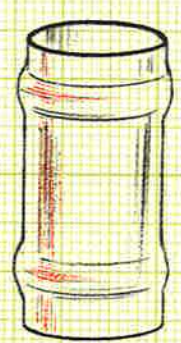
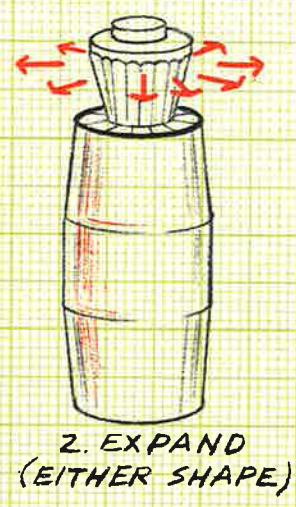
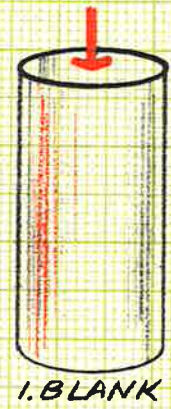


NOTE: IDLER PULLEY CAN BE SIZED FOR BEARING FIT AND LOCATION

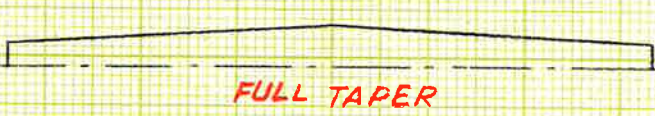
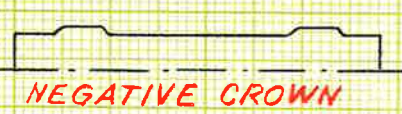
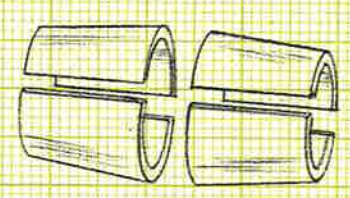
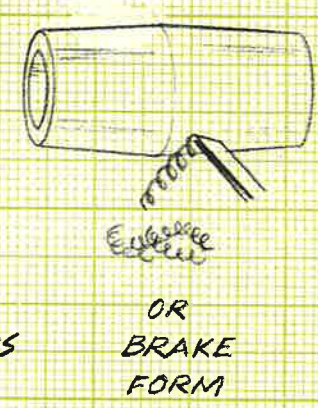
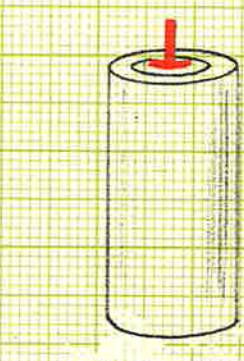
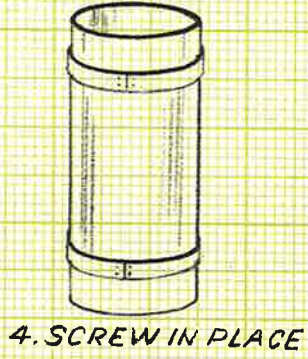
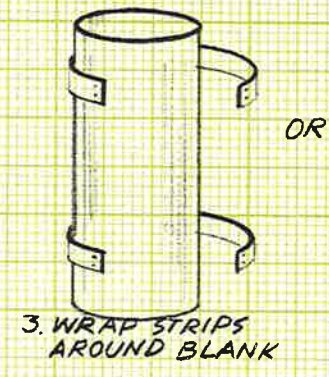
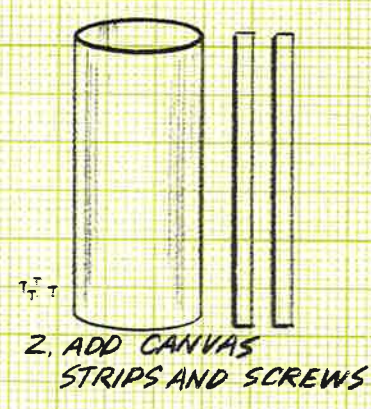
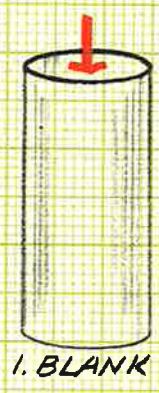
WHEN FORMED BY RADIAL STRETCH FORMING:

1. MACHINING TO CONTOUR OR BRAKE FORMING AND WELDING IN FIXTURE IS ELIMINATED
2. SIGNIFICANT REDUCTION OF MATERIAL IS ACHIEVED
3. A PULLEY IS FORMED IN LESS THAN A MINUTE
4. CONCENTRICITY & SIZE ARE WITH .005 OR BETTER
5. THE PULLEY ENDS MAY BE SIZED AND A LOCATION RIDGE FORMED FOR SIMPLIFIED AND CORRECT BEARING ASSEMBLY
6. VERSATILITY TO FORM WIDE RANGE OF SIZES AND SHAPES INHERENT IN SINGLE MACHINE WITH SIMPLE SETUP

SIMPLIFIED PRODUCTION GROTNES RADIAL STRETCH FORMING



OLD PRODUCTION METHODS OLD FABRICATION METHODS MACHINE TO FORM

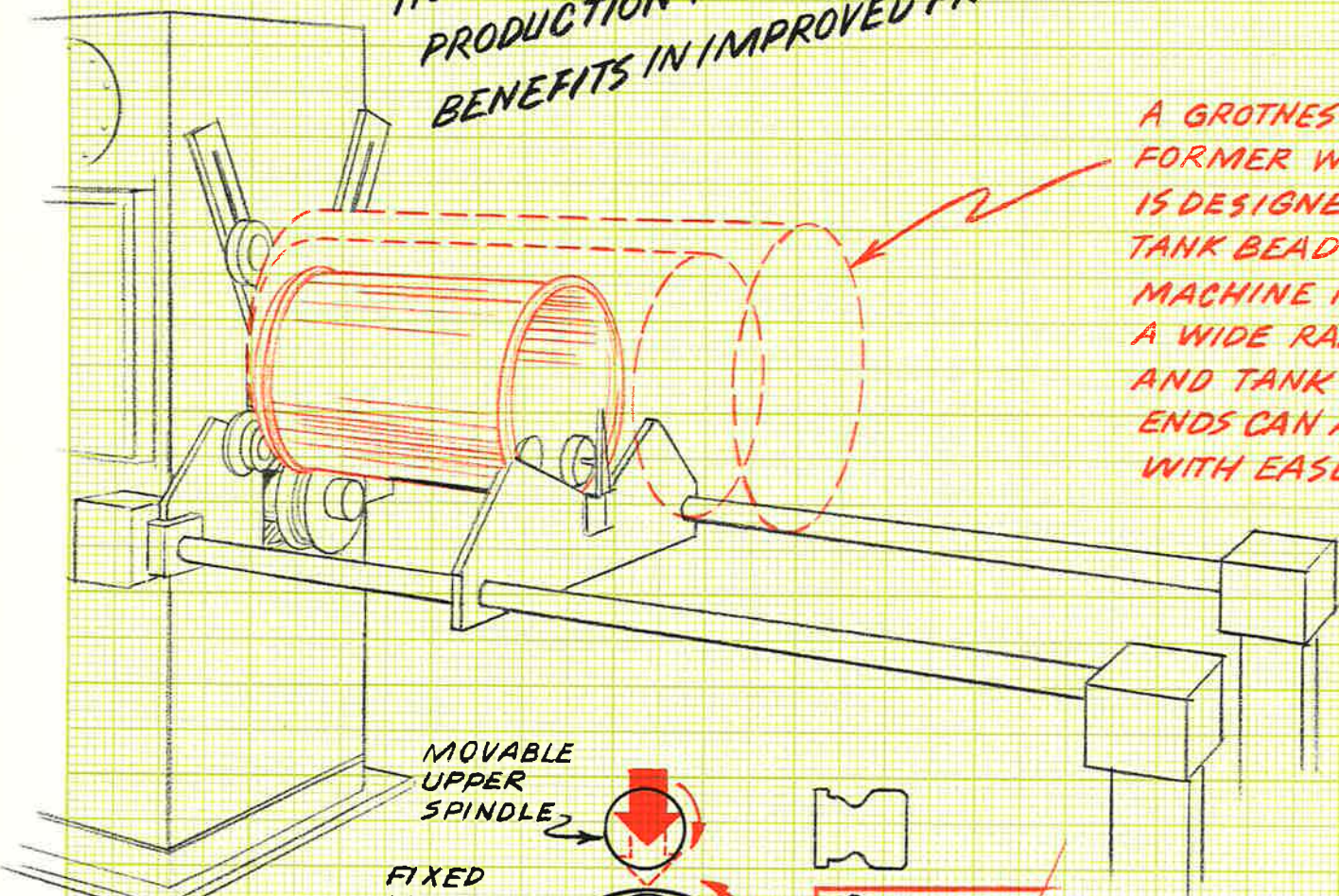


(SIMPLE DIE CHANGE PERMITS WIDE VARIATION OF PULLEY CONTOUR)

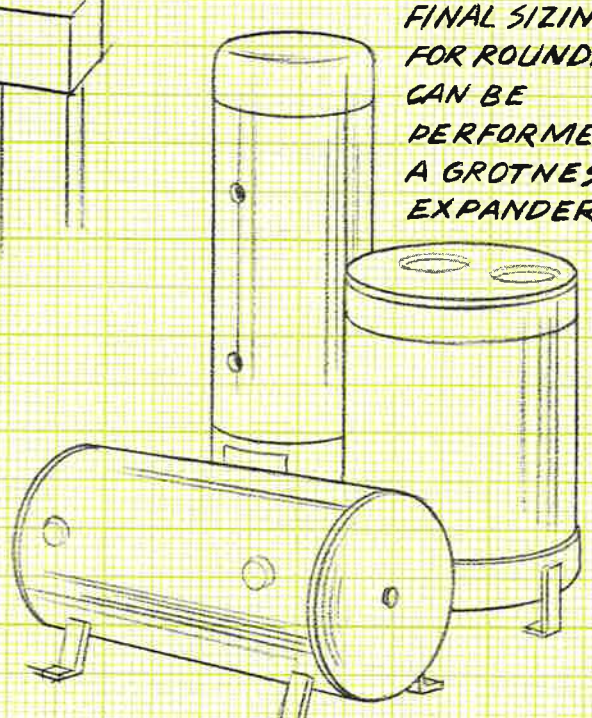
Subject:
**TRANSFORMER
TANKS
AND METAL
HOUSINGS**

**GROTNES ROTARY ROLL FORMING
AND EXPANDING MANDREL MACHINE
TOOLS PROVIDE AN IMPROVED
METHOD OF MANUFACTURING
TRANSFORMER TANKS AND OTHER METAL
HOUSINGS AT EXTREMELY EFFICIENT
PRODUCTION RATES WITH ADDITIONAL
BENEFITS IN IMPROVED PRODUCT QUALITY**

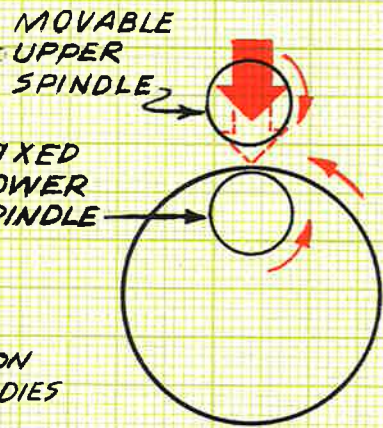
**A GROTNES MODEL 400 ROLL
FORMER WITH CRADLE SUPPORT
IS DESIGNED FOR ROLLING
TANK BEAD IN 15 SECONDS.
MACHINE IS ADJUSTABLE FOR
A WIDE RANGE OF DIAMETERS
AND TANK LENGTHS. FLANGED
ENDS CAN ALSO BE ROLL FORMED
WITH EASE**



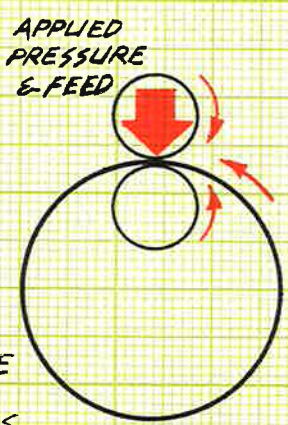
**FINAL SIZING
FOR ROUNDNESS
CAN BE
PERFORMED ON
A GROTNES
EXPANDER**



**BEADS ARE EASILY ROLL FORMED IN
TANKS FOR AIR COMPRESSORS, BRINE
STORAGE, HOT WATER, ETC. BOSSES
RIBS AND FINAL SIZING FOR PERFECT
FIT OF DOME ARE PERFORMED ON A
GROTNES EXPANDER OR SHRINKER
(SEE DESIGN SHEET G14 AND G21)**



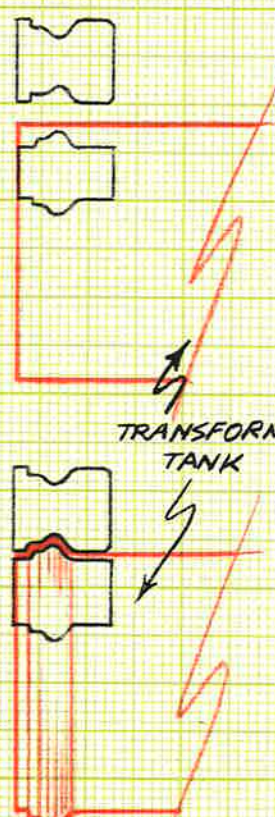
**1. THE COILED AND
WELDED TANK IS
CRADLED IN POSITION
BETWEEN ROLLING DIES**



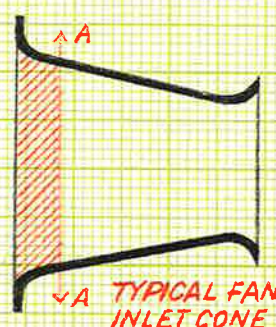
**2. AS TANK ROTATES
BETWEEN THE ROLLS
(DIES) AND FORMING
PRESSURE IS APPLIED,
BEAD IS FORMED**



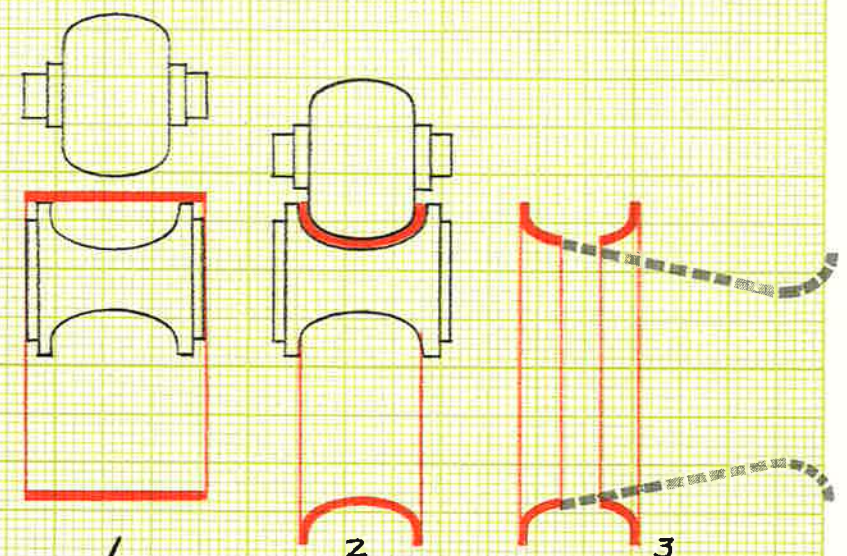
**3. ROLL FORMING TO
CLOSE TOLERANCES IS
POSSIBLE BECAUSE THE
MOVABLE SPINDLE INFEED
IS INFINITELY VARIABLE
AND PROGRAMMABLE
AND IN OPERATION, ROLLS
RUN AT CONTINUALLY
EQUALIZING PERIPHERAL
SPEEDS**



**PROFILED SEGMENTS FOR FAN CONES,
HUMIDIFIERS, ROOF EXHAUSTERS
AND SIMILAR PRODUCTS CAN BE
ROLL FORMED TWO AT A TIME
GREATLY SIMPLIFYING
MANUFACTURING AND REDUCING
UNIT COSTS. FINAL SIZING TO
INSURE EXTREME ACCURACY IN
DIMENSION AND ROUNDNESS IS
PERFORMED ON A GROTNES
EXPANDER**



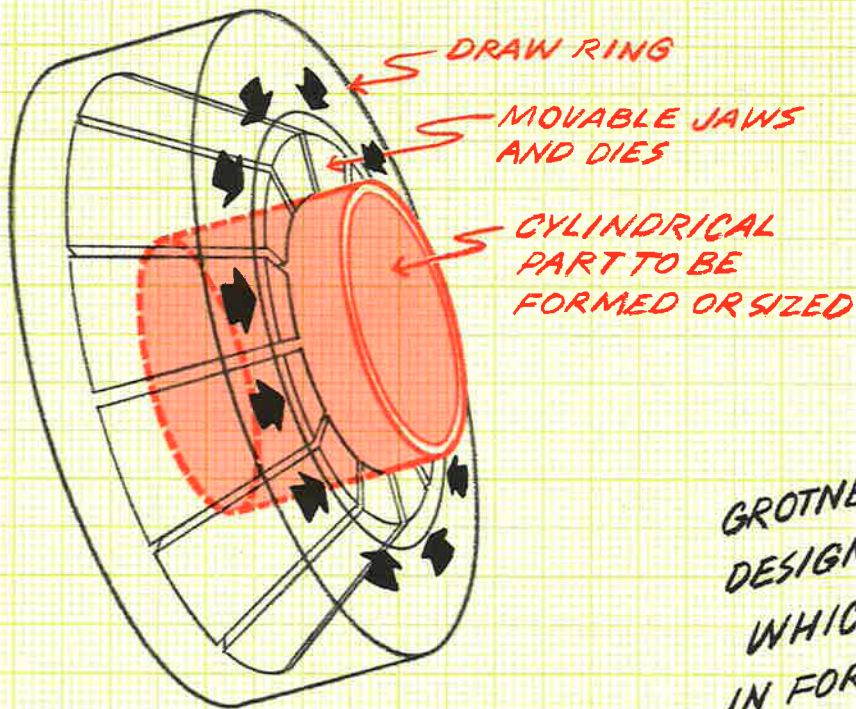
**SECTION AA OF
INLET (SHOWN
SHADED IN RED)
IS ROLL FORMED
IN PAIRS AND SLIT
AS ILLUSTRATED
SCHEMATICALLY
AT RIGHT**



**1 DUAL SEGMENTS ROTARY ROLL FORMED PART
ARE ROLLED FROM COILED DIES IMPART IS SLIT TO
CYLINDER DESIRED SHAPE PRODUCE TWO
FINISHED PARTS**

Subject:

SHRINKING METAL PARTS TO SIZE AND/OR SHAPE



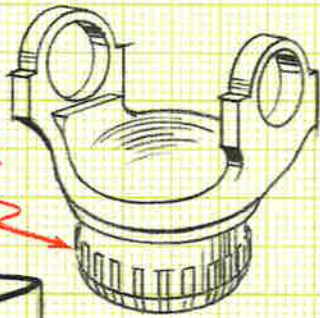
BASIC COMPONENTS OF A GROTNES SHRINKER
ARROWS INDICATE RADIAL LATERAL MOVEMENT OF JAWS AND DIES TO EXERT COMPRESSION ON PIECE TO BE SIZED AND FORMED

GROTNES SHRINKERS ARE DESIGNED TO FORM AND SIZE PARTS WHICH ARE BASICALLY CONTINUOUS IN FORM. IT IS ACCOMPLISHED BY MECHANICAL COMPRESSION APPLIED THRU OVERALL CIRCUMFERENTIAL MOVEMENT OF A SET OF RADIALY DISPOSED DIES MOUNTED ON MOVABLE JAWS. JAW MOVEMENT IS PRECISELY CONTROLLED AND IS OBTAINED THROUGH THE RELATIVE MOTION OF SLIDING INCLINED PLANES. CYLINDRICAL PARTS MAY BE SHAPED OR FORMED TO SQUARE, OBLONG OR OTHER SHAPES.

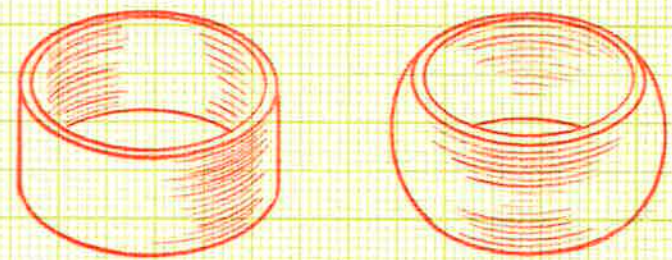
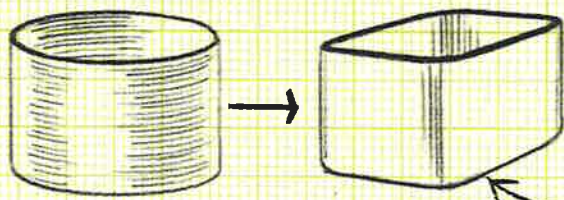
APPLICATIONS FOR FORMING BY SHRINKING ON SMALL AS WELL AS LARGE PARTS ARE UNLIMITED



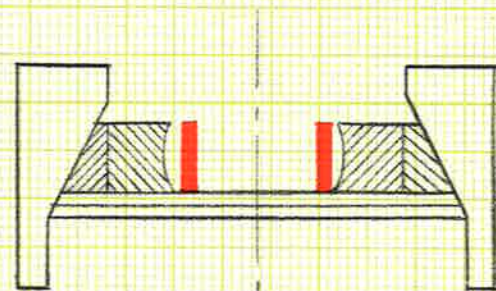
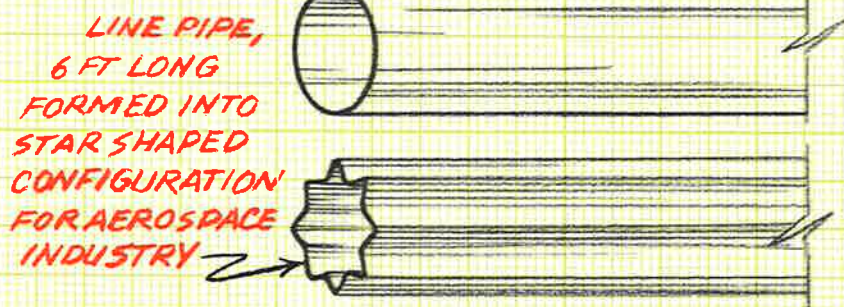
SPLINES ARE RADIALY FORGED ON CYLINDRICAL END OF FORGED PART



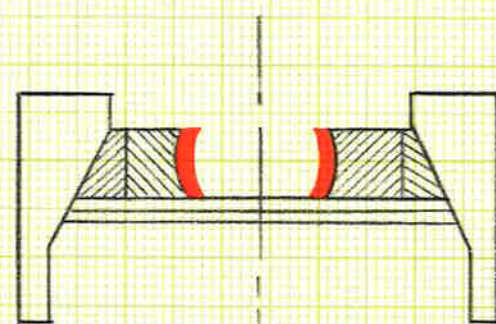
ROUND TO SQUARE PARTS SAVE FABRICATION TIME



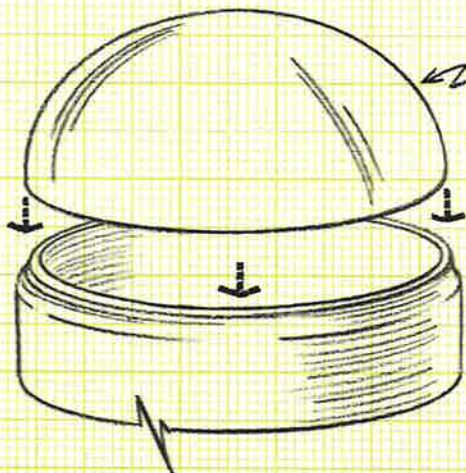
BEARING CAGES AND CONSTANT VELOCITY JOINTS REQUIRING A HIGH TOLERANCE AND SUPERIOR INNER FINISH ARE SHRUNK TO SIZE FROM MILL FORMED STOCK. MATERIAL AND MACHINING TIME SAVED.



1. PART IS POSITIONED IN SHRINKER



2. AS DRAW RING IS HYDRAULICALLY MOVED DOWNWARD DIES AND JAWS EXERT CIRCUMFERENTIAL PRESSURE TO FORM BEARING GAGES



HEAVY DOMED HEADS FOR HIGH PRESSURE COMPRESSED AIR TANKS ARE REDUCED IN DIAMETER IN A GROTNES SHRINKER AND SIZED TO FOR PERFECT FIT OF I.D. OF MAIN CYLINDRICAL SHELL



GROTNES

ENGINEERING DESIGN

Subject:

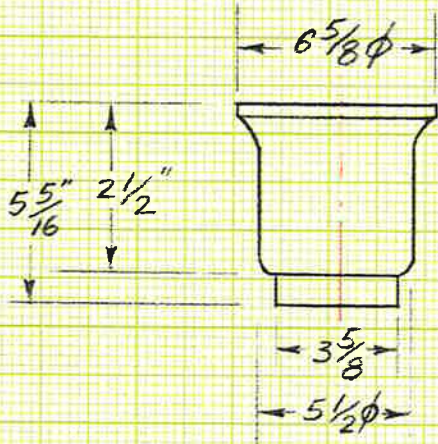
PROCESS COMPARISON

HERE'S AN EXAMPLE OF CHANGING TO RADIAL STRETCH FORMING THAT RESULTED IN A \$24,500 SAVINGS IN MATERIAL ALONE NOT TO MENTION TOOLING AND LABOR!

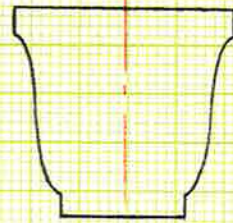
DRAW FORMING (OLD METHOD)

VS

RADIAL STRETCH FORMING (NEW MONEY SAVING PROCESS)



METAL 302 S.S. .040 THICKNESS



REDESIGNED SHAPE

BETTER FUNCTION AND GREATER STRENGTH



BLANK



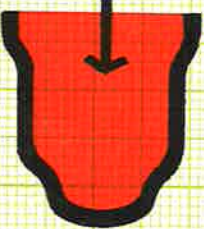
DRAW 1



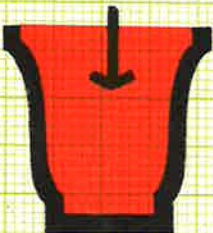
DRAW 2



DRAW 3



DRAW 4



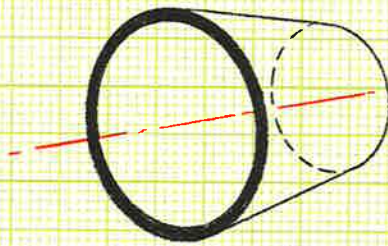
STRIKE



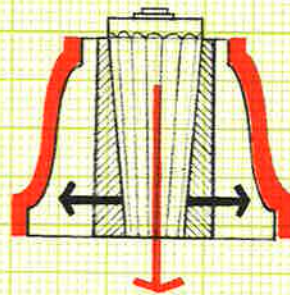
PIERCE



BLANK



COIL AND WELD INTO CONE SHAPE



SET ON GROTNES EXPANDER AND RADIAL STRETCH FORM IN A SINGLE OPERATION ACHIEVING SHAPE AND TOLERANCE WITHOUT WASTED MATERIAL

THE ORIGINAL PROCESS REQUIRED THE FOLLOWING MATERIAL

GROSS BLANK	142	□
NET (USABLE) BL.	110	□
SCRAP	32	□
BOTTOM	10	□
TOTAL SCRAP	42	□

.49 #/PC.

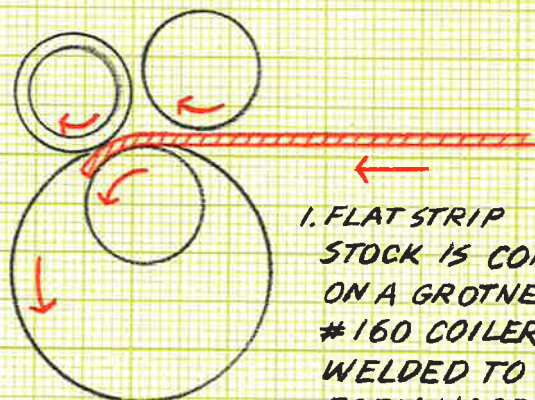
COST \$.245/PC. @ 100,000 Pcs. = \$24,500 ANNUAL SAVINGS

Subject:

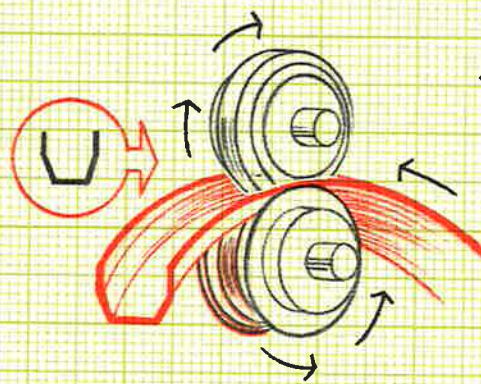
ROTARY ROLL FORMING

HIGHLY VERSATILE,
GROTNES ROTARY ROLL FORMING
AFFORDS SAVINGS IN TOOLING
AND PRODUCTION TIME FOR
UNLIMITED APPLICATIONS IN THE
MANUFACTURE OF CIRCULAR
AND CYLINDRICAL PROFILED PARTS.
SHAPES OF THE NATURE SHOWN
HERE CAN BE FORMED TO CLOSE
TOLERANCES DUE TO A PERFECT
TORQUE DIFFERENTIAL
BETWEEN SPINDLES,
INFINITE VARIABLE INFEEED
OF THE LOWER SPINDLE
AND PRECISE CONTROL OVER
APPLIED FORCES

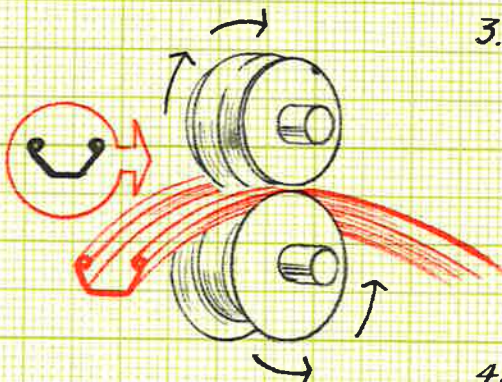
TYPICAL PRODUCTION SET-UP
FOR MANUFACTURING
BICYCLE RIMS



1. FLAT STRIP STOCK IS COILED ON A GROTNES #160 COILER AND WELDED TO FORM HOOP. WELD IS EASILY REMOVED BEFORE FORMING

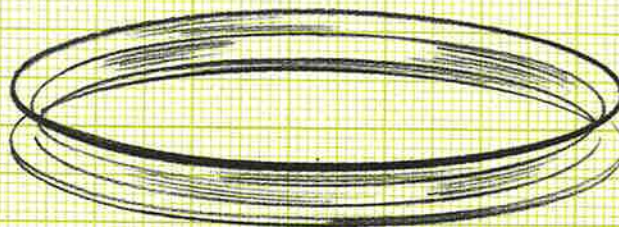
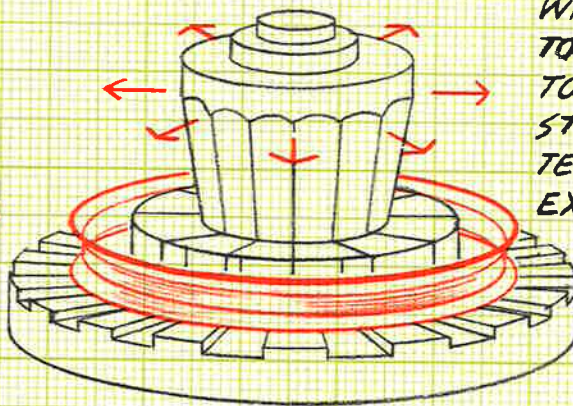


2. GROTNES #400 ROTARY ROLL FORMER IMPARTS PRELIMINARY PROFILE OF RIM IN FLAT COILED HOOP



3. A SECOND GROTNES MODEL #400 FORMS PROFILE

4. FINAL STEP IS SIZING ON GROTNES MODEL 130 EXPANDER CONCENTRICITY IS ASSURED AND WHEELS ARE FORMED TO CLOSE TOLERANCES. WELD STRENGTH IS ALSO TESTED DURING EXPANSION



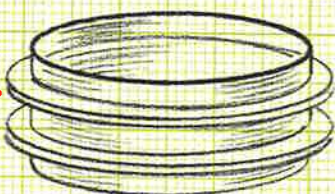
ADJUSTABLE GUARDS

GROTNES

ROLLING DIES MOUNT ON SPINDLES (NO DIES ARE SHOWN)

GROTNES MODEL 600 ROTARY ROLL FORMER IS USED TO FORM CAR WHEEL RIMS, TRACTOR RIMS AND SIMILAR HEAVY DUTY PARTS

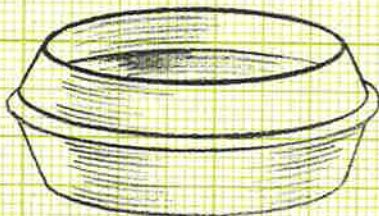
2 CONVOLUTION OR MULTI-CONVOLUTION BELLOWS ARE ROLL FORMED FOR USE AS EXPANSION JOINTS



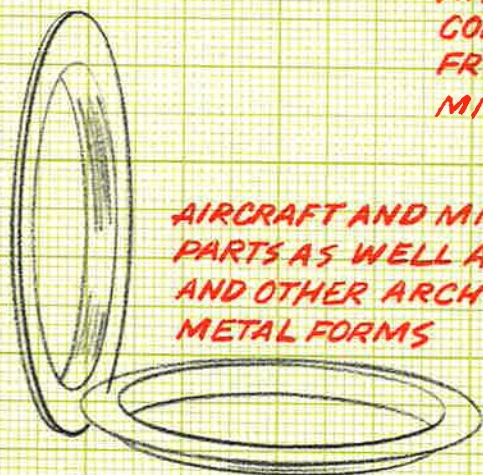
PIPE COUPLING CAN BE ROLL FORMED ECONOMICALLY AT HIGH PRODUCTION RATES



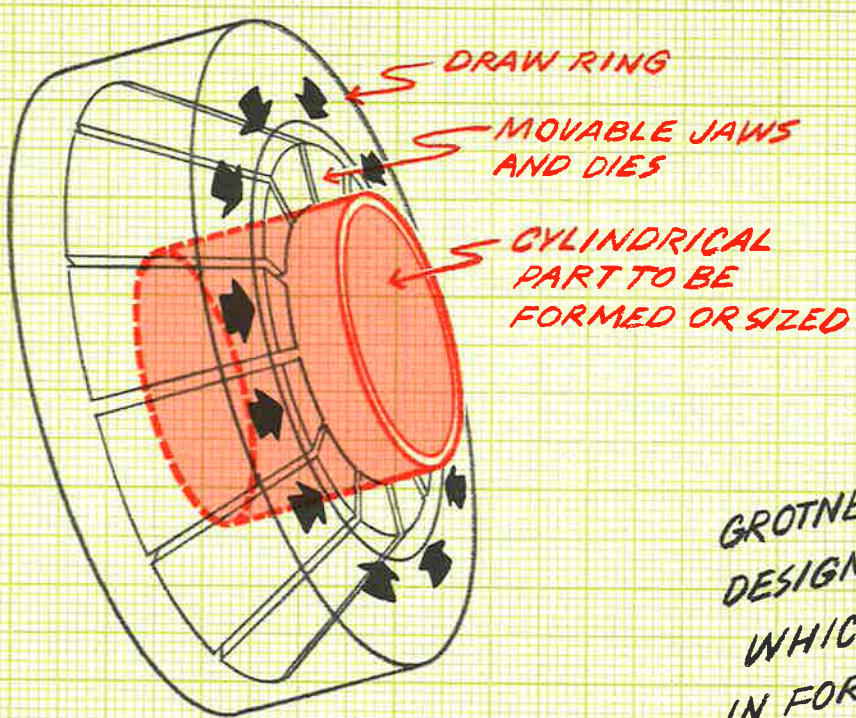
WASHING MACHINE COLLARS ARE ROLL FORMED FROM 20 GAUGE MILD STEEL



AIRCRAFT AND MISSILE PARTS AS WELL AS BEZELS AND OTHER ARCHITECTURAL METAL FORMS



Subject:
SHRINKING
METAL PARTS
TO SIZE AND/OR
SHAPE



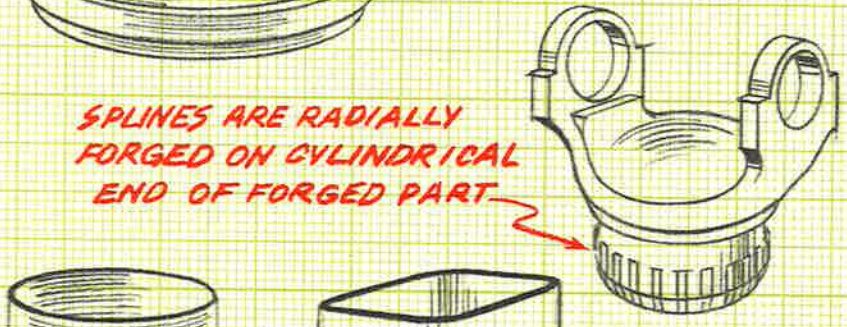
BASIC COMPONENTS OF A GROTNES SHRINKER
ARROWS INDICATE RADIAL LATERAL MOVEMENT OF JAWS AND DIES TO EXERT COMPRESSION ON PIECE TO BE SIZED AND FORMED

GROTNES SHRINKERS ARE DESIGNED TO FORM AND SIZE PARTS WHICH ARE BASICALLY CONTINUOUS IN FORM. IT IS ACCOMPLISHED BY MECHANICAL COMPRESSION APPLIED THRU OVERALL CIRCUMFERENTIAL MOVEMENT OF A SET OF RADIALLY DISPOSED DIES MOUNTED ON MOVABLE JAWS. JAW MOVEMENT IS PRECISELY CONTROLLED AND IS OBTAINED THROUGH THE RELATIVE MOTION OF SLIDING INCLINED PLANES. CYLINDRICAL PARTS MAY BE SHAPED OR FORMED TO SQUARE, OBLONG OR OTHER SHAPES.

APPLICATIONS FOR FORMING BY SHRINKING ON SMALL AS WELL AS LARGE PARTS ARE UNLIMITED

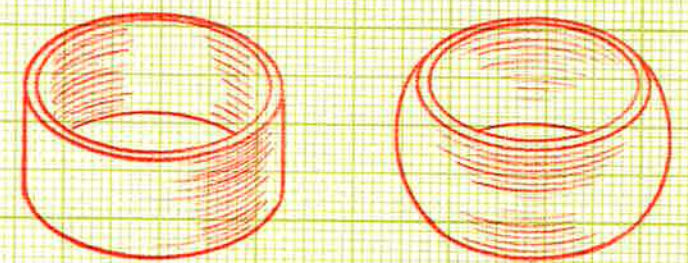


INTERNAL GEAR IS RADIALLY FORGED FROM SAE 4140 HARDENED STEEL

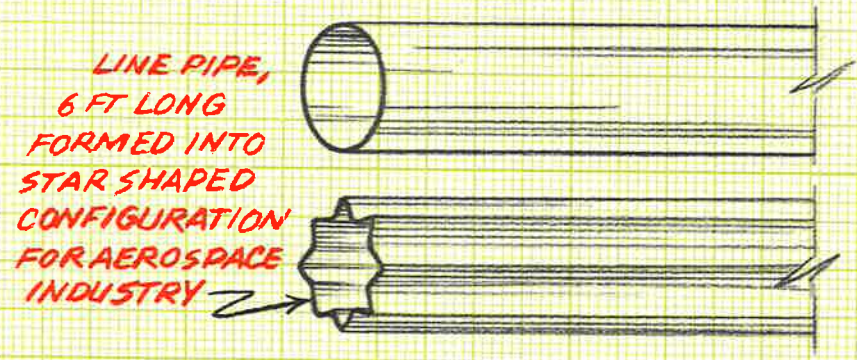


SPLINES ARE RADIALLY FORGED ON CYLINDRICAL END OF FORGED PART

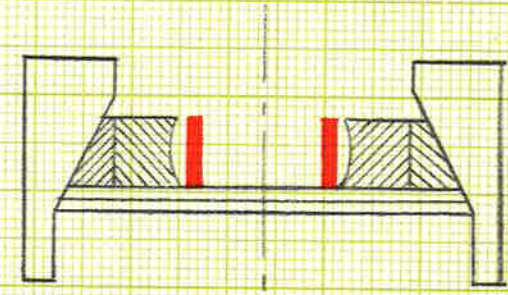
ROUND TO SQUARE PARTS SAVE FABRICATION TIME



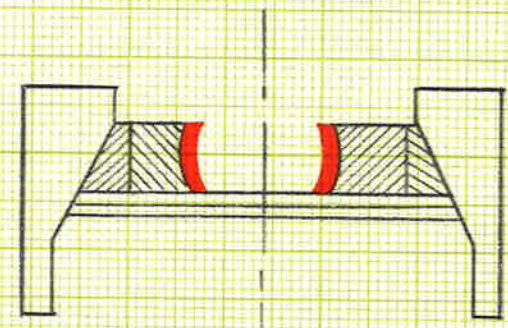
BEARING CAGES AND CONSTANT VELOCITY JOINTS REQUIRING A HIGH TOLERANCE AND SUPERIOR INNER FINISH ARE SHRUNK TO SIZE FROM MILL FORMED STOCK. MATERIAL AND MACHINING TIME SAVED.



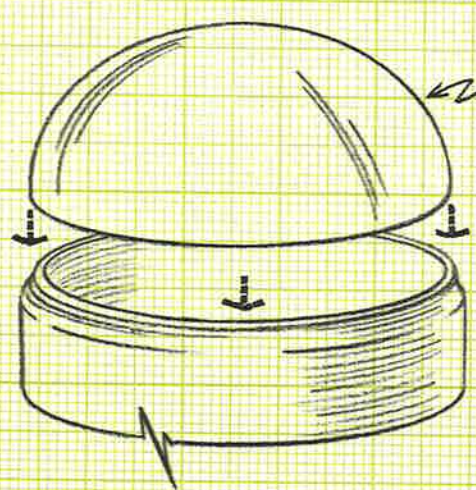
LINE PIPE, 6 FT LONG FORMED INTO STAR SHAPED CONFIGURATION FOR AEROSPACE INDUSTRY



1. PART IS POSITIONED IN SHRINKER



2. AS DRAW RING IS HYDRAULICALLY MOVED DOWNWARD DIES AND JAWS EXERT CIRCUMFERENTIAL PRESSURE TO FORM BEARING CAGES

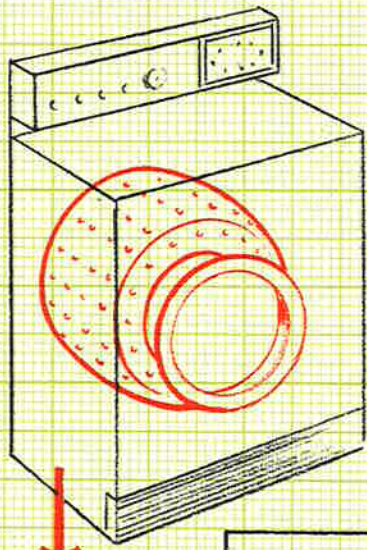


HEAVY DOMED HEADS FOR HIGH PRESSURE COMPRESSED AIR TANKS ARE REDUCED IN DIAMETER IN A GROTNES SHRINKER AND SIZED TO FOR PERFECT FIT OF I.D. OF MAIN CYLINDRICAL SHELL

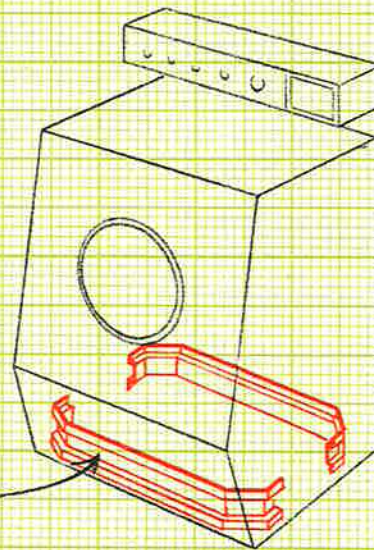
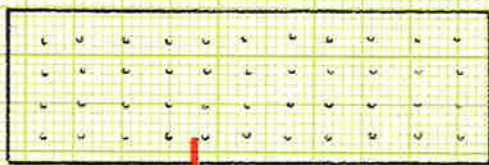
Subject:

WASHER
AND DRYER
COMPONENTS

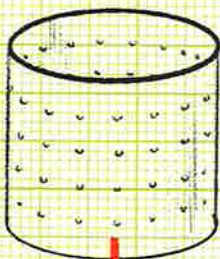
IN THE APPLIANCE INDUSTRY,
MULTI-STEP FABRICATION
METHODS CAN BE REPLACED
BY RADIAL STRETCH FORMING
ON GROTNES EXPANDING
MANDREL MACHINE TOOLS...
SIMPLIFYING MANUFACTURING
AND SAVING MONEY



DRYER
BARREL

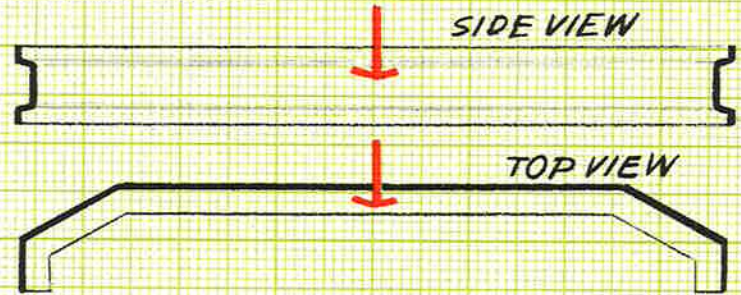


FORMED FRAME
FOR BASE
FABRICATED
FROM STAMPINGS

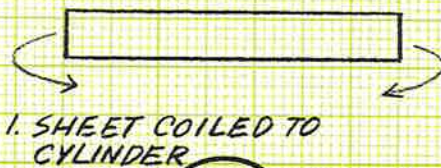


1. COIL AND WELD
2. EXPAND AND
SIZE TO DESIRED
SHAPE IN SINGLE
OPERATION

ELIMINATE
EXTRA FABRICATION
WORK BY
UTILIZING
RADIAL STRETCH
FORMING ON
GROTNES
EXPANDER



MANUFACTURING PROCESS CAN BE
SIMPLIFIED BY UTILIZING RADIAL
STRETCH FORMING AS FOLLOWS:



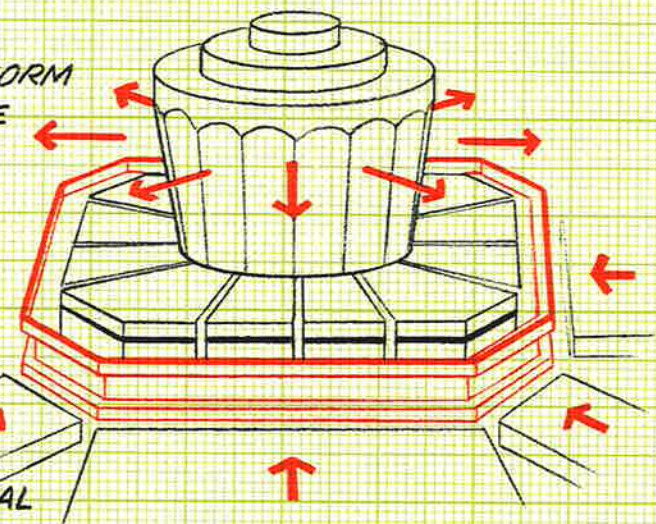
1. SHEET COILED TO
CYLINDER



2. SECOND STEP IS TO PRE-FORM
TO RECTANGULAR SHAPE

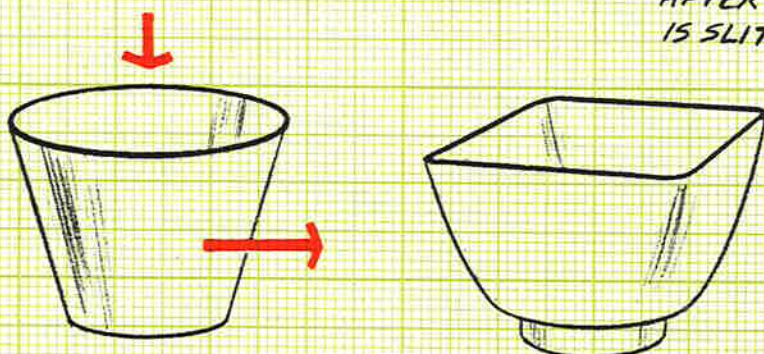


3. THIS SHAPE IS THEN
FORMED AND SIZED ON
GROTNES EXPANDER
TO PRODUCE FINAL
SHAPE. TOP AND BOTTOM
FLANGE IS OBTAINED BY
WIPING OVER OUTER
HYDRAULIC OR MECHANICAL
ACTUATED DIES



AFTER FORMING PIECE
IS SLIT INTO 2 PIECE PARTS

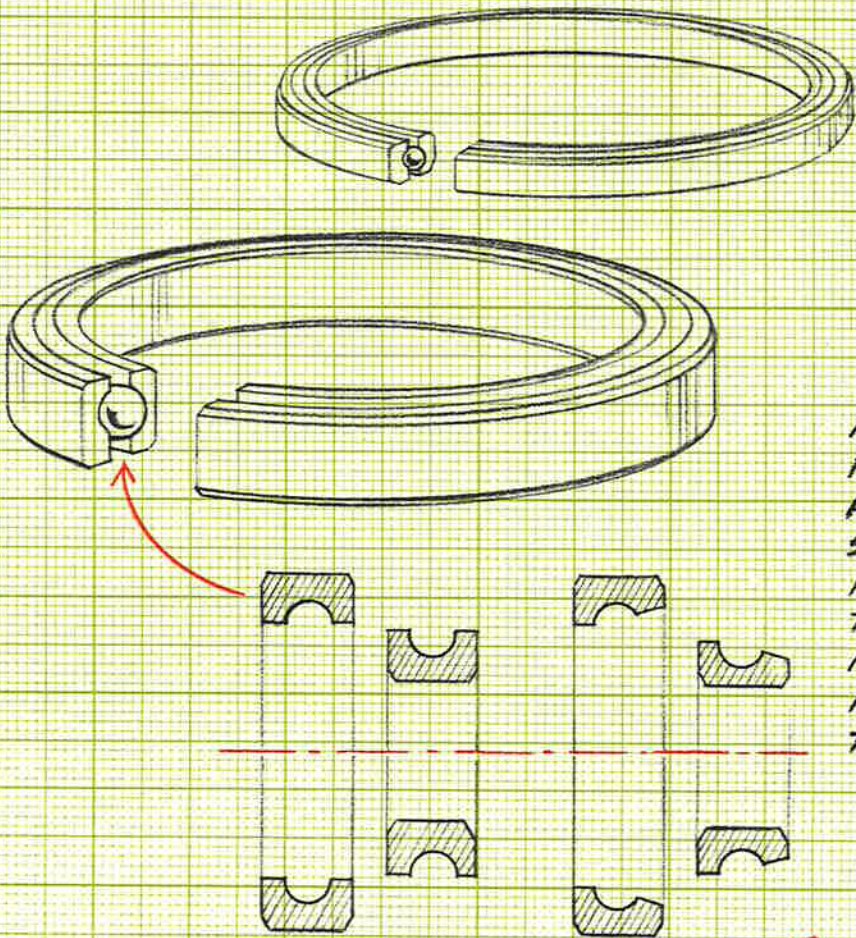
NOTE: WASHER DRUM CONFIGURATION
CAN ALSO BE PRODUCED BY
RADIAL STRETCH FORMING



METAL SHEET COILED INTO CONE
CAN BE FORMED AND SIZED INTO
POLYGON IN ONE OPERATION
FORMABILITY IS IN RELATION TO
DRAWING CAPABILITY OF MATERIAL

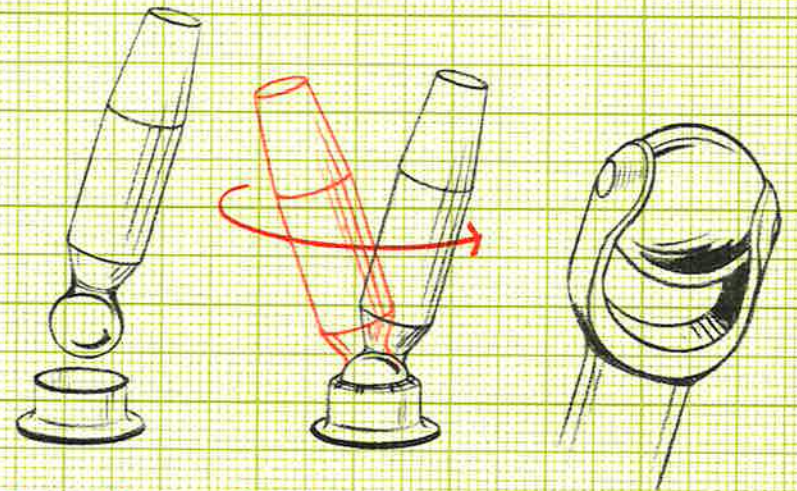
Subject:

**BEARING RACES
BALL JOINTS
AND BALL
RETAINING RINGS**



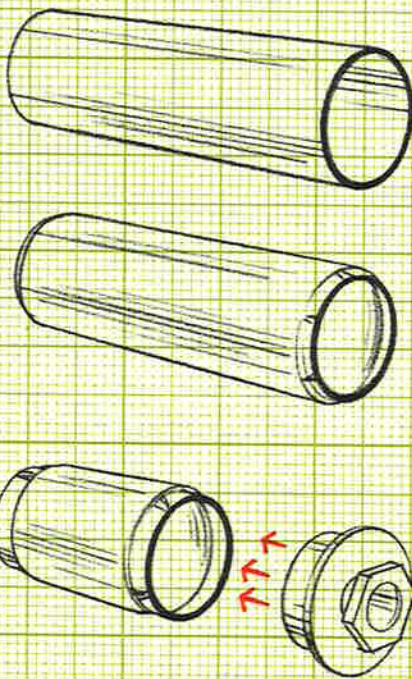
INNER AND OUTER BEARING RACES ARE ROLL FORGED IN A HEATED CONDITION TO PROPERLY ALIGN AND REFINE THE GRAIN STRUCTURE. THIS ALSO ELIMINATES MACHINING OPERATIONS AND REDUCES THE INITIAL AMOUNT OF MATERIAL NEEDED FOR THE PART. RINGS OF 1/4" TO 1" IN WIDTH 3" TO 40" BORE ARE WITHIN THE CAPABILITIES OF THE EQUIPMENT.

GROTNES ROTARY ROLL FORGING AND COMPRESSION FORMING HAVE WIDE APPLICATION IN THE MANUFACTURE OF PRECISION PARTS. THE MANUFACTURER BENEFITS THROUGH CLOSE TOLERANCE CONTROL WHILE IMPROVING THE STABILITY AND GRAIN STRUCTURE OF THE PART.



PERMANENT MATING OF MOVABLE PARTS SUCH AS SELF-ALIGNING BALL BUSHINGS, BALL AND SEAT JOINTS, BALL AND YOKE JOINTS IS DONE ON A GROTNES COMPRESSION FORMING MACHINE. THIS ENABLES CONSISTENT CONTROL TO DIMENSION OR TO PRESSURE, ASSURING UNIFORM PARTS.

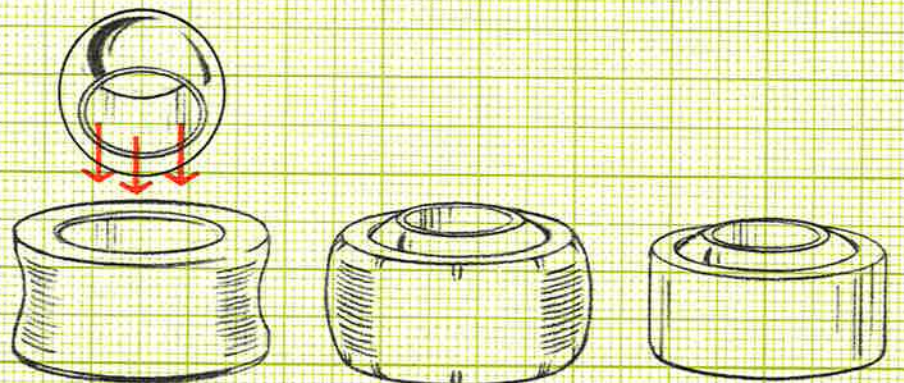
BEARING SEATS IN CONVEYER ROLLERS CAN BE FORMED USING A GROTNES HYDRAULIC SHRINKER. THE MACHINE IS DESIGNED TO FORM BOTH ENDS SIMULTANEOUSLY.



STOCK TUBING IN ANY DIAMETER AND LENGTH IS USED

BEARING SEATINGS IN BOTH ENDS ARE PRODUCED BY COMPRESSION FORMING TO I.D. TOLERANCES WITHIN .004"

ASSEMBLY OF ROLLER AND BEARINGS IS FASTER AND CONSISTENT PRESS FIT IS OBTAINED

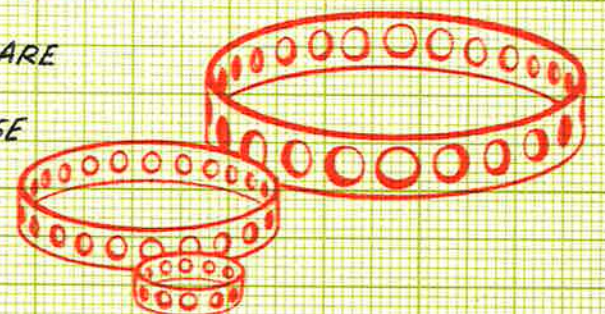


BALL BUSHING IS INSERTED INTO HOUSING AND POSITIONED IN GROTNES SHRINKER

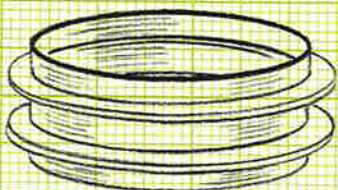
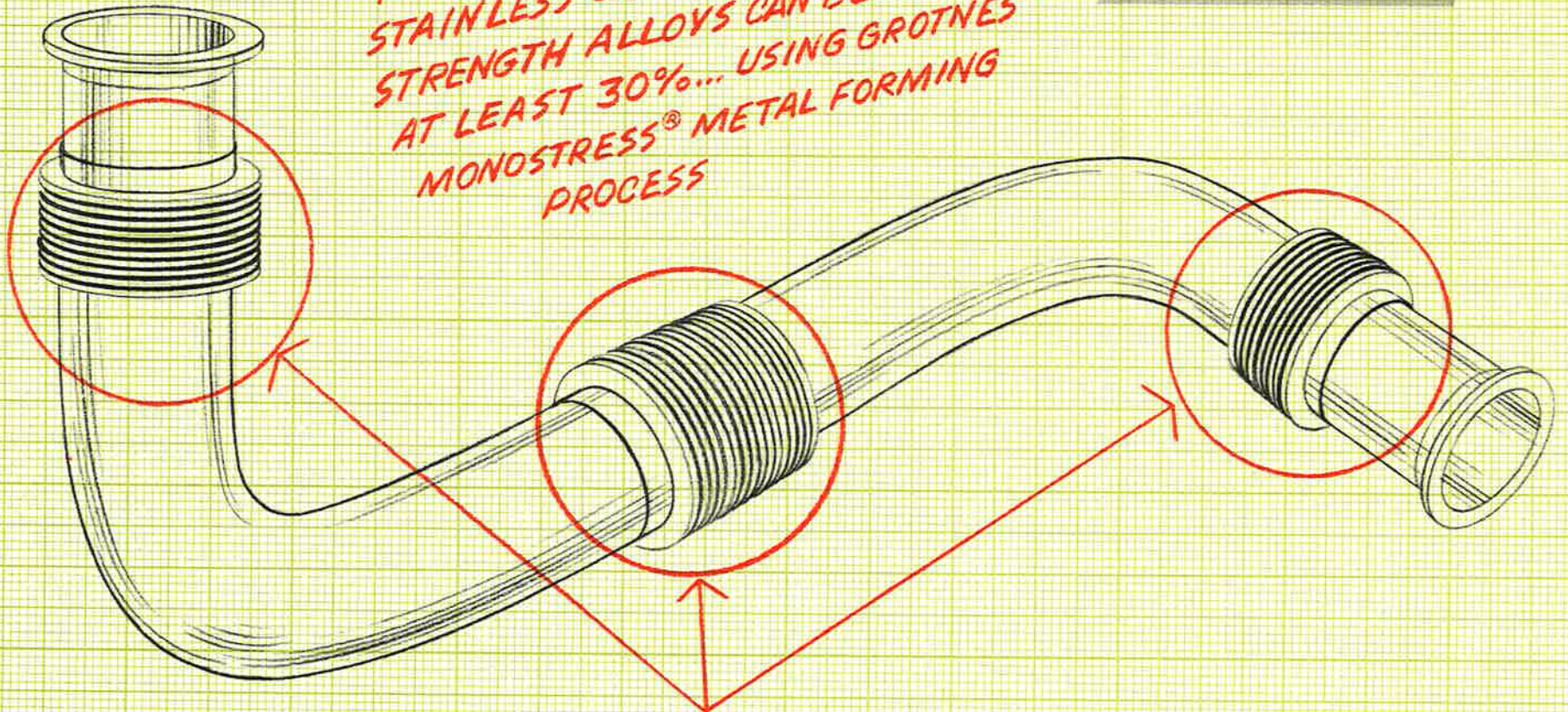
PERMANENT ASSEMBLY OF MATED MOVABLE PARTS IS ACCOMPLISHED THRU COMPRESSION FORMING

O.D AND FACE OF RETAINING RING ARE MACHINED TO SIZE TO PROVIDE FINISHED SELF-ALIGNING BALL BUSHINGS

BALL RETAINING RINGS ARE EASILY SIZED FOR TRUE CONCENTRICITY TO CLOSE TOLERANCES BY USE OF A GROTNES SHRINKER OR EXPANDER, DEPENDING ON DIAMETER SIZE



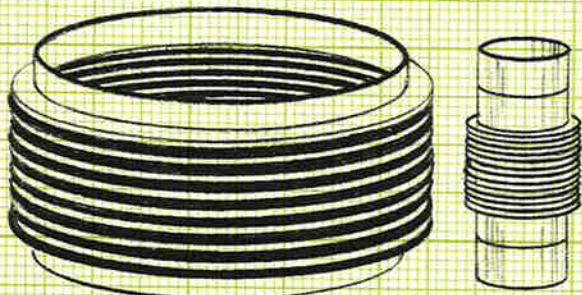
THE COST OF FORMING METAL BELLOWS OR CONVOLUTIONS IN CYLINDRICAL SHAPES OF STAINLESS OR OTHER EXOTIC HIGH STRENGTH ALLOYS CAN BE REDUCED AT LEAST 30%... USING GROTNES' MONOSTRESS[®] METAL FORMING PROCESS



2 CONVOLUTION BELLOWS

EXPANSION JOINTS OR FLEXIBLE DIAPHRAGMS ARE INTEGRAL PARTS OF LIQUID FUEL ROCKET AND MISSILE ENGINE DUCTS. WHEN FORMED BY THE MONOSTRESS[®] PROCESS THESE PARTS HAVE A GREATER RESISTANCE TO FATIGUE COMPARED TO SIMILAR PARTS MADE BY ROLLING OR HYDROSTATIC FORMING

MONOSTRESS[®] IS A METAL FORMING PROCESS THAT COMBINES AXIAL MOVEMENT WITH RADIAL DISPLACEMENT. IT IS IN FACT, A MORE SOPHISTICATED VERSION OF RADIAL STRETCH FORMING. IT PERMITS FORMING OF CONVOLUTE SHAPES IN SERIES WITH THESE ADVANTAGES:

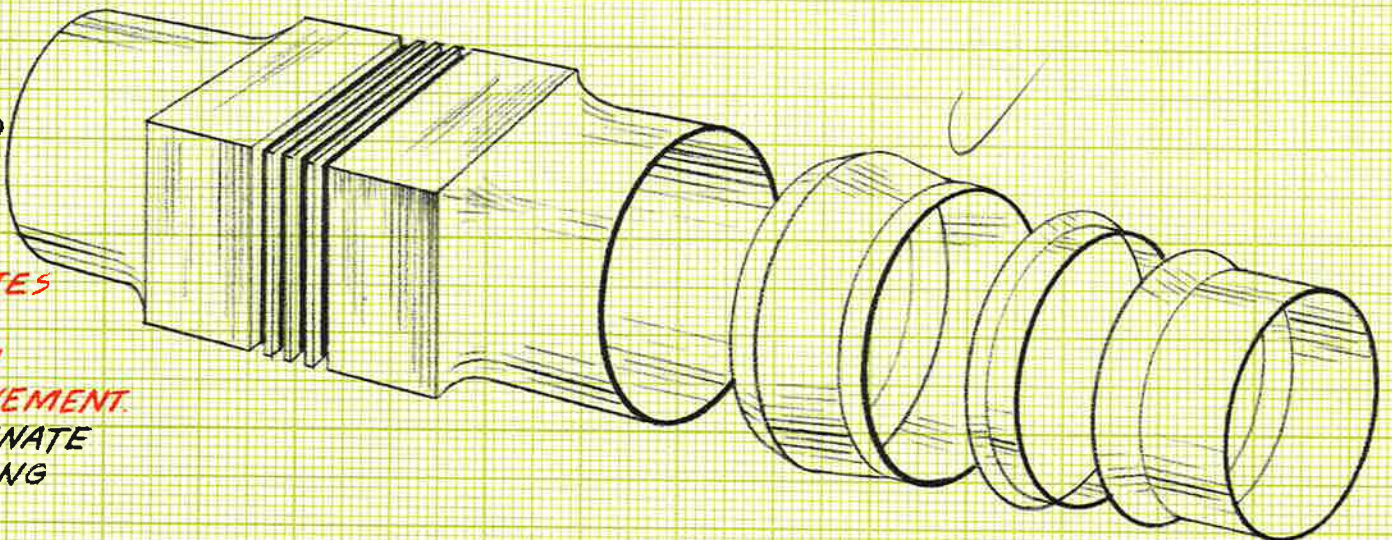


10 CONVOLUTION BELLOWS IN SMALL OR LARGE DIAMETER PIECE PARTS CAN BE FORMED WITH EQUAL EASE

1. NO WALL THINNING OR HARDENING AT POINTS OF FORMING
2. PARTS ARE FORMED ALLEVIATING RESIDUAL AXIAL STRESSES WHILE IMPARTING CONSISTENT HOOP STRESS
3. LOW TOOLING COST
4. ELIMINATION OF INTERMEDIATE ANNEALING
5. PRODUCT LIFE IS INCREASED TEN-FOLD

BELLOWS OF THIS TYPE ARE USED EXTENSIVELY FOR PIPE SECTIONS CARRYING HOT FLUIDS AND GASES IN OIL REFINERIES, CHEMICAL PLANTS AND POWER PLANTS. THEY ALLOW FOR EXPANSION FROM MOVEMENT AND PRESSURE AND REDUCE DANGER OF RUPTURE

ALL TYPES OF PARTS FOR AEROSPACE ENGINES CAN BE FORMED BY STANDARD RADIAL STRETCH FORMING OR MONOSTRESS[®]. A GROTNES FORMING PROCESS THAT COMPENSATES FOR RADIAL EXPANSION IN THE PIECE PART WITH COORDINATED AXIAL MOVEMENT. IT IS EMPLOYED TO ELIMINATE HARDENING AND THINNING IN EXTREME FORMING APPLICATIONS

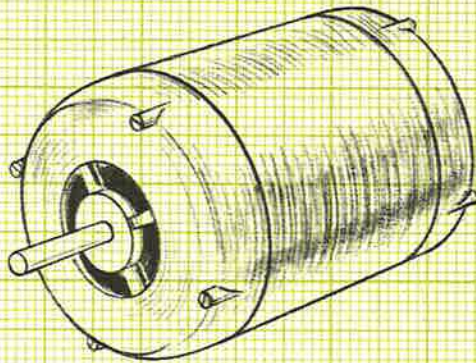


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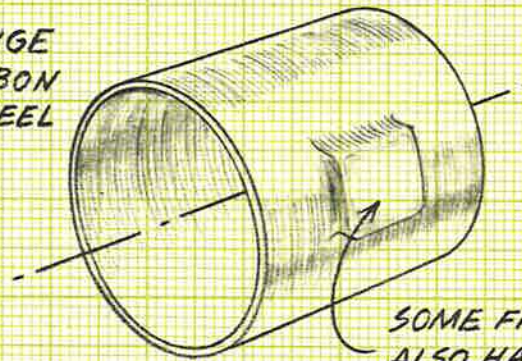
MOTOR FRAMES
GENERATOR SHELLS
AND OTHER
COMPONENTS

MOTOR FRAMES

GROTNES RADIAL
STRETCH FORMING
ELIMINATES EXCESSIVE
MACHINING AND
SAVES MATERIAL

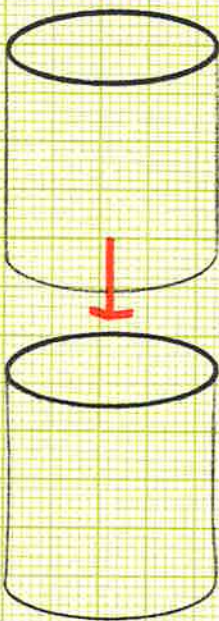


No 13 GAUGE
LOW CARBON
SHEET STEEL



SOME FRAMES CAN
ALSO HAVE BOSS FORMED
IN WALL BY SIMPLE
CHANGE IN TOOLING

COIL AND WELD
SIZE AND
SHAPE ON
EXPANDER



MOTOR FRAME
EXPANDERS HOLD
TOLERANCES AS
CLOSE AS .001"

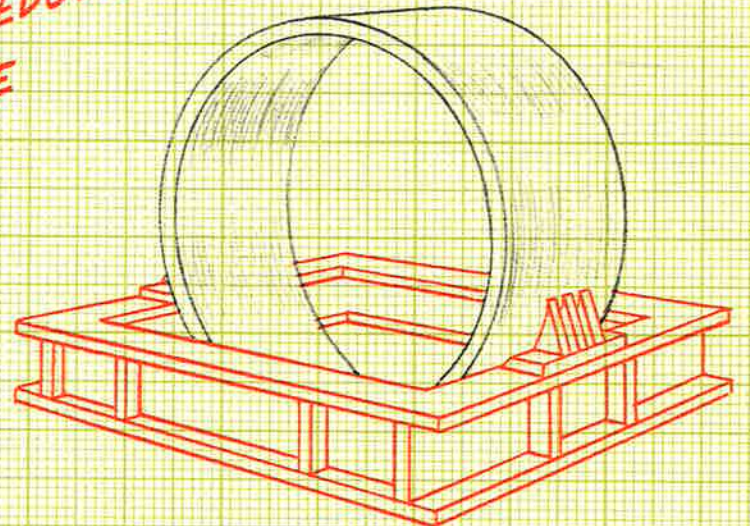
NOTE CONCAVE
CONTOUR OF
FINAL SHAPE
AND TAPERED
LEAD TO
PERMIT EASE
OF INSERTION
OF END COVERS

8.019 DIA
BEFORE
EXPANDING

8.219 DIA.
AFTER
EXPANDING

ELECTRICAL EQUIPMENT
MANUFACTURERS CAN
UTILIZE RADIAL STRETCH
FORMING ON GROTNES
EXPANDING MANDREL
MACHINE TOOLS TO REDUCE
COSTS AND IMPROVE
DESIGN

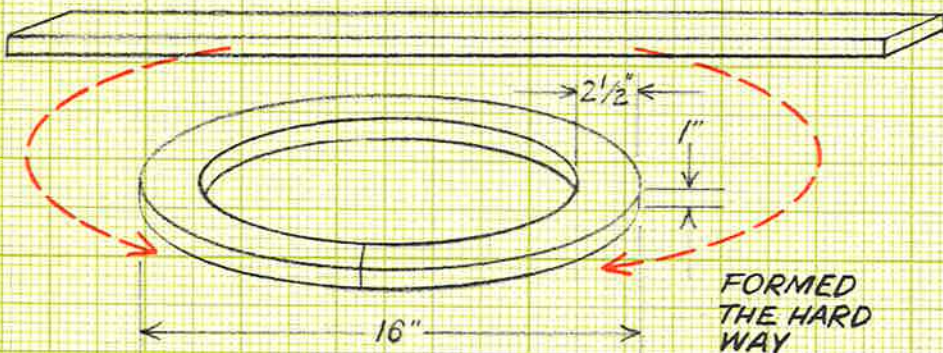
GENERATOR FRAMES



RADIAL STRETCH FORMING ON A
GROTNES EXPANDER COMPLETELY
ELIMINATES:

1. PRE-FORMING ON BLANK
2. STRESS RELIEVING IN
PREPARATION FOR MACHINING
3. ROUGH MACHINING I.D. & O.D.

RING GEARS

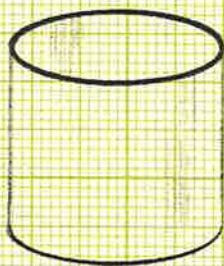
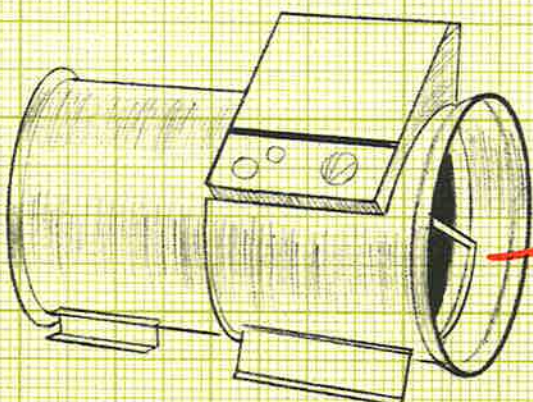


FORMED
THE HARD
WAY

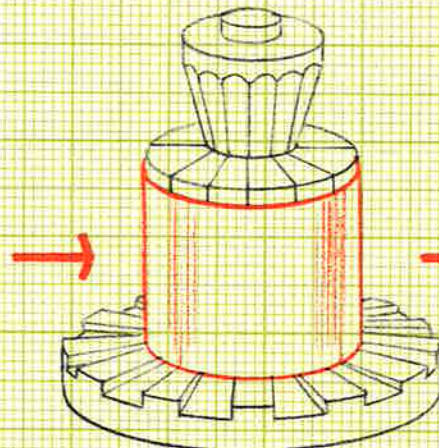
EXPANDING CAN TEST WELD AND
SIZE TO TOLERANCE TOUGH MATERIALS
SUCH AS 4140, RENE 41, HASKALOY
D6AC, TITANIUM, STAINLESS ETC.

**PLUS - IMPROVED MAGNETIC FIELD
WHICH RESULTS IN MORE EFFICIENT
EQUIPMENT PERFORMANCE**

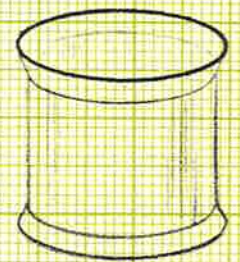
GRAIN DRYING HEATER



1. CYLINDRICAL
BLANK



2. POSITION ON
GROTNES
EXPANDING
MANDREL
MACHINE TOOL



3. FINAL PART FORMED
AND SIZED TO
EXACT TOLERANCE
AND CONCENTRICITY
INSURING EXACT FIT
OF INTERNAL
ROTATING PARTS