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DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON
(March 12, 1936)

Letter
Circular
LC 195

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TESTING LABORATORIES EQUIPPED FOR METALLURGICAL TESTS.

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Compiled by the Metallurgical Division of the Bureau of Standards, from the replies to a questionnaire which was distributed to engineering schools and laboratories and to those who answered an announcement published in the technical periodicals.

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The Bureau of Standards, in accordance with law, makes tests and carries out investigations for other government departments. Due to the large amount of this official work, it is impracticable for the Bureau to make tests for private individuals if other laboratories can do the work.

This list, alphabetically arranged, has been prepared to inform persons interested, of the location of other laboratories and of the types of work which they state they are prepared to do.

It is expected that additions to or revisions of this circular will be made from time to time as information is received as to other laboratories equipped for metallurgical testing.

The Letter Circulars are designed to answer specific inquiries to save the preparation of a large number of letters on the same subject. There is no guarantee that the information given in the Letter Circulars is correct except as of the date of issue. Material of a permanent value appears in the printed publications of the Bureau.

Letter Circulars are not available in the Government Printing Office, and the supply at the Bureau of Standards is limited.

ALABAMA.

R. H. Laverie & Sons, Inc., Birmingham.
(Branch, see New York).

Pittsburgh Testing Laboratory, 215 Clark Building, Birmingham.
(Branch, see Pennsylvania).

CANADA.

Canadian Inspection & Testing Co., Ltd., 100 Jarvis St. Toronto, Ontario, (Also Montreal, Winnepeg, Vancouver).
Metallography
(to 100 diameters) - bearing metals.

Robert W. Hunt Co., 1001 McGill Building, Montreal.
(Branch, see Illinois).

CALIFORNIA.

Robert W. Hunt & Co., 251 Kearny St., San Francisco.
(Branch, see Illinois).

R. H. Laverie & Sons, Inc., Los Angeles, San Francisco.
(Branches, see New York).

Arthur R. Maas, 308 E. 8th St., Los Angeles.
Melting points of non-ferrous alloys.

Charles C. Kawin Co., 639 Munson St., San Francisco.
Branch, see Illinois).

H. E. Morse, 954 Howard St., San Francisco.
Metallography.
Thermal analysis.
Heat treatment
Melting point only (small specimens).

Smith Emery Co., 245 S. Los Angeles St., Los Angeles.
(W. C. Bass).
Metallography.
(through a connection) - bearing metals.

Twining Laboratories, 2146-8 Merced St., Fresno.
(F. F. Twining - H. C. English - B. Casebolt).
Metallography.
Corrosion testing - gases in metals (partially equipped).
Preparation of special alloys in small quantity - bearing metals.
Solders.
Welding materials.

CONNECTICUT.

Stanley P. Rockwell Co., 112 High St., Hartford.
(S. P. Rockwell - R. W. Woodward).
Metallography.
Thermal analysis (by dilatometer).
Heat treatment in any commercial size that can be shipped - bearing metals - melting points.
Wear tests under specific commercial conditions.
Solder
Welding materials.

Henry Souther Engineering Co., 11 Laurel St., Hartford.
(J. A. Newlands - F. P. Gilligan).
Metallography
Small scale heat treatment - tensile tests at temperatures to 1500°F including stress-strain relations. - bearing metals.
Sand testing.

Yale University, Sheffield Scientific School, Hammond Metallurgical Laboratory, 14 Mansfield St., New Haven.
(C. H. Mathewson - A. Phillips).
Also Laboratory of Engineering Mechanics
(C. J. Tilden).
Metallography
X-ray diffraction - thermal analysis - rolling and wire drawing. Forging on a small scale. Experimental alloys by gas melting. High temperature tensile and flow

tests could be arranged for. Bearing metals, melting points.
Solder
Welding materials.

GEORGIA.

Georgia School of Technology, Atlanta.
(R. S. Xing).
Sand testing - core binders (after September 1, 1926).

IDAHO.

University of Idaho, College of Engineering, Moscow.
(I. C. Crawford).
Molding sand and core sand testing.

ILLINOIS.

Armour Institute of Technology, Chicago, (Chemical Engineering & Mechanical Engineering Laboratories).
(G. F. Gebhardt - P. C. Huntley - H. McCormack - A. H. Carpenter).
Metallography.
Corrosion testing.
Heat treatment of small specimens
Thermal analysis - high temperature tests (-50 to 1800°F) including stress strain relations - bearing metals.- melting points.
Wear tests.
Solders.
Welding materials
Experimental forging.

Rolling and drawing can probably be arranged for. Preparation of special alloys. Gas in metals analyses could probably be arranged for, but are not now done.
Sand testing.

Block Laboratories, 222 East Ontario St., Chicago.
(D. J. Block - H. W. Butterfield).
Sand testing and core binders.

Robert W. Hunt Co., 2200 Insurance Exchange, Chicago.
(Branches, New York, Pittsburgh, St. Louis, San Francisco, Montreal).
(J. H. Campbell - G. B. Gerault - F. W. Weifench).
Metallography.
Heat treatment (sections to 1 1/2").
Thermal analysis - high temperature testing (without stress-strain relations) - bearing metals.
Solders.
Welding materials.
Gases in metals (Ledebur oxygen & Allen nitrogen only).
Sand testing except permeability - core binders.

Charles C. Kawin Co., 431 S. Dearborn St., Chicago.
(Branches, San Francisco, Cincinnati, Buffalo).
(W. J. Mulcahy - F. R. Geis).
Bearing metals.
Molding sands (foundry practise a specialty).

R. H. Laverie & Sons, Inc., Chicago.
(Branch, see New York).

Pittsburgh Testing Laboratory, Old Colony Building, Chicago.
(Branch, see Pennsylvania).

University of Illinois, Urbana.
(A. N. Talbot - H. F. Moore - S. W. Parr - B. W. Benedict).
Metallography.
Heat treatment - (small specimens)
Thermal analysis - high temperature testing to 1600°F, with stress-strain relations by special arrangement. Fatigue testing up to 1600°F. Bearing metals, preparation of special alloys up to 10 lbs. Oxygen by Ledebur method only.
Sand tests - core binders.

INDIANA.

Purdue University, Department of Chemistry, Lafayette.
(A. R. Middleton - M. G. Mellon).
Metallography.

IOWA.

Iowa State College, Engineering Experiment Station, Ames.
(A. Marston).
Not prepared to do commercial metallurgical work except by special arrangement.

State University of Iowa, College of Applied Science, Iowa City.
(S. H. Woodward - E. Bartow - N. O. Taylor).
Metallography.
Corrosion testing.
Heat treatment
Thermal analysis - bearing metals.

KANSAS.

University of Kansas, Lawrence.
(E. D. Kinney - A. M. Ockerblad - A. H. Sluss).
Metallography
Heat treatment - (small specimens)
Thermal analysis - bearing metals.
Solders.
Welding materials.
Sand testing - core binders.

LOUISIANA.

R. H. Laverie & Sons, Inc., New Orleans.
(Branch, see New York).

MAINE.

University of Maine, College of Technology, Orono.
(E. D. Kent, W. J. Sweetser).
Metallography.

MARYLAND.

Johns Hopkins University, School of Engineering, Baltimore.
(A. G. Christie).
Metallography.
Preparation of alloys up to 100 lbs.

R. H. Laverie & Sons, Inc., Baltimore.
(Branch, see New York).

MASSACHUSETTS.

R. H. Laverie & Sons, Inc., Boston.
(Branch, see New York).

Arthur D. Little, Inc., Charles River Road, Cambridge.
(A. D. Little - E. P. Stevenson - R. C. Griffin - C. E. Carpenter).
Metallography.
Corrosion testing - X-ray work.
Heat treatment - (small specimens)
Thermal analysis - tensile testing, 0 - 500°F, including stress-strain relations - bearing metals - melting points (metals and sand or refractories).
Wear tests.
Soldering.
Welding materials - core binders.
Apparatus not now assembled for gas in metals work, but would take up this work if occasion warranted.

Massachusetts Institute of Technology, Cambridge.
(V. O. Homerberg - R. S. Williams).
Metallography.
Corrosion - X-ray work.
Heat treatment - (small specimens).
Thermal analysis - tensile testing, 70-2000°F, including stress-strain relations - bearing metals.
Wear tests.
Soldering.
Welding materials - preparation of special alloys.

Worcester Polytechnic Institute, Worcester.
(F. W. Roys).
Metallography
Heat treatment.
Thermal analysis - Equipment for high temperature tensile testing is to be installed.

MICHIGAN.

Detroit Testing Laboratory, 554 Bagley Avenue, Detroit.
(W. P. Putnam).
Metallography.
Corrosion testing by salt spray - preparation of alloys up to 5 lbs.
Heat treatment - (small specimens).
Thermal analysis - bearing metals.
Welding material.
Solders.
Sand testing - core binders.

United States Radiator Corporation (Industrial Research Laboratory), Detroit.
(J. F. McIntire - M. H. Stimpson - H. W. Dietert).
Sand testing - core binders - facings - partings and other foundry material.

University of Michigan, Department of Engineering Research, Ann Arbor.
(A. E. White - W. P. Wood - H. L. Campbell - F. N. Menefee).

Metallography.
Corrosion testing - X-ray crystal analysis and radiography - rolling, drawing and forging (using industrial plant equipment) - gas-in-metals analysis by Ledebur oxygen and Allen nitrogen (vacuum fusion apparatus would be installed on sufficient demand).
Heat treatment.
Thermal analysis - high temperature testing (with stress-strain diagrams). - bearing metals.
Wear testing (apparatus soon to be constructed).
Solders.
Welding materials.
Sand testing - core binders.

MINNESOTA.

University of Minnesota, School of Mines, Minneapolis.
(O. E. Harder).
Metallography
Gas in metals tests (Ledebur oxygen, Allen nitrogen only).
Preparation of special alloys. (Dental alloys a specialty).
Heat treatment. - (small specimens).
Thermal analysis - high temperature tensile tests without stress-strain relations - impact tests at high and low temperatures - bearing metals.
Solders.
Welding materials.

MISSOURI.

Robert W. Hunt Co., Syndicate Trust Building, St. Louis.
(Branch, see Illinois).

Kansas City Testing Laboratory, 700 Baltimore Avenue, Kansas City.
(W. M. Cross,- R. Cross).
Heat treatment.
High temperature tensile testing including stress-strain relations - bearing metals.
Solders.
Welding materials. - Rolling.
Sand testing - core binders.

R. H. Laverie & Sons Inc., St. Louis.
(Branch, see New York).

University of Missouri, School of Mines and Metallurgy, Rolla.
(C. Y. Clayton - H. R. Hanley).
Metallography.
Thermal analysis.

Waring & Williams Laboratories, 620 Joplin St., Joplin.
(B. Williams).
Solders.
Welding materials.
Sand testing.

MONTANA.

University of Montana, State School of Mines, Butte.
(C. L. Wilson).
Metallography
Thermal analysis - bearing metals.

NEW MEXICO.

New Mexico College of Agriculture & Mechanic Arts, State College.
(R. W. Goddard - H. O. Garst).
Forging. Preparation of high melting alloys.
Sand testing (permeability and sieve tests only).

NEW YORK.

College of the City of New York, School of Technology, Convent Avenue & 139th Street, New York City.
(R. E. Goodwin - R. Stevenson).
Bearing metals.
Sand tests - core binders.

Columbia University, New York City.
(Wm. Campbell - C. G. Fink - B. Davis - A. H. Beyer - H. A Fales - L. Work).
Metallography.
Corrosion testing - X-ray work - gases in metals (Ledebur oxygen & Allen nitrogen), - preparation of special alloys up to 50 lbs.
Heat treatment.
Thermal analysis - high temperature testing - bearing metals.
Solders.
Welding materials.
Sand testing - core binders.

G. F. Comstock, 967 Harrison Avenue, Niagara Falls.
Metallography.
Heat treatment - (small specimens) - bearing metals.

Cooper Union - Materials Testing Laboratory, New York City.
(F. E. Foss - R. C. Brumfield).
Metallography (infrequently)
Thermal analysis (dilatometric).

Cornell University, Experiment Engineering Department, Sibley College, Ithaca.
(H. Diederichs - E. M. Chamot - W. D. Bancroft - T. R. Briggs - F. H. Rhodes - C. W. Mason - H. Reis).
Metallography.
Corrosion testing including electrolytic thermal analysis. Preparation of special alloys - (high frequency furnace available).
Heat treatment - (small specimens). - bearing metals.
Sand testing - core binders.

Douglaston Laboratories, Inc., Douglaston, L. I.
(C. W. Bennett - E. L. Mack).
Sand testing and core binders a specialty. Equipment for preparation of special alloys and gas in metals analysis not now installed, but would take up if occasion warranted.

Electrical Testing Laboratories - 80th St. & East End Ave., New York City.
(P. S. Millar - C. H. Sharp - F. M. Farmer).

Metallography.
Corrosion testing (simulated atmospheric a specialty)
Tensile tests at high temperatures (to limited extent - stress-strain relations not accurately obtained) - melting points.

Robert W. Hunt Co., 53 Park Pl., New York City.
(Branch, see Illinois).

Charles C. Kawin Co, 110 Pearl St., Buffalo,
(Branch laboratory, see Illinois).

R. H. Laverie & Sons, Inc., (representatives of Bureau Veritas), 17 State St., New York City.
(Branches in other cities).
(J. B. Emerson - J. W. Davidson).
Corrosion testing (laboratory & field) - bearing metals.
Solders.
Welding materials.
Melting points.

Ledoux & Co., 99 John St., New York City.
(A. M. Smoot).
Metallography.
Gases in metals (Ledebur oxygen & Allen nitrogen only).

New York Testing Laboratories, 80 Washington St., New York City.
(L. R. Seidell - G. B. Jack - G. J. Horvitz).
Metallography.
Corrosion testing - X-ray work (through A. St. John).
Heat treatment - (small specimens).
Thermal analysis - bearing metals.
Solders.
Welding materials - rolling, drawing & forging (outside of our laboratory) - gas in metals work (Ledebur oxygen & Allen nitrogen only).
Sand testing - core binders
Melting points
(Foundry, forging, & heat-treating practise).

Pratt Institute, School of Science & Technology, 215 Ryerson St., Brooklyn.
(S. S. Edwards - C. B. Jones).
Heat treatment - (small specimens).
Thermal analysis.
Core binders.

Lucius Pitkin Inc., 47 Fulton St., New York City.
(E. B. Mayo - T. A. Wright - E. R. Milliring).
Metallography.
Corrosion testing (including spray and electrolytic) - bearing metals - preparation of special alloys (up to 3 lbs.) - (especially jewelers & dental alloys) - rolling and drawing - Gas in metals tests (Ledebur oxygen & Allen nitrogen only).

Pittsburgh Testing Laboratory, 35 6th Ave., New York City.
(Branch, see Pennsylvania).

Rennselaer Polytechnic Institute, Troy.
(W. P. Mason - T. R. Lawson - A. W. Davison - R. A. Patterson).
Metallography.
Corrosion testing including spray & electrolytic - X-ray work.
Heat treatment.
Thermal analysis - tensile testing at high temperatures including stress-strain relations - wire drawing - Gas in metals (Ledebur oxygen & Allen nitrogen only).
Welding materials
Preparation of special alloys (high frequency furnace, arc furnace (150-lb.), vacuum furnace, etc. available).

A. St. John, Room 501-505 Fifth Ave., New York City.
X-ray crystal analysis - also radiography up to three inches of metal.

Stillman & Van Siclen, 227 Front St., New York City.
(I. Hochstadter - R. C. Brumfield (Cooper Union)).
Metallography.
Bearing metals.
Solders.
Welding materials.

Touceda Laboratories, 943 Broadway, Albany.
(E. Touceda - L. E. Preiss - P. H. Crawmer - G. Parker)
Metallography.
Heat treatment - bearing metals.
Solders.
Welding materials.
Sand testing - core binders.

Union College, Schenectady.
(M. F. Sayre).

Corrosion testing (a specialty) - salt spray - electrolytic & special fume tests - Equipment for high temperature testing may soon be installed.
Aluminum solders.

U. S. Testing Co., 340 Hudson St., New York City.
(D. E. Dorty - W. F. Edwards).
Metallography (occasional work).

NEVADA.

Lovelock Assay Office, Box 777, Lovelock.
Bearing metals
Solders.

NORTH CAROLINA.

University of North Carolina, Department of Chemistry, Chapel Hill.
(F. C. Vilbrandt).
Metallography.
Heat treatment (on a teaching scale)
thermal analysis.
Preparation of special alloys (100 gram lots) (high frequency vacuum furnace available).

NORTH DAKOTA.

University of North Dakota, University Station, Grand Forks.
(E. J. Babcock).
Metallography
Corrosion (within limits) - bearing metals.
Wear tests.
Melting points of metals & refractories.

NEW JERSEY

Richard Moldenke, Watchung.

Malleable and Cast Iron - Experimental cupola melting.

OHIO

Case School of Applied Science, Metallurgical Engineering Laboratory, Cleveland.
(H. M. Boylston).
Metallography
Heat treatment - (small specimens).
Thermal analysis
Bearing metals
Melting points of metals and refractories

Crowell & Murray, 406-9 Perry-Payne Building, Cleveland.
(B. Crowell - C. B. Murray)
Melting points
Sand testing

James H. Herron Co., 1360-4 West 3d St., Cleveland.
Metallography (J. H. Herron, C. A. Gregory).
Corrosion testing
Heat treatment - (small specimens)
Thermal analysis
Bearing metals
Solders
Welding materials
Sand testing - core binders
Preparation of special alloys (100 lb. electric furnace available).
Gases in metals (Ledebur oxygen and Allen nitrogen only)
Melting points

Charles C. Kawin, 222 West 4th St., Cincinnati.
(Branch Office, see Illinois).

R. H. Laverie & Sons, Inc., Cleveland.
(Branch, see New York).

Ohio Brass Co., Laboratory Department, Mansfield.
(A. A. Grubb, L. H. Marshall).
Metallography
Corrosion by salt spray
Heat treatment - (small specimens)
Thermal analysis
High temperature testing - impact -50° to 600°C - tension and compression -50° - 800°C (stress-strain relation not determined)
Bearing metals
Comparative wear tests
Solders
Welding materials
Preparation of special alloys (35 K.V.A. high frequency furnace available)
Sand tests (a specialty) core binders.

University of Cincinnati, Cincinnati,
(R. O. McDuffie - P. W. Crane)
Metallography
Sand testing

Ohio State University, Metallurgical Department, Columbus.
(D. J. Demorest)
Metallography
Corrosion testing
X-ray work
Heat treatment - (small specimens)
Thermal analysis
Bearing metals
Melting points - metals and refractories
Preparation of special alloys (35 K.V.A. high frequency furnace available).
Sand testing
Gases in metals (including modified vacuum fusion methods)

Queen City Steel Treating Co., 432 Oliver St., Cincinnati.
(N. M. Sallsoner).
Commercial heat treating only

United Alloy Steel Corporation, (Metallurgical Laboratory) Canton
(M. A. Grossman)
Equipped for vacuum fusion analysis for gases in metals (chiefly applied to the corporations own problems, but outside work may sometimes be taken on).

OREGON

Oregon State Agricultural College, School of Engineering, Corvallis.
(S. H. Graf).
Metallography
Some corrosion testing
Experimental heat treatment of small specimens
Thermal analysis
Bearing metals
Wear tests (Norris slip abrasion test)
Melting points
Forging (power hammer).

I. F. Laucks, Inc., Portland.
(Branch, see Washington).

PENNSYLVANIA

J. Bishop & Co., Platinum Works, Malvern.
(G. M. Hickey - J. W. Cox - C. S. Brainin)
Preparation of special alloys of precious metals (Pt.Au. Ag).

Carnegie Institute of Technology, College of Engineering, Schenley Park, Pittsburgh.
(W. E. Mott).
Metallography
Corrosion Testing
high temperature tensile to 1500°F without stress-strain relations.
Bearing Metals
Sand Tests

W. B. Coleman & Co., 15th & Wallace Sts., Philadelphia,
(W. B. Coleman - O. R. Smith).
Metallography.
Melting points.
Sand testing.
Forging up to largest commercial sizes.
Heat treatment on commercial scale but only in the plant directly interested.
Preparation of special alloys (through local connections (specialize in open hearth and electric practice, heat treatment, foundry practice.)

Drexel Institute, 32d & Chestnut Sts,, Philadelphia.
(L. D. Stratton - J. H. Billings).
Heat treatment - (small specimens). - bearing metals.
Wear tests.
Solders.
Welding materials

Erie Laboratory, 1519 French St., Erie.
(J. A. Evans).
Bearing metals
Solders
Welding materials
Sand tests - core binders

Robert W. Hunt Co., Monon Bank Bldg., Pittsburgh.
(Branch see Illinois).

H. C. Knerr, 1500 Green St., Philadelphia.
Metallography,
Corrosion testing,
Heat treatment,
Thermal analysis - bearing metals
Solders,
Welding materials
Light alloys a specialty.

R. H. Leverie & Sons, Inc., Pittsburgh & Philadelphia.
(Branches, see New York)

Lehigh University, Metallurgical Engineering Department, Bethlehem.
(B. Stoughton) Laboratories of Bethlehem Steel Co. available).
Metallography
Heat treatment - small specimens)
Thermal analysis
Tensile tests up to 1950° including stress strain relations
Bearing metals
Rolling
Wire drawing can also be done
Preparation of special alloys (10 lb. lots)

Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia.
(T. Olsen, T. Y. Olsen).
Bearing metals
Wear tests (Norris slip abrasion machine)

Pennsylvania State College, Engineering Experiment Station, State College. (R. L. Sackett, L. G. Hechler).
Metallography
Corrosion testing
Power hammer available

Pittsburgh Testing Laboratory, Stevenson & Locust Sts.,Pittsburgh.
(J. W. Reifsnyder, H. H. Craver, J. C. Handy).
Metallography
Corrosion testing
Heat treatment - (small specimens).
Thermal analysis
Tensile tests at high temperatures to 1800°F, stress-strain relations determined
Bearing metals
Welding materials
Solders
Wear tests
Gases in metals (Ledebur oxygen and Allen nitrogen only)
Sand tests

Swarthmore College, Swarthmore.
(W. E. Fuller, G. Alleman).
Heat treatment (small specimens)
Thermal analysis
Bearing metals

PHILIPPINE ISLANDS

Bureau of Science, Manila.

(W. H. Brown).
Metallography.
Bearing metals.

RHODE ISLAND.

Saunders & Franklin, 184 Whittier Avenue, Providence.
(Wm. Saunders - F. H. Franklin).
Metallography
Sand testing (a specialty).

TENNESSEE.

Vanderbilt University, Department of Chemistry, Nashville.
(J. M. Breckenridge - W. P. Fishel).
Metallography.

TEXAS.

Fort Worth Laboratories, 828 1/2 Monroe Street, Fort Worth.
(L. B. Porter - R. H. Lash).
Solders.

Pittsburgh Testing Laboratory, Santa Fe Building, Dallas.
(Branch, see Pennsylvania).

Rice Institute, Department of Engineering, Houston.
(J. H. Pound).
Metallography.
Heat treatment - (small specimens)
Thermal analysis.

UTAH.

University of Utah, Engineering Laboratory, Salt Lake City.
(E. A. Beckstrand - Thos. Varley).
Metallography.

WASHINGTON.

I. F. Laucks, Inc., 99 Marion Street, Seattle (Also Tacoma).
(I. F. Laucks - H. P. Banks - H. F. Rippey).
Metallography.
Corrosion testing - bearing metals.
Wear tests.
Melting points.
Sand tests.

R. H. Laverie & Sons, Inc., Seattle.
(Branch, see New York).

Northwest Testing Laboratories, 2113 Third Avenue, Seattle.
(A. T. Maning - J. L. Avis - F. H. Conrad).
(Branch laboratories in other cities).
Metallography.
Corrosion, including electrolytic.
Heat treatment (small specimens).
Thermal analysis - bearing metals.
Wear tests - melting points.
Soldering & welding.
Sand tests.

University of Washington, College of Engineering, Seattle.
(C. E. Magnusson - M. Roberts - E. R. McMunn).
Metallography.
Heat treatment (small specimens).
Thermal analysis.
Core sands & core binders.

WISCONSIN.

University of Wisconsin, Chemical Engineering Laboratory & Mining & Metallurgical Laboratory, Madison.
(O. L. Kowalke - O. P. Watts - R. A. Ragatz - O. A. Hougen - R. S. McCaffery - G. J. Barker - J. F. Oesterle).
Metallography.
Corrosion testing (salt-spray and alternate immersion - thermal analysis - melting points - preparation of special alloys - (arc furnace 100 lbs., electric crucible furnace 10 lbs. - vacuum furnace 100 grams) -
Heat treatment - (small specimens).
Sand testing.