Organ Pipe Metallurgy

Featuring local organ builder Richard Bond Assisted by Lou Paff & Joe O’Donnell

Portland Section
ACS

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First Unitarian Church
Portland, OR

1873 Hutchings-Plaisted tracker action organ rebuilt & enlarged by Richard Bond at the First Unitarian Church, Portland, Or.

Photo: http://www.bondorgans.com/gallery_first_unitarian.html

Slide Presentation by Martha Dibblee
METALS used in casting organ pipes

Tin, Lead, Copper, Aluminum, Zinc

Chemical mixtures of Tin & Lead ("spotted metal", "pipe metal")

Brass for reed tongues; trace elements Antimony, Bismuth; Silver

Brass tongue of reed pipe

1Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy” (http://www.albany.edu/piporg-l/pipemet.html#introduction)
# PHYSICAL PROPERTIES OF METALS

used for casting organ-pipe metal

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Aluminum</th>
<th>Copper</th>
<th>Zinc</th>
<th>Silver</th>
<th>Tin</th>
<th>Antimony</th>
<th>Lead</th>
<th>Bismuth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al</td>
<td>Cu</td>
<td>Zn</td>
<td>Ag</td>
<td>Sn</td>
<td>Sb</td>
<td>Pb</td>
<td>Bi</td>
</tr>
<tr>
<td>Atomic number</td>
<td>13</td>
<td>29</td>
<td>30</td>
<td>47</td>
<td>50</td>
<td>51</td>
<td>82</td>
<td>83</td>
</tr>
<tr>
<td>Atomic weight</td>
<td>27.0</td>
<td>63.5</td>
<td>63.4</td>
<td>108</td>
<td>119</td>
<td>122</td>
<td>207</td>
<td>209</td>
</tr>
<tr>
<td>Sp. gr. (g/cm³)</td>
<td>2.70</td>
<td>8.69</td>
<td>7.04</td>
<td>10.46</td>
<td>7.36</td>
<td>6.70</td>
<td>11.35</td>
<td>9.79</td>
</tr>
<tr>
<td>Melting point °C</td>
<td>660.37</td>
<td>1083.0</td>
<td>419.6</td>
<td>961.9</td>
<td>232.0</td>
<td>630.7</td>
<td>327.5</td>
<td>271.3</td>
</tr>
<tr>
<td>Melting point °F</td>
<td>1220.7</td>
<td>1981</td>
<td>787</td>
<td>1761</td>
<td>449</td>
<td>1169</td>
<td>621</td>
<td>520</td>
</tr>
</tbody>
</table>

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**2**CRC Handbook of Chemistry and Physics 64th Edition 1984

**3**Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy”

([http://www.albany.edu/piporg-l/pipemet.html#introduction](http://www.albany.edu/piporg-l/pipemet.html#introduction))
“SPOTTED METAL” pipes

“Spotted Metal” is a chemical mixture of lead and tin. It is not an alloy.\(^4\)

Spots appear when tin:lead concentration is between 45-55%; spots are more prominent at higher tin concentration

\(^4\)http://panther.bsc.edu/~jhcook/OrgHist/begin.htm
SPOTTED METAL METALLURGY

Spots develop on cooling because of “... molten lead and tin having different melting temperatures. As the liquid ... passes through its eutectic point and begins to solidify, the metals separate and crystallize in small regions or “pools” on the casting table.”

\[^5\] piporg-l Samuel McKeon 24 July 1995 week 4 #323
COMMON METAL PIPES

Mixture of tin and lead where tin:lead ratio is below 45% and does not form “spots”\(^6\)

Less expensive metal costs; used where visual or tonal effect is less important


Photo: Dibblee
TIN PIPES

melting point of tin: 232° C/450° F

Pure tin (99.97%) may be used for display or façade locations\(^7\)

“Tin Pest”, in which tin metal changes to the powdery “grey tin”, may occur at temperatures below -13° C\(^8,9,10,11\)

\(^7\) www.metals26.freeserve.co.uk/tin/tin.html
\(^8\) Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy” (http://www.albany.edu/piporg-l/pipemet.html#introduction)
\(^9\) http://members.aol.com/pewtrsocty/glossary.htm
\(^10\) http://corrosion-club.com/tinplague.htm
ZINC PIPES

melting point: 420° C; 687° F

Less costly than tin, spotted metal, or common metal

Used where visual and sound effects are less important such as large bass pipes

Photo: Dibblee
LEAD PIPES

melting point: 328° F; 622° F

Common in Bach-era organs in Europe

Recent discoveries by Brombaugh, Fisk, & others using modern analytic tools made successful casting possible nowadays.¹²

¹²Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy” (http://www.albany.edu/piporg-l/pipemet.html#introduction)
LEAD METALLURGY

Modern-day lead pipes collapse if today’s pure lead is used for casting.

Recently discovered impurities\(^{13}\) in 17th-century lead kept pipes from collapsing:

- Sb 0.75%
- Cu 0.06%
- Bi 0.05%
- Sn 1.0%

Impurities were determined using Electron Microprobe Analysis, which measured Auger electrons. Analyses were done on 300-year-old pipes to recreate the tonal qualities.\(^{13}\)

\(^{13}\)Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy” quoting Charles Fisk (AGO Magazine 1978) (http://www.albany.edu/piporg-l/pipemet.html#introduction)
POURING MOLTEN LEAD INTO CASTING TROUGH TO CAST LEAD SHEET

Photo: Dibblee
PYROMETER USED TO MEASURE TEMPERATURE OF LEAD MELT BEFORE CASTING
BUCKET FLOATING IN MOLTEN LEAD

Photo: Dibblee
OSHA ISSUES

Tests conducted by OSHA in organ shops that cast lead confirmed that lead is not an occupational hazard, as long as lead melt is kept below 800° F\textsuperscript{14}, areas are kept clean, and there is no grinding or sanding of lead surfaces.

One shop’s data documented that the “average YEARLY output of lead into the atmosphere ... [was] 0.56 grams.”\textsuperscript{15}

\textsuperscript{14}Excerpt from piporg-l archives September 1994, week 5 (#54)

\textsuperscript{15}Excerpt from piporg-l Wednesday 3 October 2001 (list440@earthlink.net)