CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 59-66

EXAMINATION OF CURB STOP VALVE

by

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PHYSICAL METALLURGY DIVISION

Copy No. 11

JULY 16, 1959

Industrial Confidential

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SUMMARY

A curb stop water line valve which had failed in service was examined. Because of limited background information the cause of failure could not be conclusively established.

From the examination made, it is suggested that the failure was most likely related to use of a part of incorrect design combined with the presence of a localized casting defect in the valve body wall.

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CONTENTS

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(10 pages, 4 illus.)

INTRODUCTION

In a letter dated April 15th, 1959 (115-3-20-4-3), Mr. D. F. Marsland, Assistant Supervisor, Building Materials Department, Central Mortgage and Housing Corporation, Ottawa, requested assistance in determining the cause of failure of a curb stop water line valve. The valve had been buried in sandy soil in close proximity to an underground electrical distribution system and had been in service for approximately one year. The valve body and valve plug were both copper alloy castings.

Following a preliminary examination, further information was requested on the valve design and the actual service conditions to which it had been subjected. On June 25th, 1959, Mr. Marsland reported that his efforts in this direction had been unsuccessful.

VISUAL EXAMINATION

The large hole which had been worn through one side of the valve body and the pronounced directional wear of the outer surface is shown in Figure 1. The wear pattern points towards the outlet end of the valve. A characteristic feature of this and other severely worn internal areas was the polished surface which had been produced.

The sectioned valve body, with the inlet end uppermost, is shown in Figure 2. In addition to penetration of the wall, principal internal wear was confined to the highlighted area indicated by the arrow and to the oval-shaped markings on the side walls. The latter mated with the main passage of the valve plug when this was in the fully closed position. While the wear at different points in these oval areas was non-uniform the maximum depth of penetration was relatively small. This suggests that penetration of the valve body wall must have occurred at a fairly early stage in the process.

A photograph of the valve plug showing the large hole worn on the inlet-port side is shown in Figure 3. The degree of enlargement of the small pressure relief hole, which was presumably present originally, is clearly evident by comparison with the unaffected hole in the opposite side of the valve stem. Pronounced but variable wear was apparent on the internal walls of the plug orifice, and as mentioned above, all areas so affected showed a relatively smooth polish.

From external examination, both castings appeared to be of good quality with no significant surface defects. Some small isolated blow holes were observed but these are not uncommon in commercial castings of this type.

RADIOGRAPHIC EXAMINATION

Radiographic examination of the sectioned valve body revealed some isolated inclusions and fine pinhole porosity scattered throughout the walls. Somewhat heavier porosity was localized in the thicker walls at the threaded inlet end.

Radiographic examination of the valve plug was confined to the thinned walls adjacent to the main flow channel. No defects were found.

MICROSCOPIC EXAMINATION

The microstructures of polished and etched samples cut from the valve body were typical of 85 : 5 : 5 : 5 gunmetal. The grain structure was equiaxed and alloy constituent distribution was normal.

The only defect of note was an aggregation of fine to coarse pinhole porosity as illustrated in Figure 4. While the metal at and near the surface was sound, the otherwise general distribution of porosity suggested that this condition was principally related to excessive gas content of the alloy while molten. Shrinkage contraction was probably a contributing factor as indicated by the increased porosity in the thicker walls at the inlet end of the valve.

Microscopic examination of samples from the eroded areas revealed uniform removal of metal with no evidence of preferential chemical or other attack of alloy constituents or of the solid solution matrix. At and near the surface in these affected areas characteristic strain lines, indicative of surface deformation such as might be caused by impingement attack, were observed. This evidence, however, was not conclusive since grains remote from the surface showed the same effect.

DISCUSSION

Because of the limited background information provided it was not possible to establish conclusively the cause of failure of the valve. However, from the examination made, it is suggested that a combination of two factors was probably responsible. These are discussed below.

The unusual penetration of the thick valve body over the short period of one year suggests that some localized casting defect such as a blow hole, large sand inclusion, interconnected porosity, cracks, etc., must have been present. No actual evidence for this was found due to the extensive metal removed.

In discussion with valve manufacturer's agents it was learned that water shut-off valves of this type do not normally have holes drilled through the plug. This practice was formerly used where such valves were installed in a hot water system having no thermostatic control. The holes provided a pressure release in the event of the system being heated when the water supply (and the valve) was shut off at the tank.

It is apparent from the wear pattern that penetration of the wall occurred with the plug in the fully closed position. From this it is interesting to speculate whether the valve was supposed to be turned off, or if the water supply was in fact delivered through the small holes in the barrel instead of through the main passage as intended. In either case, because of the open system provided by the holes, the most likely mechanism of failure appears to be as follows: seepage through a defect in the valve wall must have occurred at an early stage and a turbulent abrasive action with entrained sand was set up at the outside surface. This would account for the smoothly-polished wear pattern around the hole as shown in Figure 1. As the hole was enlarged from the outside, the turbulent conditions set up could have caused recirculation of some of the water-sand-eroded metal mixture back into the valve. This in turn would explain the variable wear inside the valve body chamber and the plug orifice. as well as the gross enlargement of the originally small drilled hole in the latter.

It is interesting to note that had the valve been open, the thick side walls of the plug would probably have covered the supposed defect in the body and the valve may have functioned perfectly in the open position. Similarly, pressure tests with the valve open would have revealed no defect unless the drilled holes had corresponded to the location of the defect.

To what extent other factors, such as electrochemical attack due to proximity of the valve to an underground electrical line, excessively high pressure in the system, chemical composition of the water, etc., contributed to the failure is not known.

CONCLUSIONS

It is suggested that the valve failure was most likely related to the use of a part of incorrect design combined with the presence of a localized casting defect in the region of failure.

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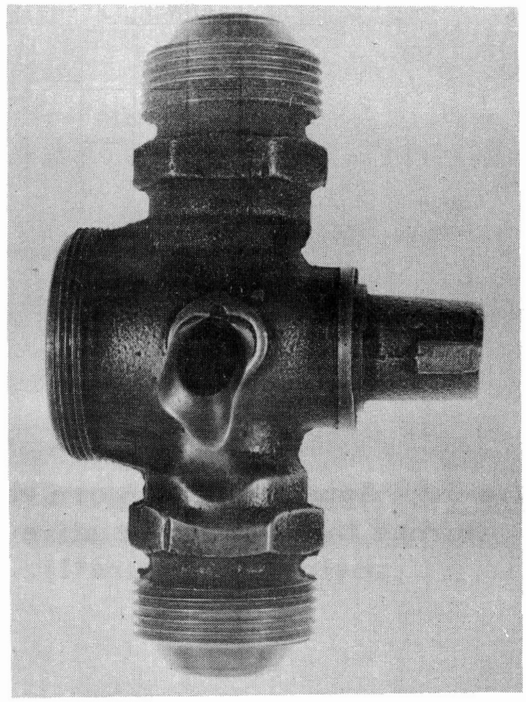

Figure 1. - External appearance of failed valve. Inlet end is uppermost.

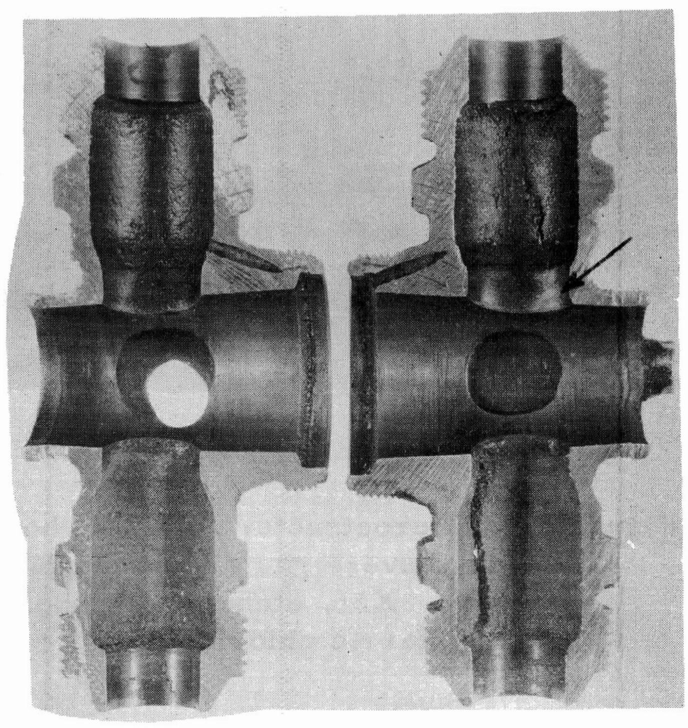

Figure 2. - Sectioned valve body showing internal wear.

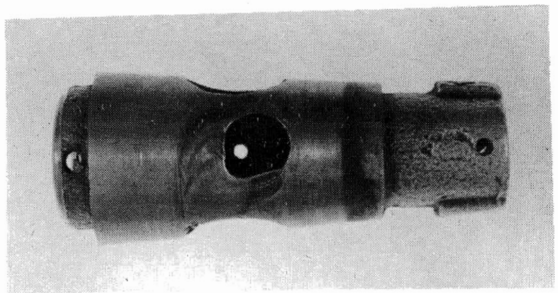

Figure 3. - Appearance of worn valve plug (turned through 90° relative to position in Figure 1).

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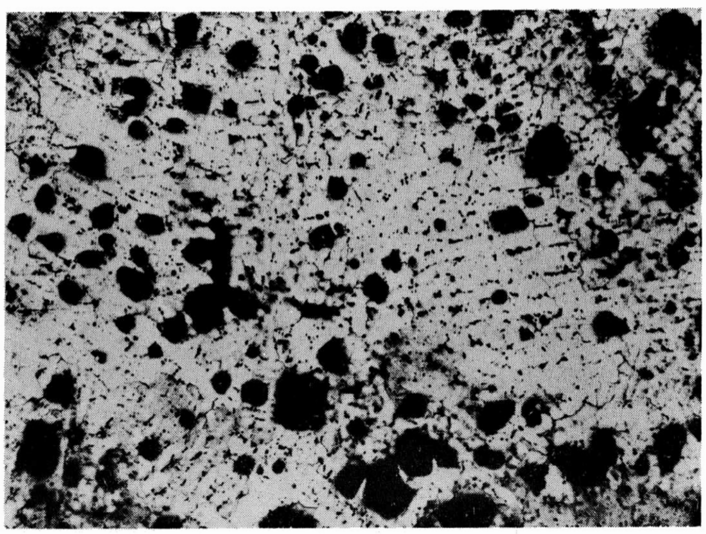

Figure 4. - Microstructure of valve body showing severe gas or shrinkage porosity. X.36, etched in alcoholic ferric chloride.

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