



the mandrel stop nut to increase the expansion from the initial setting used is required. Three to four turns of the mandrel stop nut is recommended as the initial starting point to seal leaking or bleeding tube joints.

#### oversize tube sheet holes

If the tube sheet hole diameter is 1/16" or larger than the tube outside diameter, ferrules or sleeves must be used to obtain proper tube expansion without excessive thinning of the tube wall thickness. The combination beading and expanding tool has been designed to provide sufficient expansion for tube sheet holes up to 1/16" over the tube outside diameter. Therefore, ferrules or sleeves are required to perform the expansion and beading of the tube end in oversize tube sheet holes.

#### probable cause of failures

##### 1. Bead not completely formed or tight against tube sheet:

This condition is caused by one of three reasons:

- (a) The amount of tube expansion may not be sufficient; therefore, check, and if necessary, reset the mandrel stop nut for further expansion.
- (b) Tube sheet projection not correct. The initial tube sheet projection was not sufficient to provide enough material to form the bead tightly against the tube sheet. It would be necessary to increase the tube projection in increments of 1/32".
- (c) Lubricant or anti-rust in tube or on expander rolls. Clean tube or expander assembly thoroughly to remove lubricant or anti-rust.

##### 2. Excessive bead formed:

This condition is evidenced by the outer diameter of the bead being flattened against the tube sheet. This has resulted from an excessive tube sheet projection. It will be necessary to decrease the tube projection in increments of 1/32" until the proper bead is formed.

##### 3. Tube galling or flaking:

This condition of excessive galling and flaking evidenced on the tube bead

is caused by excessive heat being retained in the tool from the prior tube's expansion and beading. The elimination of this problem requires the use of a coolant and that the tool be dunked into a container of coolant to remove as much heat as possible. It is recommended that the alternate use of tube tools be considered to completely eliminate any heat buildup problems. If flaking inside tube, this usually indicates overexpansion. Correct by resetting stop nut of mandrel.

##### 4. Cage stops, mandrel continues to rotate prior to completion of expansion and beading:

This condition is caused by excessive heat being retained in the tool. Continued rotation of the mandrel will cause the appearance of a glaze on the rolls and mandrel. The beading roll will appear to have sunk into the tube end, therefore, it is of utmost importance that coolant be used and the tool dunked into a container. The alternate use of two Combination Beading Expander assemblies is highly recommended to prevent excessive heating.

##### 5. Needle bearing failure:

Failure of the needle bearings that are part of the beading roll support assemblies is an indication of insufficient lubrication. The tool should be lubricated at least twice per shift during its use.

## "COMBINATION BEADING EXPANDER"

For 2", 2-1/2" and 3" Tube OD



## Operating and Maintenance Instructions

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## specifications

(in inches)

| TUBE O.D. | (1) CAT. NO. | COMBINATION BEADING EXPANDER |                   |               |                    |              | (2) TUBE PROJECTION |      |      |      |  |  |  |
|-----------|--------------|------------------------------|-------------------|---------------|--------------------|--------------|---------------------|------|------|------|--|--|--|
|           |              | CONTRACTED DIAMETER          | EXPANDED DIAMETER | BODY DIAMETER | BEAD ROLL DIAMETER | DRIVE SQUARE | (1) TUBE GAUGE      |      |      |      |  |  |  |
|           |              |                              |                   |               |                    | 10           | 11                  | 12   | 13   |      |  |  |  |
| 2         | 41633-OWXY   | 1.700                        | 1.875             | 1.688         | 5/8                | 3/4          | 1/4                 | 1/4  | 1/4  | 1/4  |  |  |  |
| 2-1/2     | 41634-OWXY   | 2.200                        | 2.375             | 2.156         | 7/8                | 3/4          | 9/32                | 9/32 | 9/32 | 9/32 |  |  |  |
| 3         | 41359-OWXY   | 2.700                        | 2.900             | 2.625         | 7/8                | 1            | 9/32                | 9/32 | 9/32 | -    |  |  |  |

(1) See note no. 1 on page no. 3 for EXPANDER ASSEMBLY CAT. NO. code.

(2) TUBE PROJECTION above is nominal for the best bead. It may be necessary to adjust this tube projection depending on (1) tube type and hardness or (2) tube sheet material. See paragraph no. 8 under OPERATING PROCEDURE.

## introduction

The Combination Beading Expander will in one operation quickly and quietly expand and bead tubes.

Successful operation is readily achieved by following three (3) simple rules.

The guide roll assembly and the beading roll (Key #9 and 17, page no. 3 and 4) must be the proper size for the tube wall being expanded and beaded.

2. Tubes must have correct amount of projection from tube sheet before starting expansion. (Refer to Specifications.)

3. Both tube and tool must be totally free of any anti-rust, oil or lubricant.

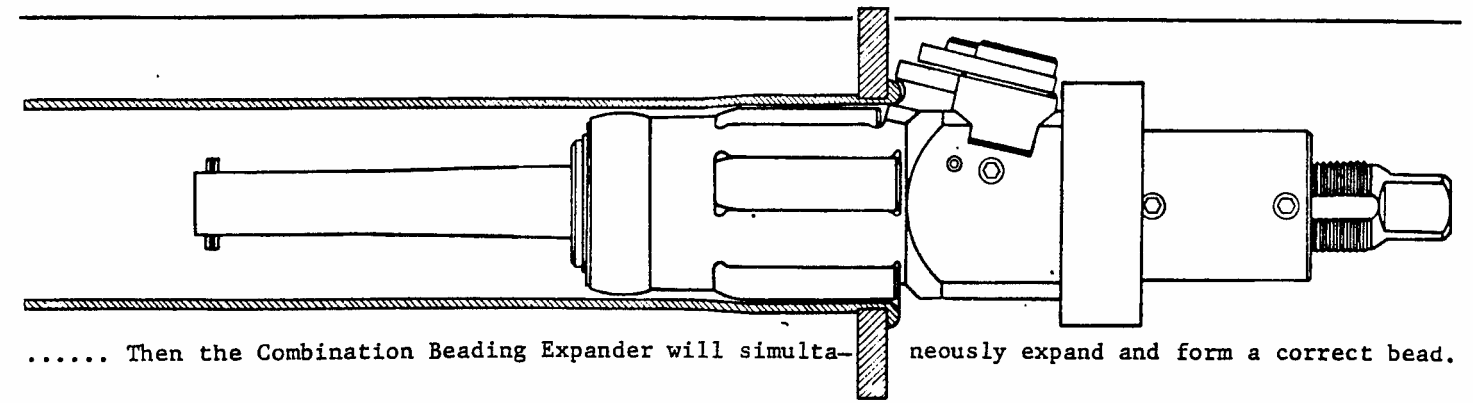
## theory of operation

The Combination Beading and Expanding tool simultaneously expands and beads the tube end in a single operation. Operating as it does, the tool assures the creation of a joint which is both pressure-tight and has a bead in intimate contact with the tube sheet. The tool achieves this objective by utilizing the natural feed force built into the expander to force the beading roll against the end of the tube while expansion is taking place. The ability of the tool to satisfactorily accomplish this depends upon the amount of tractive force available being of sufficient magnitude to enable feeding forces to be developed which will enable the beading roll to deform the end of the tube and press the bead tightly against the sheet. The tractive force is made a maximum by utilizing five expansion rolls in place of the three or four normally used in expanders of this type and by the use of a coolant which has the quality of minimum lubricity. If the beading roll or expander is set so that full expansion is accomplished before the bead has been formed, it will not be possible to complete a proper bead without further expansion of the tube.

The tool operates such that, once the beading roll has come into contact with the end of the tube, the entire inward force of the tool is available to form the bead. However, this force is not always of sufficient magnitude to perform the required operation. The force is at a minimum initially while the expander is expanding the tube to a metal to metal condition. At this point, the tractive force increases sharply and builds to a maximum as the expansion progresses. When the stop nut on the mandrel engages the thrust bearing on the cage housing preventing any further axial movement of the mandrel, this force stabilizes and then diminishes as continued rotation of the expander irons out the tube bead. This is why it is necessary that the beading operation be completed before final expansion of the tube since it will require the maximum tractive force available to perform this beading. Because of normal manufacturing practices, it would be possible to perform a proper beading and expanding operation with the tool without necessarily setting it so that the beading roll was in contact with the end of the tube. How far back would be determined by two factors, one would be the amount of clearance between the tube sheet hole and the tube O.D. The greater this clearance, the further back the beading roll could be set since effective tractive force will not be developed until the tube has been expanded to the metal to metal condition. The second factor would be the effective thickness of the tube sheet. However, the safest course to follow in the use of this tool would be to set the tool with the beading roll close to or in contact with the tube end. It must be emphasized that no expanding tool can do a satisfactory job unless the following three items are complied with:

- (1) Tool of the correct size
- (2) Tube ends and tube sheet holes have been properly prepared and are clean.
- (3) The tool is properly lubricated.

Compliance with these three requirements is even of more critical nature when using the Combination Beading Expander tool.



..... Then the Combination Beading Expander will simultaneously expand and form a correct bead.

- b. A stamped "V" on the support roll holders to indicate the set screw dimple position so that the mandrel clearance grooves are located in their proper position.

If a 10% tube wall reduction is satisfactory, expanding may continue, otherwise the mandrel stop nut must be reset. (Each 1/32 inch mandrel movement equals .001 inch change in tube expansion I.D.)

## calculating the required expansion

The amount of expansion desired may usually be determined from past experience. Records will indicate that there is quite a variable between installations. This variable may be due to personal preference as well as service conditions. The type and hardness of tube metal and the tube sheet will also have a bearing on the amount of expansion. Depending on tube O.D., sheet thickness, pressure and service, etc., a ten per cent wall reduction (thinning of the tube wall after expanding) may suffice. In another case a fifteen per cent reduction or greater may be required.

The amount of tube wall reduction generally considered most desirable for the average ferrous tube application is approximately ten to fifteen per cent. Extensive experimentation has established that the most reliable method of determining what a joint should be and its effectiveness is to measure displacement of tube metal, after metal to metal contact of tube wall with tube seat has been made.

An example of how to determine the desired expanded diameter for a 2" x 12 gauge (.109) tube is shown.

$$\begin{aligned}
 & 2.015 \text{ Tube Sheet Hole} \\
 & \text{minus - } 2.000 \text{ Tube O.D.} \\
 & \text{equals } .015 \text{ Clearance (Diametral)} \\
 & \text{plus + } 1.782 \text{ Tube I.D.} \\
 & \text{equals } 1.797 \text{ Tube I.D. at metal to metal} \\
 & \quad \quad \quad \text{contact} \\
 & \text{plus + } .022 \text{ Increase in I.D. to obtain 10\%} \\
 & \quad \quad \quad \text{tube wall reduction} \\
 & \quad \quad \quad \text{(10\% x .109 wall x 2)} \\
 & \text{equals } 1.819 \text{ Desired expanded diameter of I.D.}
 \end{aligned}$$

## tool maintenance

THE TREMENDOUS FORCE TO SIMULTANEOUSLY EXPAND AND BEAD THE TUBES, RESULTS INTO A EXTREMELY HEATED TOOL. THIS REQUIRES A PROPER SCHEDULE OF MAINTENANCE TO LUBRICATE THE BEARINGS INVOLVED TO PREVENT THEIR PREMATURE FAILURE. LUBRICATE THE SUPPORT ROLL ASSEMBLY BEARINGS ( KEY -13 AND -15 ) AND THE FRONT GUIDE ROLL ASSEMBLY ( KEY- 9 ) FREQUENTLY. APPLY A GOOD BEARING GREASE THROUGH THE GREASE FITTINGS PROVIDED IN PARTS ( KEY- 14,-16 AND -4 ).

## rework techniques

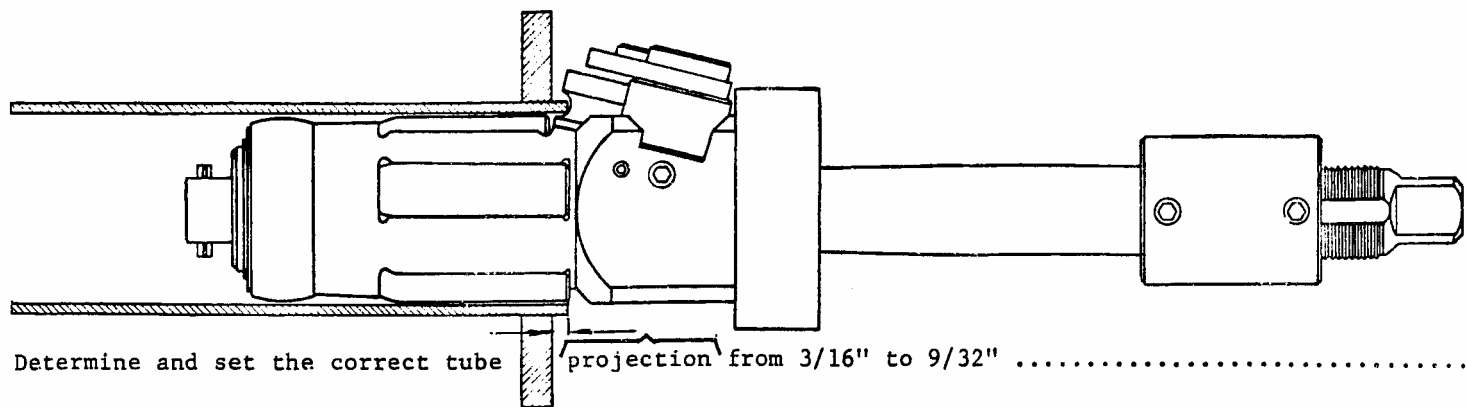
Certain conditions will arise which are not acceptable and require that the bead or expansion be reworked. This rework can and should be accomplished with the Combination Beading Expander. Under no circumstances should it become necessary to utilize hand methods to rework the expanded, beaded joint. Some of these conditions are:

### A. Bead not tight against tube sheet

This condition requires an increase in the tube I.D. expansion to pull the bead against the sheet. It is only necessary to readjust the mandrel stop nut to provide an increased expansion from the setting used in the original expansion/beading operation. It is recommended that approximately five turns of the mandrel stop nut be the initial increase in expansion.

### B. Leaking or bleeding tube joints

The repair of leaking or bleeding tubes can be accomplished by the use of the Combination Beading Expander if leaking is not due to overexpansion. To seal the tube joint, it will be necessary to increase the tube I.D. expansion to seal. Therefore, readjusting



Determine and set the correct tube projection from 3/16" to 9/32" .....

2. Thoroughly clean the Combination Beading Expander Assembly to remove all anti-rust, oil or grease.
3. All tubes to be expanded and beaded must be clean and have the proper tube projection from the tube sheet as listed in specifications. Swabbing the tube I.D. with a good solvent to remove oil or grease is recommended.
4. Set the mandrel stop nut for the calculated required tube I.D. expansion. (Refer to the section on Calculating the Required Expansion.)  
  
A simple method of setting this tool would be to insert the Combination Beading Expander into the tube so that the beading roll groove rests against the tube end. Use caution to avoid throwing expander body off center but allow expanding rolls to centralize body when mandrel is thrust forward. The mandrel then can be pushed into the tube until the expanding rolls contact the I.D. of the tube. At this point, the mandrel stop nut can be adjusted to approximately the position for the required expansion. To do this, it is only necessary to measure the distance from the thrust bearing face to the mandrel stop face allowing for each inch of mandrel movement a .031 inch increase in the tube I.D. (1/32 inch mandrel movement equals .001 inch increase in tube I.D.)
5. The Combination Beading Expander should now be set approximately to the required expansion and is ready to be tried.
6. After swabbing tube with coolant, insert cleaned expander assembly into tube to be expanded until the beading roll groove touches the tube end. Attach the drive motor to the mandrel square and begin expanding and beading. Continue the clockwise rotation of the drive motor for several turns of the expander cage after the mandrel stop nut engages thrust bearing face, indicating that the expansion has been accomplished and the beading of the tube end is complete. Do

- not stop drive rotation until this point. Continued rotation will not overexpand tube I.D. or degrade bead formation.
7. If the expansion or bead is not sufficient, the mandrel stop can be readjusted and the tube re-expanded and beaded to this new setting.
8. If the bead is not completely against the tube sheet, it may be necessary to do one of two things to correct. They are:
  - a. Decrease the tube projection by 1/32 of an inch increments.
  - b. Adjust the mandrel stop nut to allow further expansion.
9. It is highly recommended that a coolant be used for each tube as it is expanded. It is also recommended that the front end of the Combination Beading Expander be dipped into a bucket of coolant mixture between each tube expansion to remove as much heat from the tool as possible and to keep it clean, a prime necessity for this operation. Do not immerse the entire tool to a depth which permits the lubricant from being washed out of the thrust bearing. The use of two expander assemblies alternating between each tube beaded is recommended.
10. The tool has been designed such that the only adjustment necessary is the movement of the mandrel stop for the proper expansion required. All other adjustments have been designed into the tool.
11. Replacement of any part of this tool can be accomplished easily. All parts are designed such that the proper assembly is evident. Two indicators which have been added to prevent any misinterpretation are:
  - a. A dimple on one side of the beading roll to indicate that this is the bottom surface.

**specifications**  
(in millimeters)

| TUBE O.D. | (1) CAT. NO. | COMBINATION BEADING EXPANDER |                   |               |                    |              | (2) TUBE PROJECTION |     |     |     |
|-----------|--------------|------------------------------|-------------------|---------------|--------------------|--------------|---------------------|-----|-----|-----|
|           |              | CONTRACTED DIAMETER          | EXPANDED DIAMETER | BODY DIAMETER | BEAD ROLL DIAMETER | DRIVE SQUARE | (1) TUBE WALL       |     |     |     |
|           |              |                              |                   |               |                    |              | 3.4                 | 3.0 | 2.8 | 2.4 |
| 50.8      | 41633-OWXY   | 43.2                         | 47.6              | 42.9          | 15.9               | 19.0         | 6.3                 | 6.3 | 6.3 | 6.3 |
| 63.5      | 41634-OWXY   | 55.9                         | 60.3              | 54.8          | 22.2               | 19.0         | 7.1                 | 7.1 | 7.1 | 7.1 |
| 76.2      | 41359-OWXY   | 68.6                         | 73.7              | 66.7          | 22.2               | 25.4         | 7.1                 | 7.1 | 7.1 | -   |

(1) See note no. 1 on page no. 3 for EXPANDER ASSEMBLY CAT. NO. code.  
 (2) TUBE PROJECTION above is nominal for the best bead. It may be necessary to adjust this tube projection depending on (1) tube type and hardness or (2) tube sheet material. See paragraph no. 8 under OPERATING PROCEDURE.

**guide roll**

Guide rolls of different diameters are made to bracket the range of tube diameters that the expander can handle. Pick the correct guide roll for the gauge of tube to be expanded and beaded. The dash number of the guide roll part number indicates the gauge of tube. Guide rolls that are too large or small will prevent proper bead formation. Guide rolls are mounted eccentrically on the body of the expander. This means that a guide roll that is too large may prevent entry of the expander into the tube even though the guide roll itself is smaller than the tube I.D. Guide rolls that are too small will not centralize the expander in the tube and this excessive cocking of the expander will be reflected in the forming of a poor bead or marking of tube I.D. by the cage. Actual original tube I.D. is the only factor controlling guide roll selection.

**beading roll**

Beading rolls will operate on a range of wall thicknesses but the best results will be obtained by using the correct beading roll for the tube gauge to be worked on. The dash number of the beading roll part number indicates the gauge of tube.

**tube projection**

The best bead will be formed when the tube projects the proper amount from the tube sheet before it is expanded. The amount of projection can vary depending on tube diameter, wall thickness, tube sheet thickness and whether or not the tube is cut off square or has a flare due to use of an internal type tube cutter. Normal range of tube projection is 3/16" to 9/32". When the tube sheet is bowed or warped so that it is not parallel to the end of the tube, the desired projection should be measured at the midpoint so that half of the tube will have greater and half will have less than the desired projection.

**tube and tool cleanliness**

BOTH THE TUBE AND BEADING EXPANDER SHOULD BE FREE OF ANY LUBRICANT, OIL, GREASE AND ANTI-RUST. THE PRESENCE OF ANY SUCH MATERIAL WILL PREVENT THE EXPANDER ROLLS FROM HAVING THE TRACTION REQUIRED TO DEVELOP THE FORCE NEEDED TO FEED THE BEADING ROLL AGAINST THE END OF THE TUBE AND FORM A PROPER BEAD. SWAPPING OUT THE ENDS OF THE TUBES WITH A GOOD SOLVENT TO REMOVE ANY ANTI-RUST OR OIL IS RECOMMENDED PRIOR TO TOOL USE.

**tool coolant**

The pressures of bead formation, due to tube end material deformation, impart extreme heat to the tool. This heat must be removed by the use of a good water-soluble coolant. Dipping the roll end of the expander in a bucket of coolant between tube expansions is recommended. This will not only prevent the tool from overheating but will assist in maintaining the cleanliness which extends the service life of the highly stressed rolls and mandrel. Tool overheating will cause tube material flaking, cage rotation stoppage due to beading roll gouging tube end (excessive feed), seizure of expander feed action due to roll and mandrel glazing and poorly formed beads.

**operating procedure**

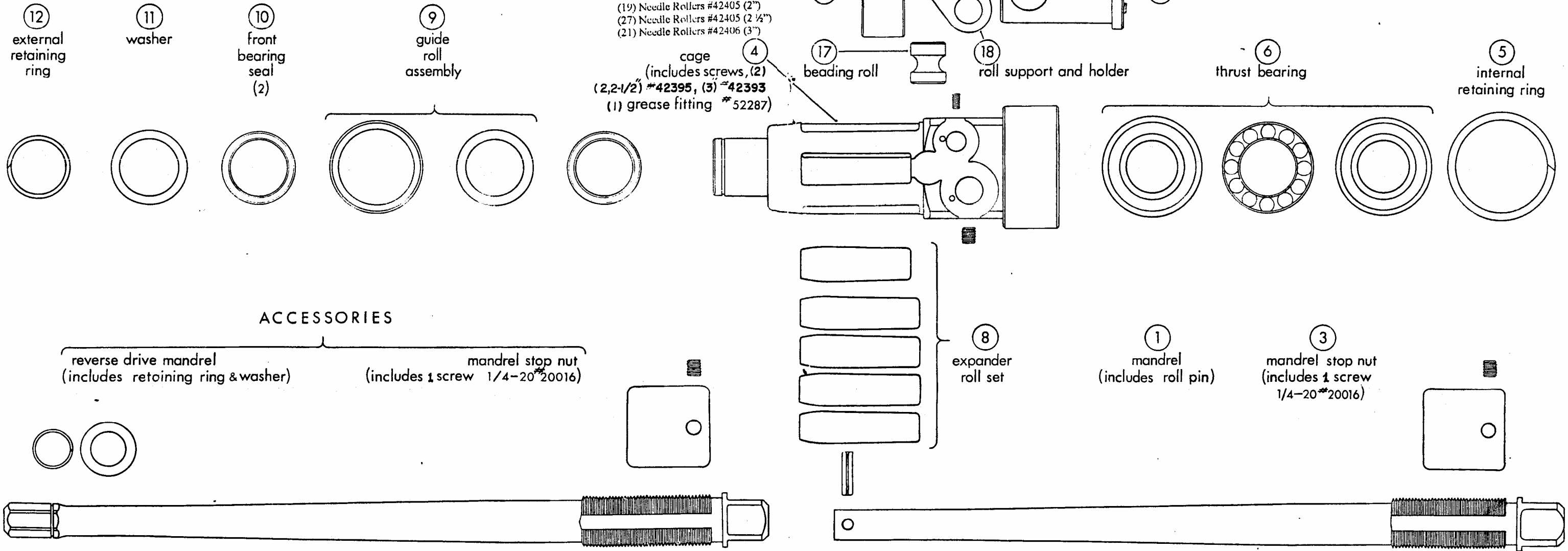
The expansion and beading of the tube ends can only be accomplished successfully by use of a properly equipped Combination Beading Expander Assembly and the correct operating procedures. The minimum requirements of a proper operating procedure are as follows:

1. The Combination Beading Expander must have the proper gauge guide roll assembly and beading roll for the tube to be expanded and beaded. (See page nos. 3 and 4.)  
(CONTINUED ON PAGE NO. 5.)

(15) Needle Rollers #42405 (2")  
 (19) Needle Rollers #42405 (2 1/2")  
 (19) Needle Rollers #42405 (3")

small support roll assembly  
 (19) Needle Rollers #42405 (2")  
 (27) Needle Rollers #42405 (2 1/2")  
 (21) Needle Rollers #42406 (3")

cage  
 (includes screws, (2)  
 (2, 2-1/2") #42395, (3) #42393  
 (1) grease fitting #52287)



ACCESSORIES

reverse drive mandrel  
 (includes retaining ring & washer)

mandrel stop nut  
 (includes 1 screw 1/4-20 #20016)

8  
 expander  
 roll set

1  
 mandrel  
 (includes roll pin)

3  
 mandrel stop nut  
 (includes 1 screw  
 1/4-20 #20016)

| TUBE<br>O.D. | *(1) ASSEMBLY<br>EXPANDER<br>CAT. NO. | 1          | 3                      | 4        | 5                             | 6                 | 8                            | 9                              | 10                       | 11       | 12                            | 13                                   | 14                                 | 15                                   | 16                                 | 17                   | 18                               | ACCESSORIES                 |                        |       |
|--------------|---------------------------------------|------------|------------------------|----------|-------------------------------|-------------------|------------------------------|--------------------------------|--------------------------|----------|-------------------------------|--------------------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------|----------------------------------|-----------------------------|------------------------|-------|
|              |                                       | MANDREL    | MANDREL<br>STOP<br>NUT | CAGE     | INTERNAL<br>RETAINING<br>RING | THRUST<br>BEARING | *(2) EXPANDER<br>ROLL<br>SET | *(3) GUIDE<br>ROLL<br>ASSEMBLY | FRONT<br>BEARING<br>SEAL | WASHER   | EXTERNAL<br>RETAINING<br>RING | LARGE<br>SUPPORT<br>ROLL<br>ASSEMBLY | LARGE<br>SUPPORT<br>ROLL<br>HOLDER | SMALL<br>SUPPORT<br>ROLL<br>ASSEMBLY | SMALL<br>SUPPORT<br>ROLL<br>HOLDER | *(3) BEADING<br>ROLL | ROLL<br>SUPPORT<br>AND<br>HOLDER | REVERSE<br>DRIVE<br>MANDREL | MANDREL<br>STOP<br>NUT |       |
|              |                                       | CAT. NO.   | CAT. NO.               | CAT. NO. | CAT. NO.                      | CAT. NO.          | CAT. NO.                     | CAT. NO.                       | CAT. NO.                 | CAT. NO. | CAT. NO.                      | CAT. NO.                             | CAT. NO.                           | CAT. NO.                             | CAT. NO.                           | CAT. NO.             | CAT. NO.                         | CAT. NO.                    | CAT. NO.               |       |
| 2"           | 50.8mm                                | 41633-OWXY | 41615                  | 41683    | 42810                         | 34266             | 28123                        | 42811-OABC                     | 41701-00XY               | 41681(2) | 41682                         | 41624                                | 41668                              | 41627                                | 41669                              | 41630                | 41631-00XY                       | 41632                       | 42157                  | 41683 |
| 2-1/2"       | 63.5mm                                | 41634-OWXY | 41635                  | 41637    | 41639                         | 34268             | 28070                        | 41673-OABC                     | 41702-00XY               | 41697(2) | 41696                         | 41644                                | 41671                              | 41647                                | 41668                              | 41650                | 41651-00XY                       | 41652                       | 42158                  | 41637 |
| 3"           | 76.2mm                                | 41359-OWXY | 41653                  | 41654    | 41657                         | 34268             | 28070                        | 41676-OABC                     | 41703-00XY               | 41699(2) | 41698                         | 35135                                | 41674                              | 41663                                | 41668                              | 41665                | 41666-00XY                       | 41667                       | 42159                  | 42177 |

\*(1) EXPANDER ASSEMBLY CAT. NO. code: W=0 for standard 1-1/2" effective roll lengths; W=8 for 7/8" effective roll lengths; W=9 for 1-3/16" effective roll lengths. XY=10, 11, 12, or 13, equal to tube gauge except that expanders are not offered for 3" O.D. x 13 ga. tubes.  
 \*(2) EXPANDER ROLL SET CAT. NO. code: OABC=0000 for standard 1-1/2" effective roll lengths; OABC=0087 for 7/8" effective roll lengths; OABC=0118 for 1-3/16" effective roll lengths.  
 \*(3) GUIDE ROLL ASSEMBLY and BEADING ROLL CAT. NOS. code: XY=10, 11, 12, or 13, equal to tube gauge except that parts for 3" O.D. x 13 ga. tubes do not apply.