PENNSYLVANIA RAILROAD SYSTEM

Locomotive Maintenance Instructions No. L-5-C

ISSUED ALTOONA, PA.
DECEMBER 13, 1923.

Method of Applying and Maintaining Flues and Arch Pipes in Boilers and Instructions for Welding Flues to Flue Sheets

(SUPERSEDING LOCOMOTIVE MAINTENANCE INSTRUCTIONS No. L-5-B, DATED JUNE 15, 1918.)

GENERAL

1. **Flues and Arch Pipes:** Boiler flues and arch pipes must be in accordance with Standard Specification No. 17 and the tracings designated.

Where specifications, instructions or tracings are referred to, the latest issues of the same are intended.

2. **Safe Ends:** Safe ending material must be .134 inch in thickness, B. W. G. No. 10, for repairing all flues or tubes that have a wall thickness of .134 or less. For repairing all flues or tubes that have a wall thickness of .148 inch, B. W. G. No. 9, or over, the thickness of the safe ending material must be the same as that of the flue repaired.

The outside diameter of safe ending material must be the same as that of the flue or tube ends to which it will be applied.

Where possible, the safe ends should be applied to the fire box end of the flues. When the length of the swaged ends of large superheater flues is 16", the safe ends must be applied to the smoke box end of the flues.

3. **Ferrules:** Ferrules for boiler flues, including those for superheater flues, must be made of soft copper, which is .075 inch thick. The length of the ferrules must be $\frac{1}{32}$ inch greater than the thickness of the flue sheeet. The outside diameter of the ferrules must conform to dimensions shown on standard tracings. Where the outside diameter is not shown on any tracing, it should be made the same as the outside diameter of the flue.

4. **Preparation of Fire Box Sheets:** The diameter of holes in fire box sheets for flues and arch pipes must conform to dimensions shown on standard tracings. Where tracings do not show dimensions, the diameter of the holes must be the same as the outside diameter of the flues and arch pipes.

All holes in fire box sheets for flues and arch pipes must have the inside and outside edges rounded to $\frac{1}{16}$" radius as indicated by Sketch "A".

SKETCH "A"

4. **Reaming of Flue Sheets:** When a flue hole in a fire box sheet becomes 1/8 inch out of round, it must be reamed.

6. **Preparation of Smoke Box Tube Sheets:** Unless otherwise shown on standard tracings, the diameter of the holes in the smoke box flue sheet must be 1/16 inch larger than the flues whose diameter is 2½ inches or less, and 3/32 inch larger than the flues whose diameter is 2¼ inches or more.

All holes must be cleaned and sharp edges removed. In superheater locomotives, the outside edges of the two rows of flue holes just below the lower row of large superheater flues and the outside edges of all flue holes above these two rows, must be rounded to 1/16" radius as shown in Sketch "A", since all these flues must be beaded at the smoke box end.

7. **Preparation of Fire Box End of Flues:** Fire box end of flues must be swaged down with a slight taper toward the end of the flue so that the diameter at the end will be .150 inch less than the diameter of the flue hole in order to permit the end of the flue to fit the ferrule neatly after the ferrule has been tightened in the flue hole.

The swaged ends of all flues, except the large superheater flues, must be at least 1⅛ inches long as shown in Figure 3. The swaged ends of large superheater flues must be at least 2 inches but not more than 16 inches in length as shown in Figure 10. The fin which is formed on safe ends when they are cut, must be rolled flat when the safe ends are used at the fire box end of the flues.

8. **Preparation of Smoke Box End of Flues:** Flues should be cut to length and the smoke box end opened hot to such a size that when placed in boilers they will drive snug in front flue sheet. This should not be done to flues which are to be transferred in the boiler.

9. **Tools for Working Flues:** All tools for working flues or arch tubes in locomotive boilers must be in accordance with standard tracings and the tool numbers stamped on each tool with ¼ inch figures. In addition, tools Nos. 4 and 8 must be stamped to show the thickness of the flue sheet with which they are to be used. All tools No. 5 must be maintained within limits of standard gauges, and tools Nos. 4 and 8 must be taken out of service when worn or distorted to such an extent that the tool will not force the flue sqaurely agains the sheet.

APPLICATION OF FLUES IN SATURATED STEAM LOCOMOTIVES AND THE SMALL BOILER FLUES IN SUPERHEATER LOCOMOTIVES

10. **Operation No. 1:** Ferrules must be placed in flue holes in fire box flue sheet as shown in Fig. 1, and rolled tight with tool No. 1, or expanded with tool No. 2.

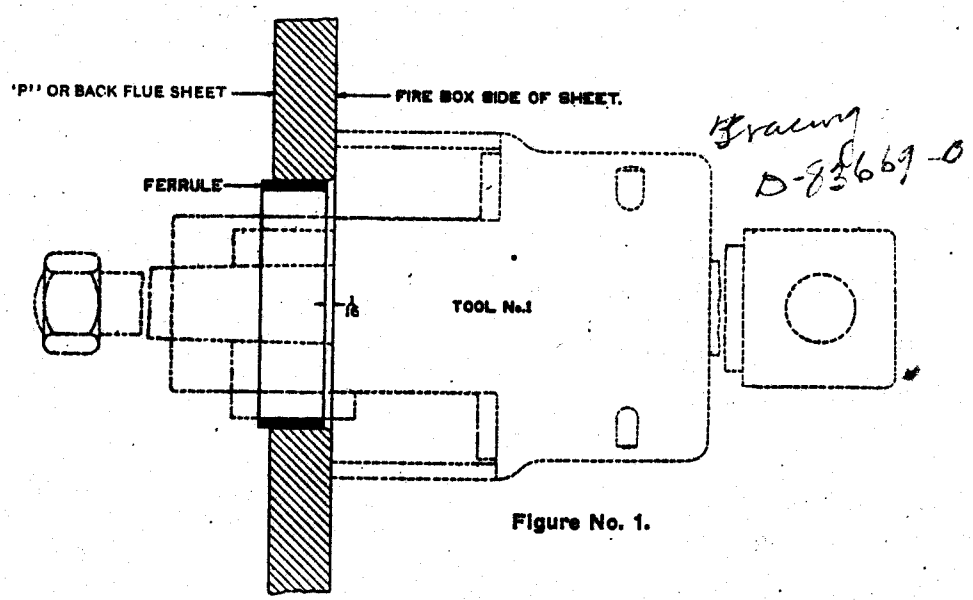


Figure No. 1.

11. **Operation No. 2:** Smoke box end of flues, as shown in Fig. 2, must be tightened with tool No. 2.

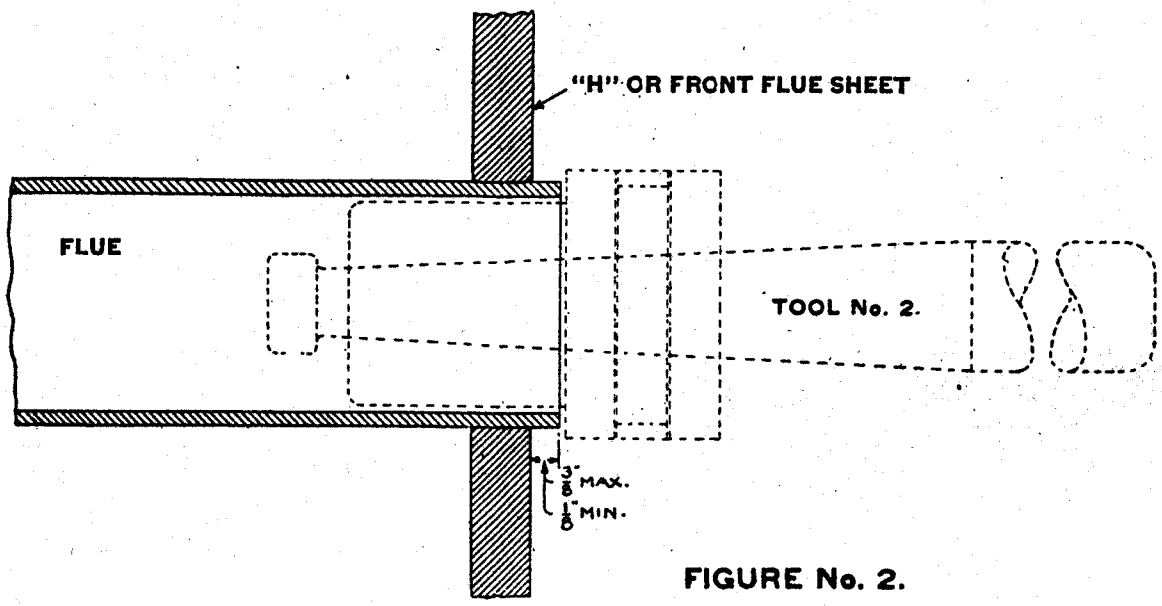


FIGURE No. 2.

12. **Operation No. 3:** Flues must be placed in flue holes in fire box sheet neatly fitted, as shown in Fig. 3, and tightened with tool No. 2.

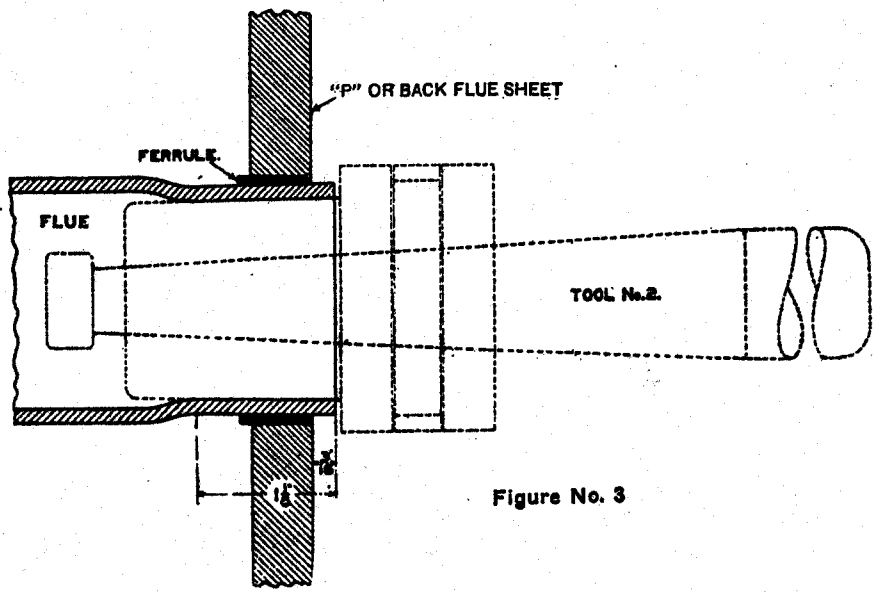


Figure No. 3

13. **Operation No. 4:** The fire box end of flues, as shown in Fig. 4, and the smoke box end of the two rows of flues just below the lower range of large superheater flues, and all flues above these two rows in superheater locomotives must be opened with tool No. 3, using either a pneumatic or hand hammer.

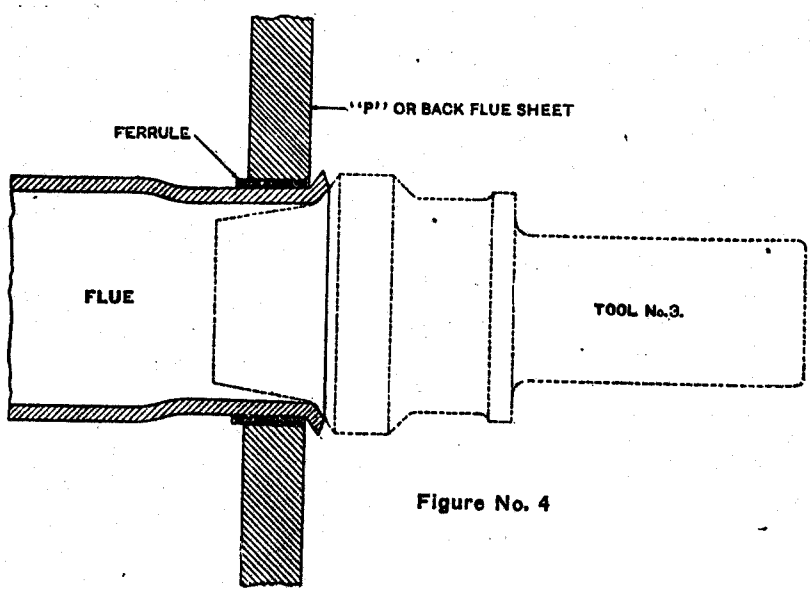


Figure No. 4

14. **Operation No. 5:** The fire box end of flues, as shown in Fig. 5, must be expanded with tool No. 4. This operation should be done on flues along the lines "E—F" —and "G—H" respectively, as shown in sketch "B," and then sections "A," "B," "C" and "D" should be worked by performing this operation in each section, commencing at the outer edge of the sheet and working the flues in these sections in circumferential rows toward the center.

In superheater locomotives the smoke box end of the two rows of flues just below the lower row of large superheater tubes, and all flues above these two rows, must also be expanded with tool No. 4.

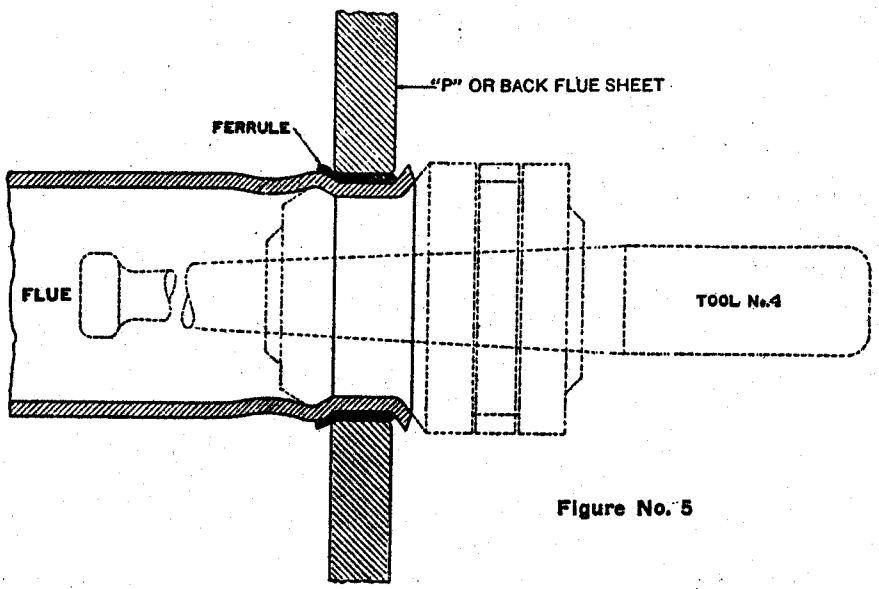
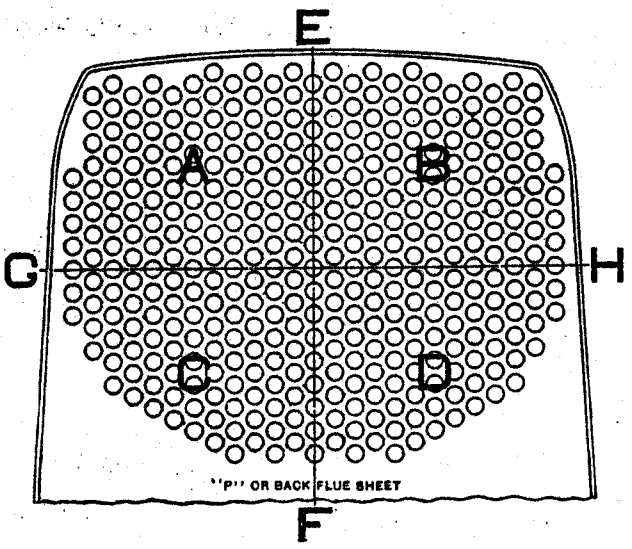


Figure No. 5



SKETCH "B"

15. **Examination for Defective Flues:** After operation No. 5 has been completed, the flues should be examined by an Inspector and all flues with longitudinal cracks or defects of any kind should be cut out and replaced with sound ones before starting the next operation.

16. **Operation No. 6:** When the smoke box end of flues have not been opened before placing in the boiler ,they may be opened with tool No. 3, as shown in Fig. 6. If they are flues which must be beaded then tool No. 3 must be used.

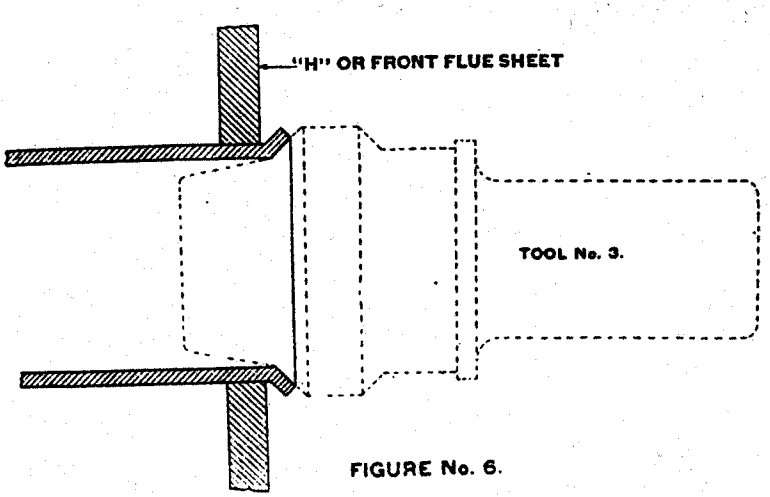


FIGURE No. 6.

17. **Operation No. 7:** The smoke box end of flues, as shown in Fig. 7, must be rolled with tool No. 1.

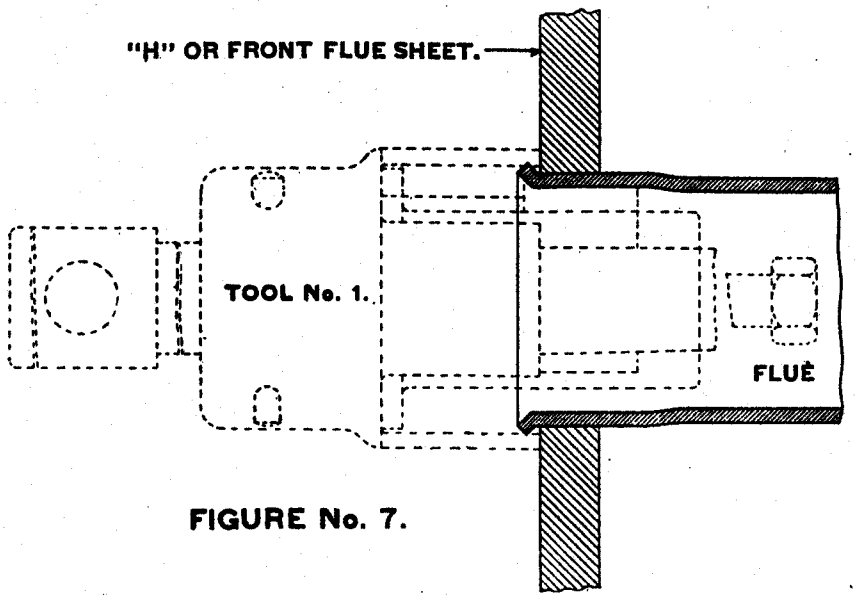


FIGURE No. 7.

18. After the above operation is completed the boiler should be filled with water and all leaks taken up before the next operation is commenced.

19. **Operation No. 8:** The fire box end of flues, as shown in Fig. 8, must be beaded with tool No. 5, using either a pneumatic or hand hammer. In superheater locomotives the smoke box end of the two rows of flues just below the lower row of large superheater flues, and all flues above these two rows must also be beaded in like manner.

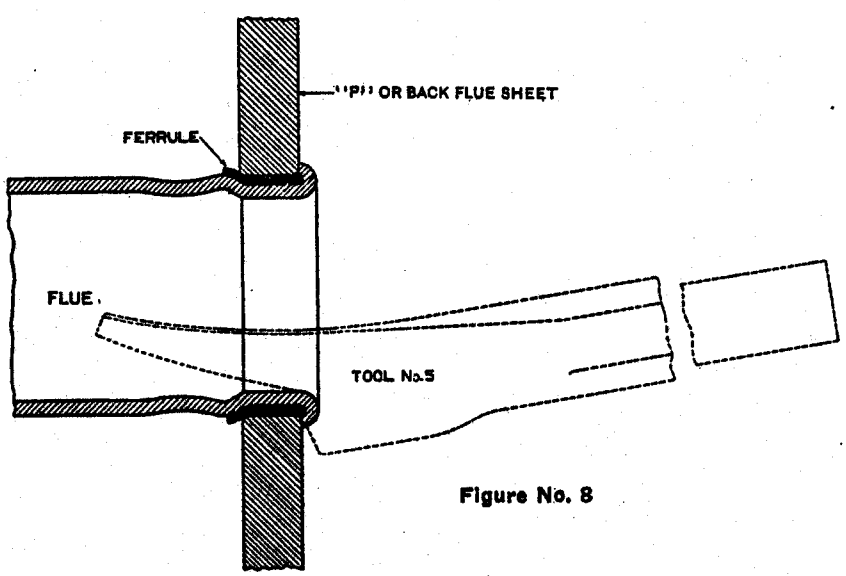


Figure No. 8

Note: After this operation fire box ends of flues may be slightly rolled with tool No. 1, if necessary.

20. **Operation No. 1:** Ferrules must be placed in the flue holes in the fire box tube sheet, as shown in Fig. 9, and rolled tight with superheater tool No. 1, or expanded with superheater tool No. 4.

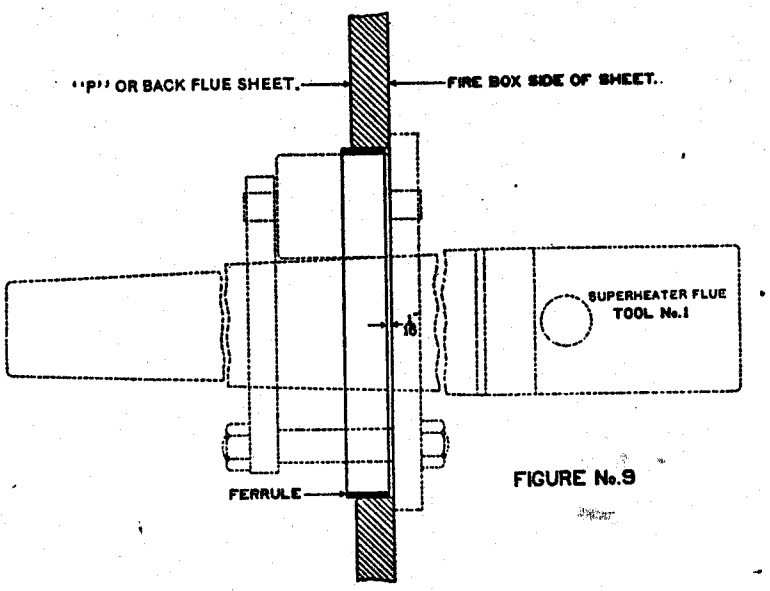


FIGURE No.9

21. **Operation No. 2:** Flues must be placed in flue holes in fire box flue sheet neatly fitted, as shown in Fig. 10, and tightened with superheater tool No. 1.

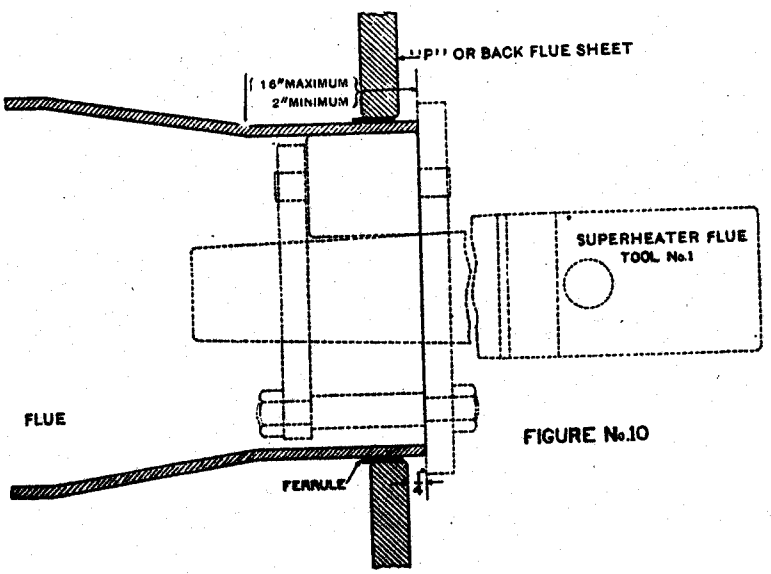


FIGURE No.10

22. **Operation No. 3:** The smoke box end of flues, as shown in Fig. 11, must be rolled with superheater tool No. 1.

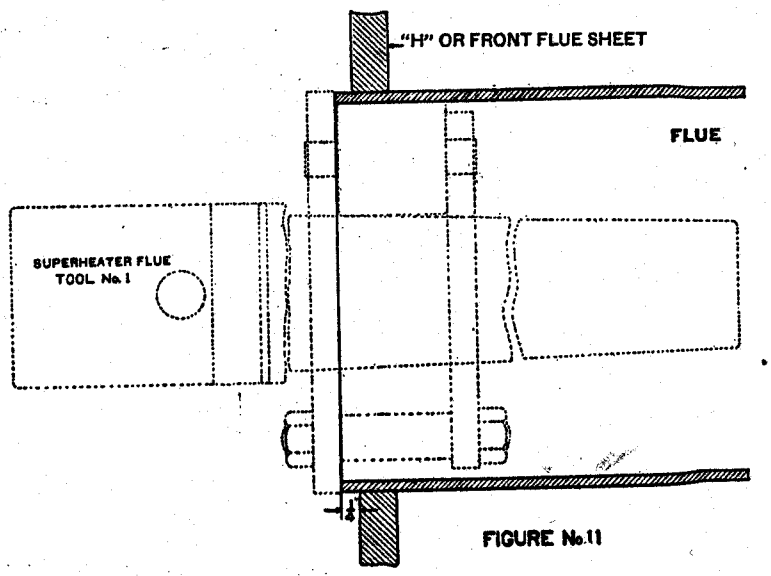


FIGURE No.11

23. **Operation No. 4:** Both the fire box and smoke box ends of flues must be flared for beading with a heavy hammer, as shown on tracing, and the fire box end then expanded, as shown in Fig. 12, with superheater tool No. 4.

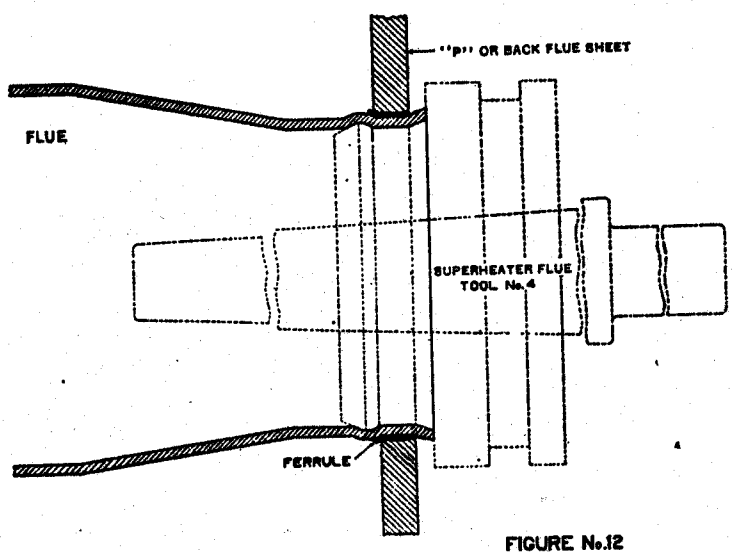


FIGURE No.12

24. After the above operation is completed the boiler should be filled with water and all leaks taken up before the next operation is commenced.

25. **Operation No. 5:** Both fire box and smoke box ends of flues must be beaded with superheater tool No. 5, using either a pneumatic or hand hammer. Fig. 13 shows the fire box end of a flue after the beading operation is complete.

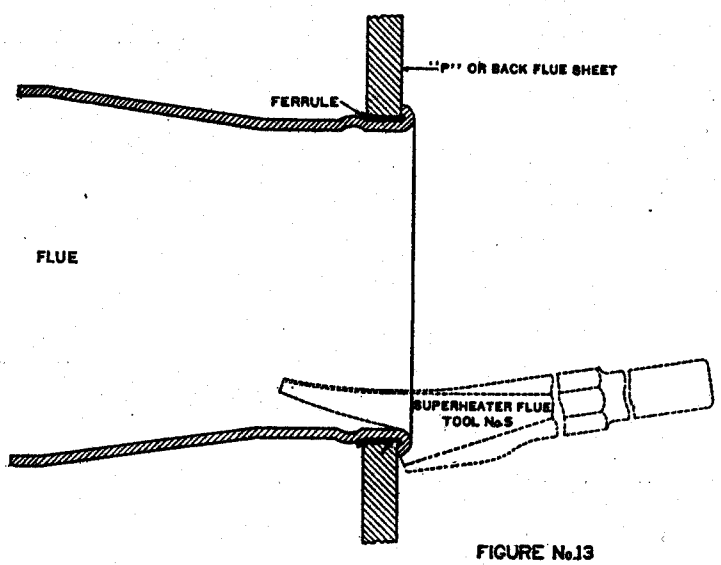


FIGURE No.13

APPLICATION OF ARCH PIPES

26. **Operation No. 1:** Arch pipes must be placed in position, neatly fitted in the fire box sheet, as shown in Fig. 14, and tightened at both ends with arch pipe tool No. 2.

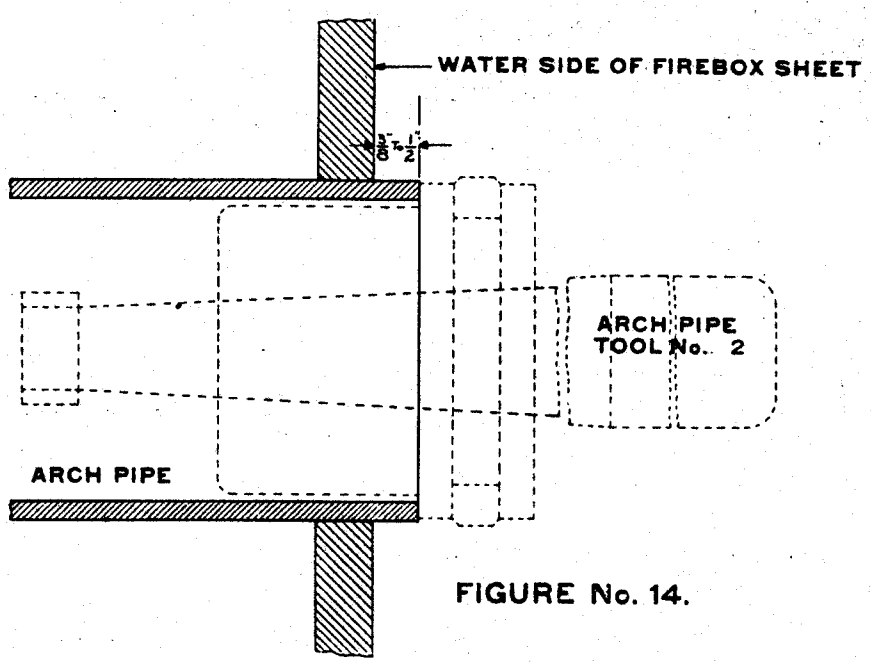


FIGURE No. 14.

27. **Operation No. 2:** Arch pipe must be opened at both ends, as shown in Fig. 15, with arch pipe tool No. 3, using either a pneumatic or hand hammer.

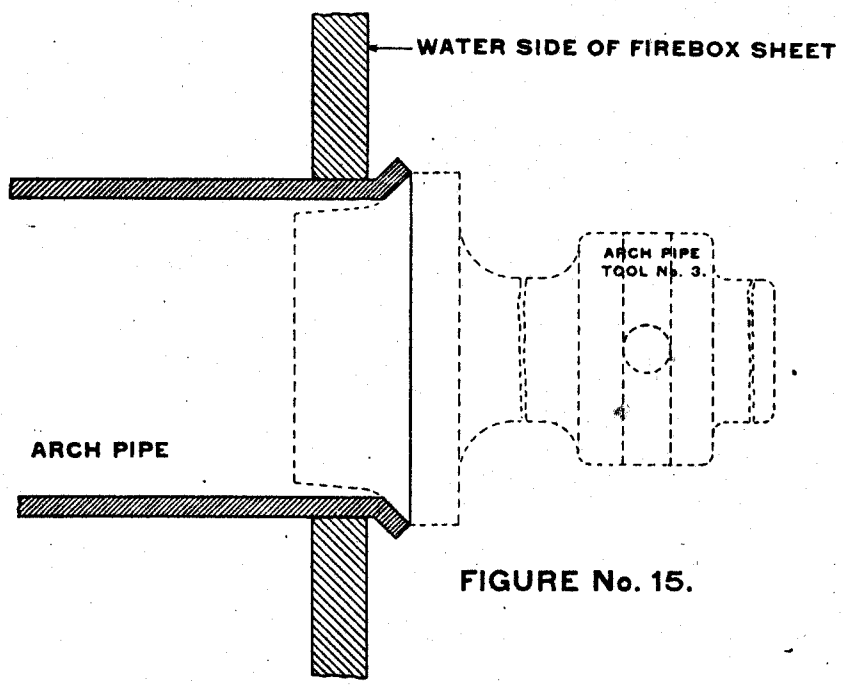


FIGURE No. 15.

28. **Operation No. 3:** Arch pipes must be rolled at both ends with arch pipe tool No. 1, as shown in Fig. 16.

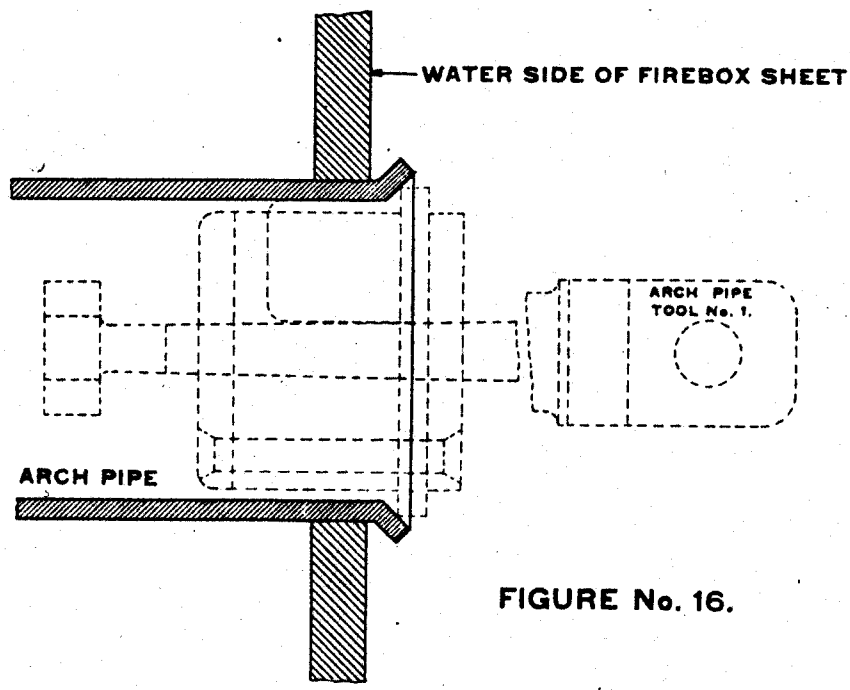


FIGURE No. 16.

INSTRUCTIONS FOR WELDING FLUES TO FLUE SHEET

29. Flues that have been in service more than six months should not be welded until safe ends have been applied. The electrical process only must be used in welding flues to flue sheet. In locomotive type boilers, only the fire box end of flues must be welded to flue sheet. In vertical flue boilers both ends of flues must be welded to flue sheets, but copper ferrules should be applied to the fire box flue sheet only.

a. Old flues should be reset with tool No. 8 and beaded with tool No. 5, and the sheet and beads of flues should be thoroughly cleaned by sand blast before welding. When an old flue has to be re-

Paragraph 29-C

When full or partial sets of flues are applied at class repair or annual test periods, all flues must be made tight under the hydrostatic test of 25% above working pressure before they are beaded and welded. When any flues are applied in the enginehouses at other than class repair or annual test periods, the flues must be made tight under a water pressure test equal to the working pressure before they are beaded and welded. While welding is being done the boiler must be filled with warm water to a level above the flues. The welding should begin with the top row and progress downward, all superheater flues being welded first, and each flue must be welded as per standard tracing supplement to Circular L-30.

removed with a wire brush before starting to weld one of the adjacent beads.

e. While welding, the work should be watched very carefully by the operator, so that, if there is any indication of improper fusing of the metal, it can be cut off immediately and re-welded.

Paragraph 29-G

The welding must be tested with a water pressure of 100 pounds and if there is any leakage, the weld must be cut off and the flue re-set and re-welded.

MAINTENANCE OF UNWELDED FLUES AT ENGINE HOUSE

30. **Slightly Leaking Flues:** Flues which are slightly leaking at the fire box end of locomotive boilers in service, must be tightened with tool No. 8, Figure No. 17, if necessary, after which the beads must be re-set with tool No. 5.

Flues which are slightly leaking at smoke box end must be tightened with tool No. 1.

31. **Resetting Flues in Fire Box:** When a locomotive arrives at an engine house with flues leaking so badly at the fire box end that it must be taken out of service, the boiler must be drained, after which the fire box end of flues must be re-set with tool No. 8, and the beads then re-set with tool No. 5.

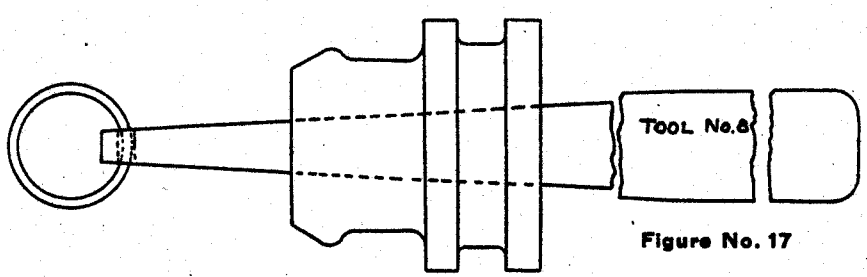


Figure No. 17

MAINTENANCE OF ELECTRICALLY WELDED FLUES AT ENGINE HOUSE

32. When electrically welded flues develop any leaks while the locomotive is in service, a careful examination should be made and, where leakage is taking place at pin holes, the same may be closed with a tee or angle fuller, tapping the fuller lightly with a hand hammer. Leaks of this nature must not be caulked nor repaired by any other means.

Where the flues leak at the sheet or under the weld, they should be rewelded in accordance with paragraph 29a. If facilities for welding are not at hand, the flues may be temporarily tightened with tool No. 2 only, but the defective flues must be rewelded at the first opportunity.

PREVENTION OF LEAKING FLUES

33. In order to reduce flue leakage to a minimum, the following practices must be followed:

a. **Use of Blower When Cleaning Fires:** When a fire is being cleaned or drawn, the blower should be used only sufficiently to prevent smoke escaping from the fire door.

b. **Banking of Fires:** After a fire has been cleaned, the clean fire should be placed at the front end of the grates, if gas coal is used, and distributed evenly over the grates, if low volatile coal is used.

c. **Use of Injectors in Engine Houses and Yards:** Unless absolutely necessary, injectors should not be used ,while a fire is being cleaned, neither when there is no fire in the fire box, nor while the locomotive is being moved under its own steam in the engine storage yards or in engine house territory without first brightening up the fire.

J. T. WALLIS,
Chief of Motive Power.