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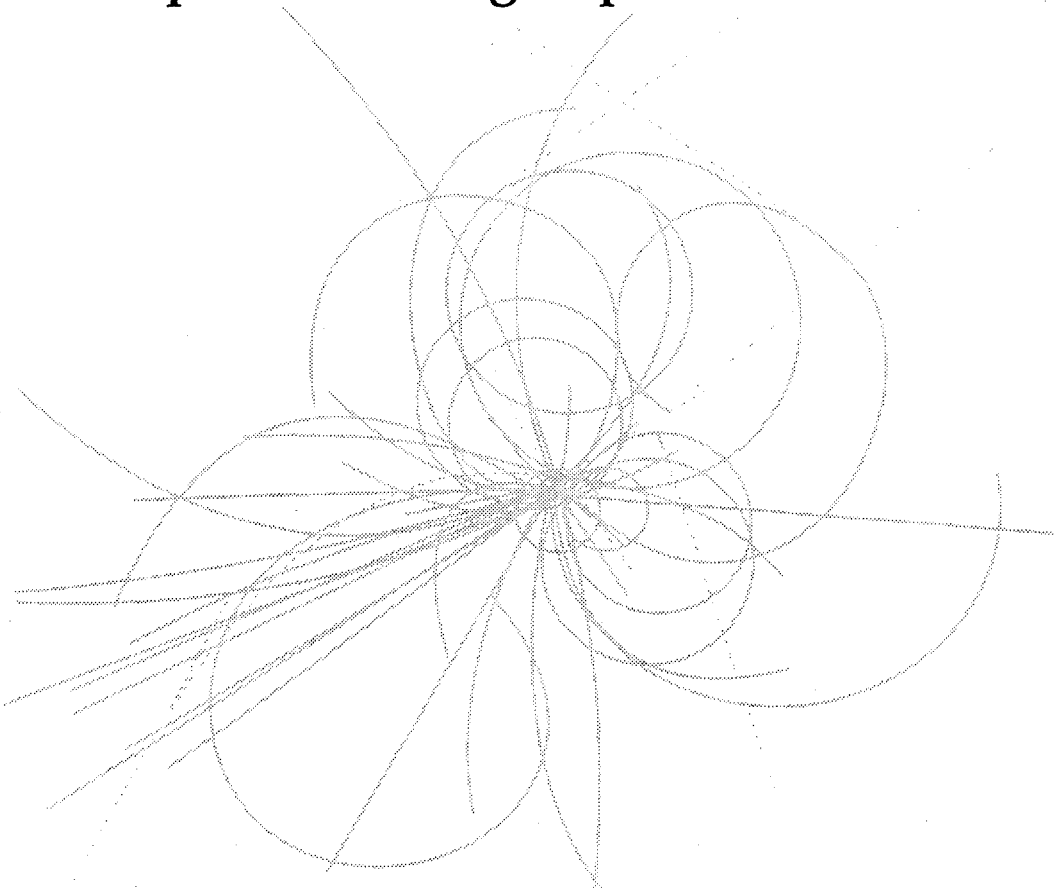

ASST Interconnect Region Single Phase Pressure Tests

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Abstract

The Accelerator System String Test (ASST) single phase line was pressure tested to meet ASME B31.3-1990 piping code requirements. Two test specimens, one without a bellows assembly and one with a bellows assembly, were tested under hydrostatic pressure in 0.689 MPa (100 psi) increments. All parts met code requirements except the bellows squirm protector, which met ASST-rated pressure levels but not Collider-rated levels, due to inadequate tab weld quality. Extra support such as hose clamps and possible minor redesign would allow the squirm protector to meet ASME code requirements for the Collider.

CONTENTS

FIGURES

1.0 INTRODUCTION

The Interconnect Region single phase line serves as the means for refrigeration of the cold mass, and is normally subject to an internal pressure of 405 300 Pa (60 psi). However, during quenches, this system may undergo a Collider-rated maximum operating pressure of 2.067 MPa (300 psi), or an ASST-rated maximum operating pressure of 1.592 MPa (231 psi). The purpose of these tests is to meet ASME piping code requirements for all parts of the single phase line. In particular, the weld between the single phase flange and sleeve is not a standard ASME weld joint type. Therefore, it is necessary to show that this weld can withstand the desired loading conditions including an appropriate factor of safety. Additionally, a squirm pressure factor of safety of 2.25 and a burst pressure factor of safety of 3 must be included for the bellows assembly and squirm protector (ASME B31.3-1990 Piping Code, pg. 292, para. X3.1-1).

2.0 TEST SETUP

Two test configurations were developed to represent the ASST single phase line. The first configuration included the single phase sleeve (M30-000513A) with a flange welded at each end (M30-000499C), sealed with 25-mm-thick, 125-mm-diameter endcaps, and held together by four evenly-spaced threaded rods (see Figure 1). The second configuration included the sleeve, flange, bellows assembly (M30-000501B), and bellows squirm protector (M30-000830B), similarly capped and held together by threaded rods (see Figure 2).

The test concerns included the following: (1) The weld between the flange and sleeve, which is applied by an automatic welding tool programmed for a depth of penetration of 1.5 mm, (2) bellows actions, including squirm activity and ultimate burst pressure, and (3) the squirm protector tab welds. The first test specimen was used to analyze the flange/sleeve weld in particular, while the second specimen duplicated the actual ASST setup, and was used to analyze all the parts.

The test specimens were hydrostatically tested using water and hydraulic fluid by applying 0.689 MPa (100 psi) pressure increments with a manual pump, including a hold time of 30 seconds per increment (see Figure 3). In the first test configuration, the threaded rod nuts were tightened using a torque wrench to 11.3 N-m (100 in-lb). The specimen was filled with water and installed in the pressure chamber. In the second specimen, the bellows was first extended by 25 mm (1 in.) to simulate the loading conditions at cryogenic temperatures before the nuts were tightened by 11.3 N-m (100 in-lb). Then the specimen was filled with water and installed.

3.0 TEST RESULTS

3.1 Test 1 (Assembly without Bellows)

The first test was concluded with no leak at 26.2 MPa (3800 psi). This corresponds to a factor of safety of 12.6 for the Collider and 16.4 for the ASST. Considerable yielding of the flanges and flange/sleeve weld occurred. The flange outer diameter, initially 57 mm, permanently deformed by 9 mm to a 66 mm diameter. The flange sheared away from the sleeve at the weld region by 0.5 to 1.5 mm (see Figure 4).

3.2 Test 2 (Assembly with Bellows)

In the second test, a squirm protector weld near the bellows fractured at 5.93 MPa (860 psi), at which time the pressurization was lost when the bellows volume increased. Repressurization of the same specimen led to a second tab weld failure near the bellows at 3.86 MPa (560 psi) (see Figures 5 and 6). The pressure at which the initial weld fracture occurred corresponds to a Collider factor of safety of 2.86, short of the required factor 3. However, the ASST factor of safety at this point was 3.72.

Although the squirm protector had failed twice, there was no leak in the flange, sleeve, or bellows, although the bellows had buckled into its first mode shape. Therefore, the squirm protector was repaired by installing several hose clamps to keep it in place, and a retest was done. Upon retest, the bellows ruptured while in its

third buckling mode at a pressure of 11.02 MPa (1600 psi), providing a Collider factor of safety of 5.3 and an ASST factor of 6.9. The repaired squirm protector had no difficulties, and flange/sleeve weld showed no signs of large shear deformation as it had in the first test (see Figures 7 and 8).

4.0 CONCLUSION AND RECOMMENDATIONS

The results of these pressure tests show that the flange/sleeve weld meets all pressure requirements. Similarly, the bellows meets squirm pressure requirements for ASST and Collider. While the bellows does meet ASST burst pressure requirements, the squirm protector will need extra support for Collider-rated pressures. The squirm protectors presently installed in the ASST have inadequate tab weld quality, and additional support such as hose clamps should be installed if the ASST pressure rating is increased to Collider levels. Minor redesign of the squirm protector for future use in the Collider would insure ease of manufacturing and ability to meet ASME code requirements. Improvements to the squirm protector design could include lengthening of the tabs for additional weld space, increasing the number of tabs and bolts, and checking depth of weld penetration.

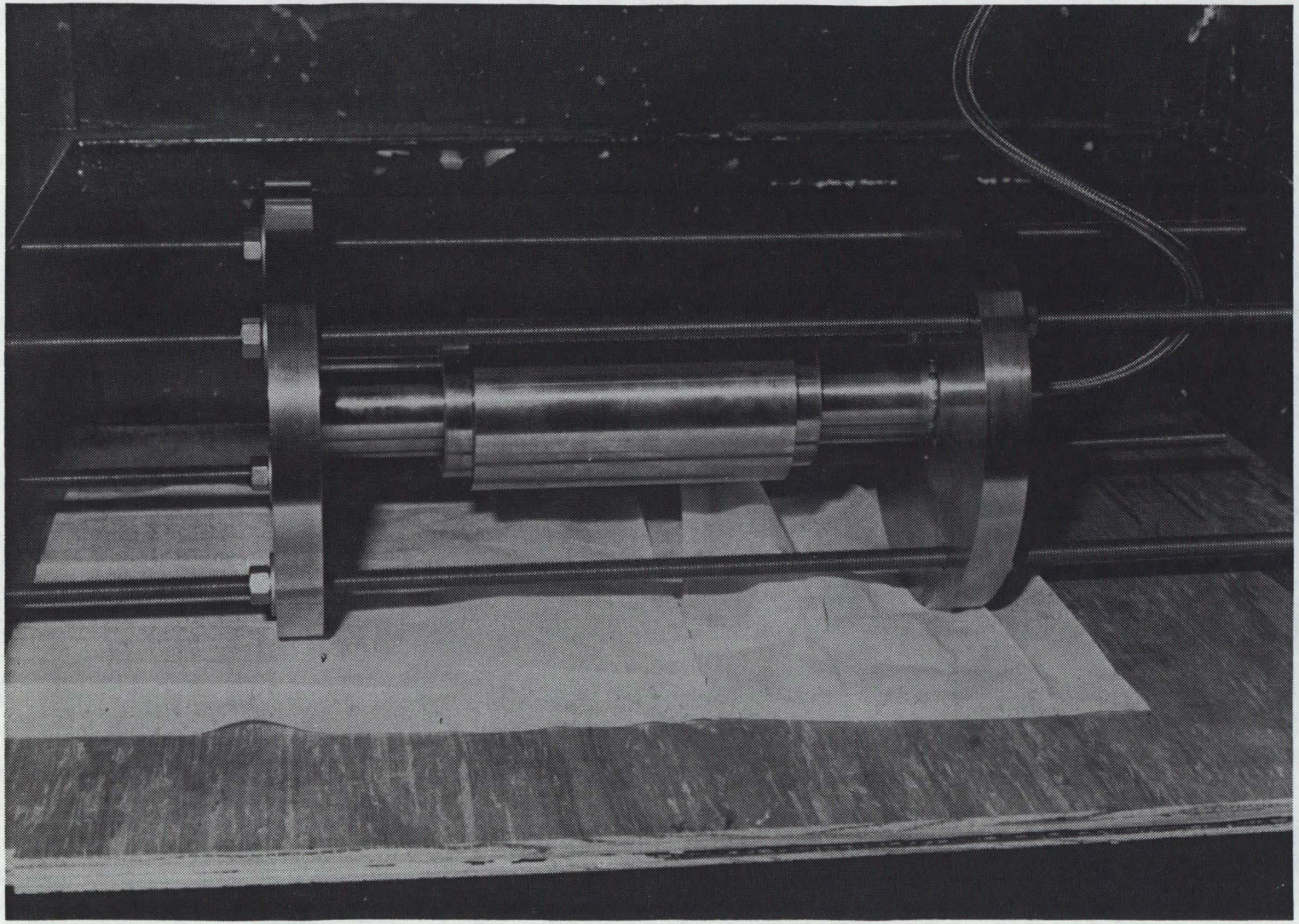

Figure 1. Test 1—Assembly without Bellows.

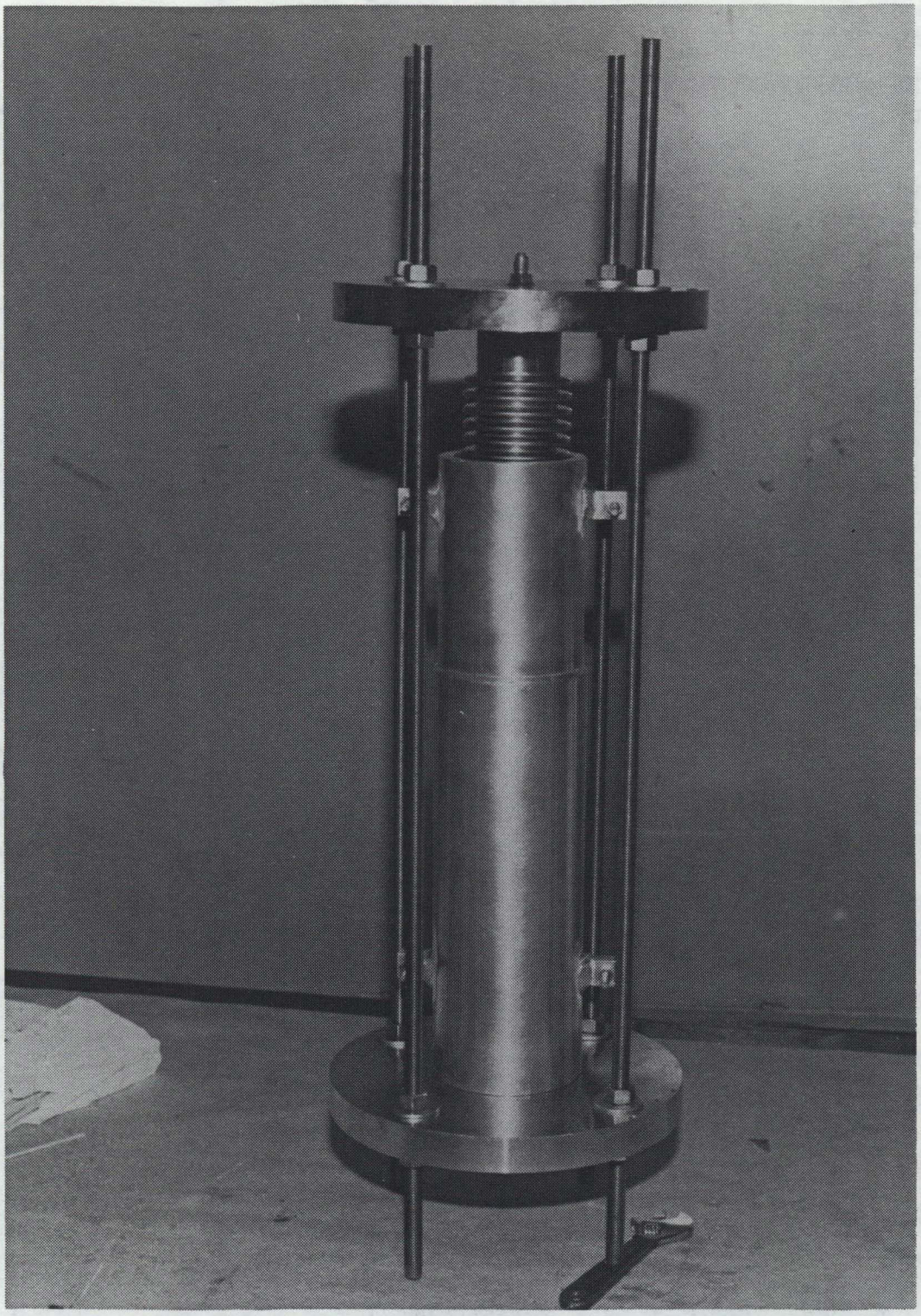

Figure 2. Test 2—Assembly with Bellows.

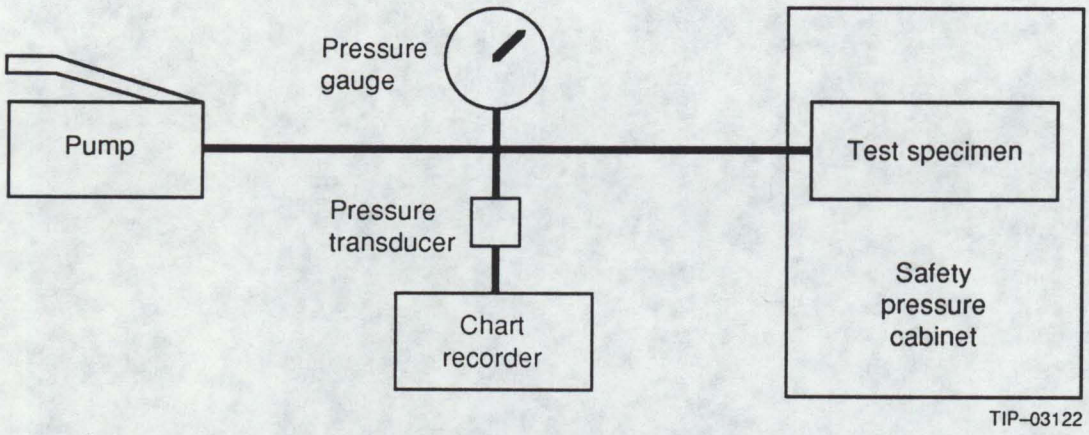

Figure 3. Test Setup.

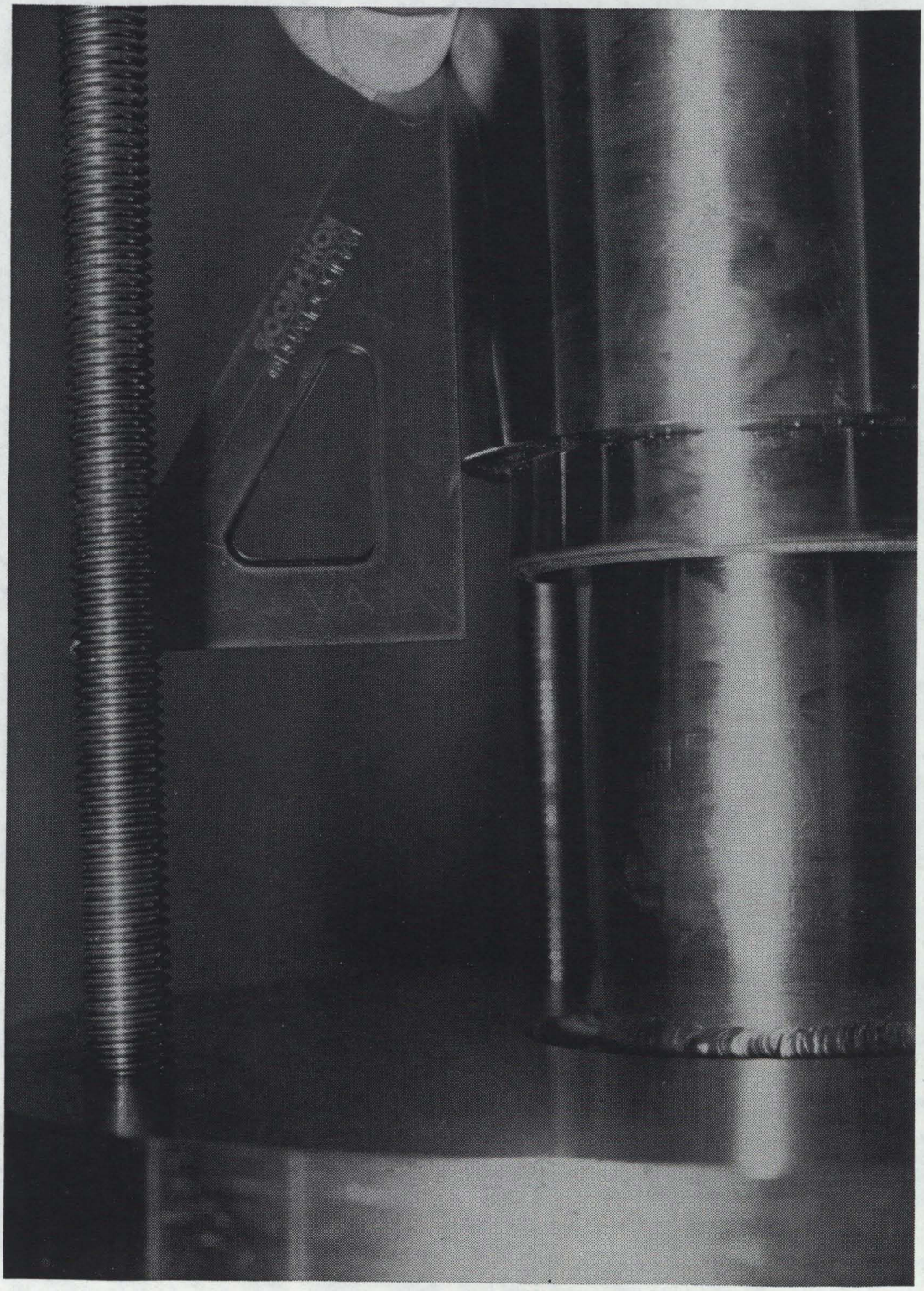

Figure 4. Deformed Flange and Weld.

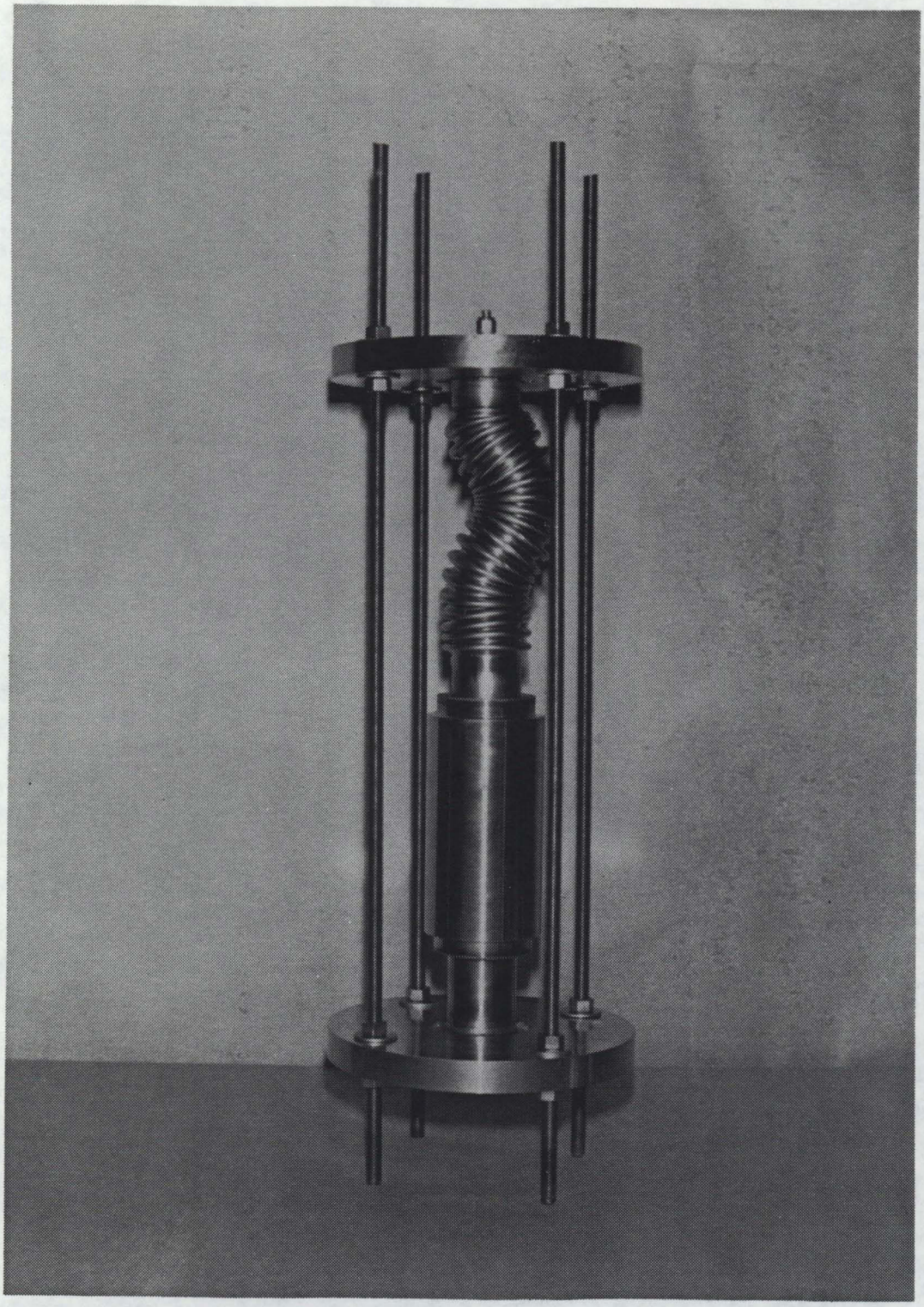

Figure 5. Bellows Deflection.

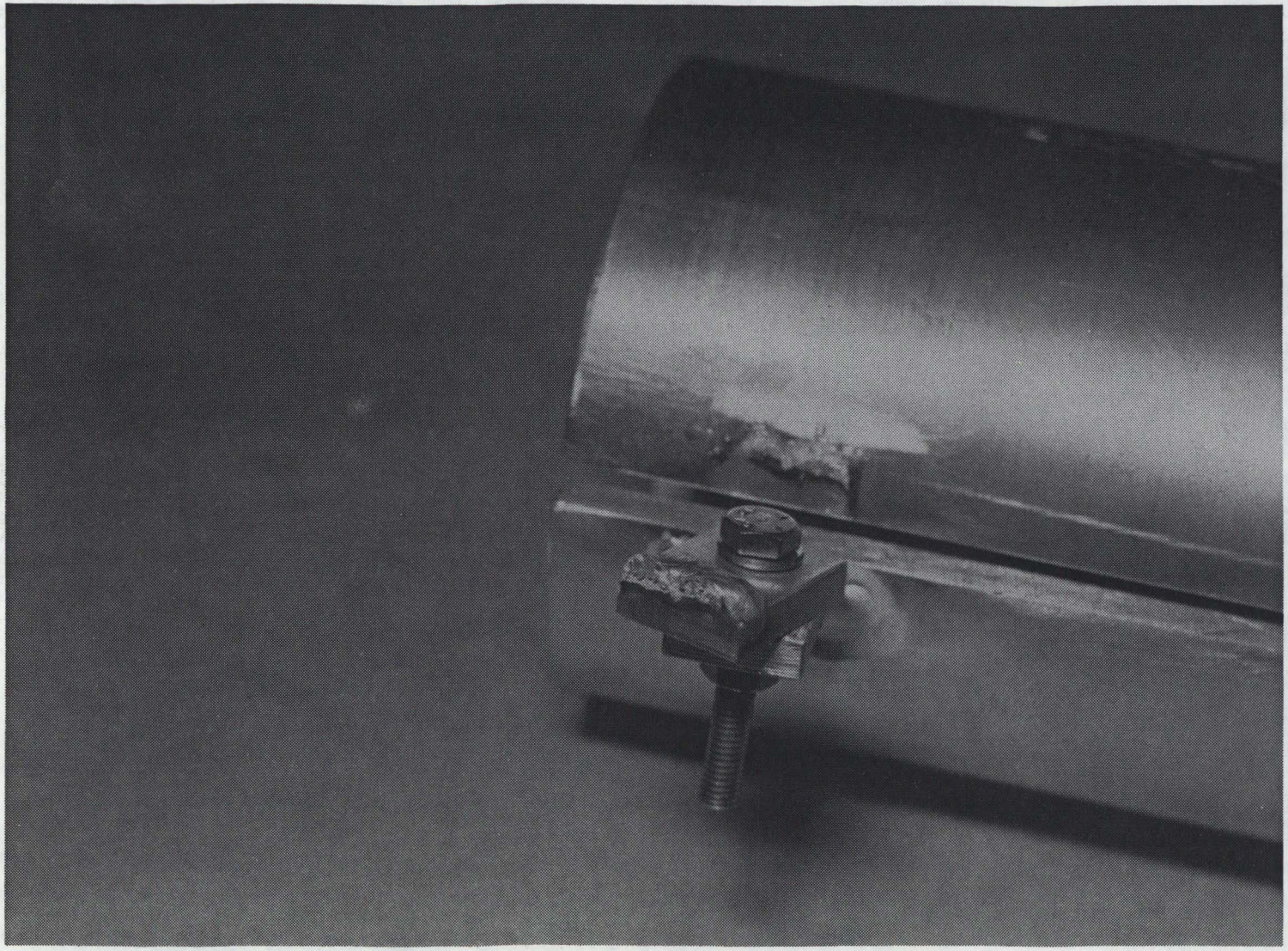

Figure 6. Tab Weld Failure.

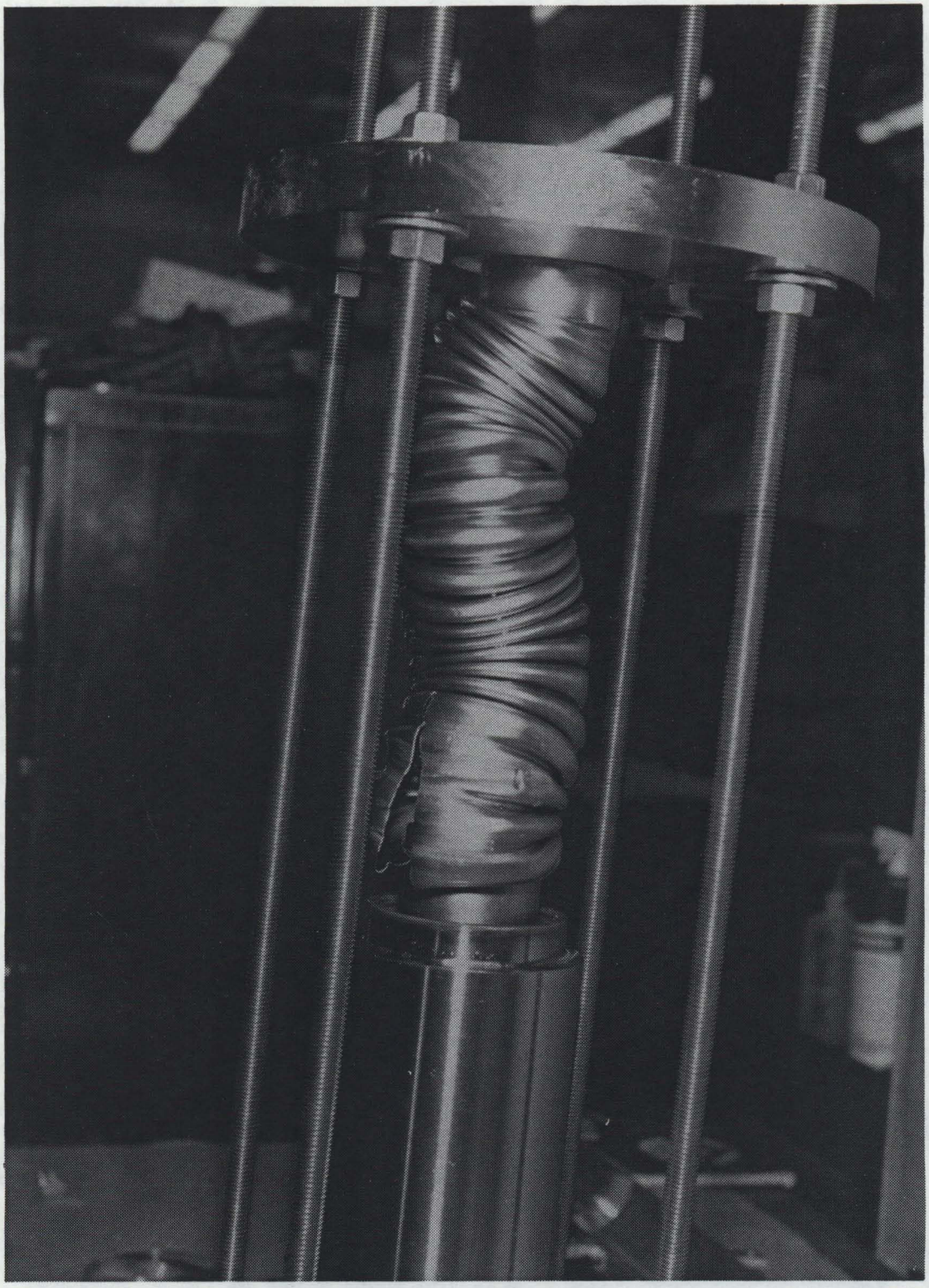

Figure 7. Bellows Burst Failure.

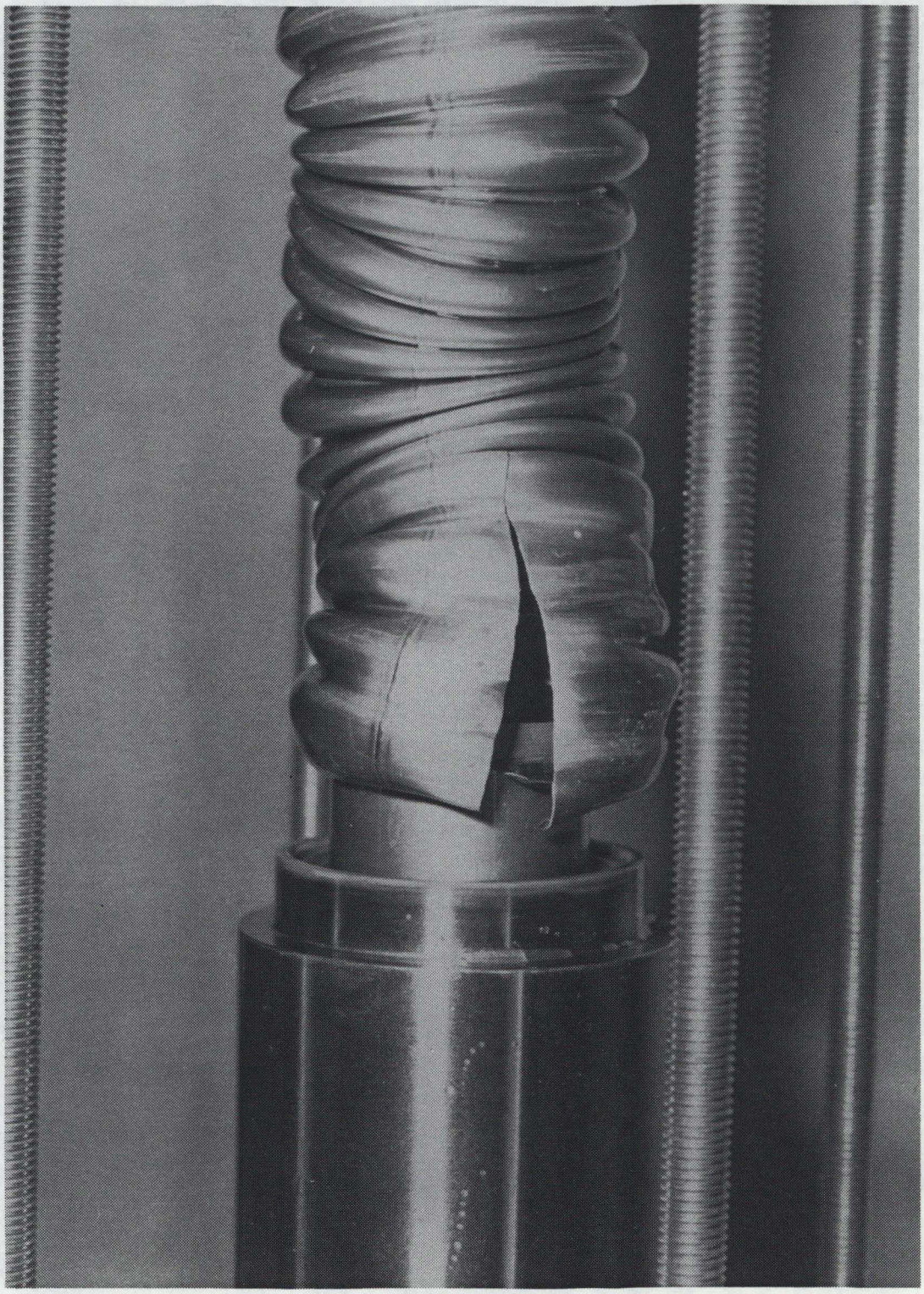

Figure 8. Bellows Burst Failure Closeup.