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in a High School

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Scope of Study: This course of study was developed as a suggestive plan of foundry work for industrial arts in the senior high school shop, using aluminum for the casting metal. Data were taken from a number of listed text and reference books. The study considers specific objectives to be achieved, grade placement, teaching methods, and teaching aids including a course outline.

Importance of the course: The use of aluminum has been greatly increased both for military equipment and to meet the demands by the average person for products of greater beauty and utility. Aluminum is easy to work, weighs one third as much as iron or copper, is the fifth most commonly used metal, is highly resistive to atmospheric activity, is highly malleable and ductile, and will not tarnish or oxidize. The skills and processes involved in aluminum founding are similar to those involved in the founding of other metals. The materials and tools used are readily available and are appropriate to the ability of the senior high school student. Scrap aluminum has become relatively inexpensive since the ending of the war. This course constitutes the basic manipulative processes in foundry practice and extends over a period of one semester.

It is recommended that the course in foundry work be taught by the combination method consisting of (1) lecture, demonstration, and class discussion periods utilizing from fifteen to twenty per cent of the total time, and (2) actual shop practice in casting parts of light equipment selected for the needs of the school or home shop.

ADVISER'S APPROVAL

Buell Eldredge Helm

A COURSE OF STUDY
FOR ONE SEMESTER OF FOUNDRY WORK
IN A HIGH SCHOOL

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IN A HIGH SCHOOL

By

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A COURSE OF STUDY
FOR ONE SEMESTER OF FOUNDRY WORK
IN A HIGH SCHOOL

This course of study was developed as a suggestive plan of foundry work for industrial arts in the senior high school shop, using aluminum for the casting metal. Foundry work is becoming more important in schools because of its value both as a vocational and as an avocational subject. By taking this course the pupil learns about one of the most fundamental of manufacturing processes. He learns about the liquifying of metals, the making of molds and castings and the basic procedures of foundry practice. He also develops responsibility through safe practices in handling these molten metals.

Importance of a Course in Aluminum Founding Work

The use of aluminum has been greatly increased both for military equipment and to meet the demands by the average person for products of greater beauty and utility. Aluminum is easy to work, weighs one third as much as iron or copper, is the fifth most commonly used metal, is highly resistive to atmospheric activity, is highly malleable and ductile, and will not tarnish or oxidize. The skills and processes involved in aluminum founding are similar to those involved in the founding of other metals. The materials and tools used are readily available and are appropriate to the ability of the senior high school student. Scrap aluminum has become relatively inexpensive since the ending of the war. This course constitutes the basic manipulative processes in foundry practice and extends over a period of one semester.

Specific Objectives for the Course in Foundry Work

1. Technical knowledge is applied in the design and production of light equipment.
2. Abstract items of academic knowledge are applied in designing a product for artistic purposes.
3. Provides understanding of basic industrial processes in foundry practice.
4. Provides for the development of fundamental abilities in foundry work and an appreciation of good workmanship.
5. Provides activities which will appeal to the interests of the high school student.

6. Develops self-confidence and initiative through having successfully completed a foundry project.
7. Provides experience in practical problem solving through analyzing and working out the solution of a problem using actual materials.
8. Develops an attitude of safety-consciousness.
9. Develops understandings and skills in pattern making and mechanical drawings.
10. Discovers interests and aptitudes that have significance in life work.
11. Contributes to the pupils' understanding of industrial values and in their cooperative work with others.

Grade Placement

Foundry work should be offered in the senior high school only to the pupils in the eleventh or twelfth grades. Because of the dangers involved in foundry practice, only the mature students should be permitted to take the course.

Prerequisites

Pupils enrolling in this course should be regularly enrolled senior high school students who have had hand woodworking. The making of patterns may be included as a part of the foundry practice course.

Teaching Methods

It is recommended that the course in foundry work be taught by the combination method consisting of (1) lecture, demonstration, and class discussion periods utilizing from fifteen to twenty percent of the total time, and (2) actual shop practice in casting parts of light equipment selected for the needs of the school or home shop.

Recommended Textbooks

A single basic textbook is recommended for this course. Sufficient numbers of the adopted text should be available in the shop so that there is at least one book for each two pupils. The following textbooks are recommended as satisfactory for the course.

1. Lewis, Melvin S., and Dillon, John R., Instruction Sheets for the General Shop Foundry, McGraw-Hill Book Co., New York, 1932, 77 pages.

2. Richards, William Henry, Principles of Pattern and Foundry Practice, McGraw-Hill Book Co., Inc., New York, 1930, 121 pages.
3. Smith, Robert E., Units in Patternmaking and Founding, The McCormick-Mathers Publishing Company, Wichita, Kansas, 1939, 72 pages.
4. Stinson, William G., Gray, Burton L. and Grennan, John, Foundry Work, American Technical Society, Chicago, 1939, 214 pages.

A Selected Bibliography for a Course in Foundry Work

In addition to the recommended textbooks, at least ten more books selected from the following list should be in the shop or available for the accrediting of this course. The following books will be acceptable for the reference material.

1. A&M College Students, Accident Prevention in School Shops, Oklahoma State Department of Education, Oklahoma City, Oklahoma, 40 pages, 1940, free.
2. American Foundrymen's Association, Cast Metals Handbook, Chicago, 1949, 523 pages.
3. American Foundrymen's Association, Foundry Sand Testing Handbook, Chicago, 1945, 176 pages.
4. American Foundrymen's Association, Magnesium Alloys Foundry Practice, Chicago, 1944, 136 pages, \$3.00.
5. American Foundrymen's Association, Recommended Practices for the Sand Casting of Non-ferrous Alloys, Chicago, 1944, 159 pages, \$3.00.
6. American Foundrymen's Association, Tentative Recommended Practices for Aluminum Alloys, Chicago, 1944, \$.90.
7. American Foundrymen's Association, Tentative Recommended Practices for Sand Cast Copper-silicon Alloys, Chicago, 1944, \$.30.
8. American Foundrymen's Association, Testing and Grading Foundry Sands, Chicago, 1931, 151 pages.
9. Chase, Herbert, Handbook on Designing for Quantity Production, McGraw-Hill Book Co., New York, 1944, 517 pages.
10. Dietert, H. W., Modern Core Practices and Theories, American Foundrymen's Association, Chicago, 1945, \$5.00.
11. Hartley, L. A., Elementary Foundry Technology, Penton Publishing Co., Cleveland, Ohio, 1941, \$3.00.
12. Kealey, R. J., Non-ferrous Casting, International Textbook Co., Scranton, Pennsylvania, 1943, \$1.60.

13. Soderstrom, Edwin D., Notes on Foundry Practice, Oklahoma Agricultural and Mechanical College Engineering Shops, Stillwater, Oklahoma, 43 pages, 1942.
14. Wendt, R. E., Foundry Work, McGraw-Hill Book Co., Inc., New York, 1923, 206 pages.

Recommended Magazines

Magazines are an additional source for instructional materials for the shop library. The following magazines are recommended for foundry work.

1. The American Foundryman, American Foundryman's Association, 222 West Adams St., Chicago.
2. Die Casting, The Technical Publishing Co., Cleveland, Ohio.
3. The Foundry, Penton Publishing Co., Penton Building, Cleveland, Ohio.
4. Modern Metals, 160 N. LaSalle St., Chicago, Illinois.
5. National Safety News, National Safety Council, Inc., 20 N. Wacker Drive, Chicago 6, Illinois.

Motion Pictures, Visual Aids and Trade Publications on Aluminum and Aluminum Alloy Casting

Many instructors who have used visual education extensively believe students retain more information from charts, photographs, and motion pictures than by reading and hearing. The writer of this course of study believes that trade publications, motion pictures, and charts issued by manufacturers are of value chiefly to assist in achieving the objectives of the school shop and to meet the needs of industry and modern living. An immense amount of this material can usually be secured free or at little cost from manufacturers.

Motion Pictures

Aluminum Company of America, 801 Gulf Building, Pittsburgh, Pennsylvania lists the following films in either 16 mm or 35 mm sound that may be secured by paying for mailing costs and insurance.

Aluminum: From Mine to Metal. The history of the mining and manufacturing of aluminum, running time, 17 minutes.

Aluminum Fabricating Processes. Shows the many processes of fabricating the aluminum ingot into finished products, running time, 20 minutes.

How to Machine Aluminum, illustrates the use of machine tools on different aluminum alloy castings, running time 32 minutes.

How to Weld Aluminum, shows techniques involved in oxyacetylene, arc, and resistance welding, and brazing of cast aluminum, running time 36 minutes.

Trade Publications

Aluminum Company of America, 801 Gulf Building, Pittsburgh, Pennsylvania.
This company offers the following free trade publications.

Alcoa Aluminum and Its Alloys, designates types of cast alloys, charts and other informative material on the chemical composition and characteristics of aluminum.

Aluminum Casting Alloys, foundry practice in melting, molding, and finishing aluminum and aluminum alloys.

An Outline of Aluminum, information on the history, chemistry, and uses of aluminum.

Finishes for Aluminum, discusses mechanical, chemical, electrolytic oxide, electroplating, paint and lacquer finishing methods.

Machining Alcoa Aluminum, gives cutting speeds and feeds, types of grinding wheels, proper rake for filing cutting tools for machining, drilling, reaming, tapping and threading, and sawing aluminum castings.

Welding and Brazing Alcoa Aluminum, information on arc, fusion, and resistance welding, and brazing aluminum castings.

Nicholson File Co., Providence, R.I., A File for Every Purpose, a booklet on the selection and use of files, 25 pages, free.

Visual Aids

Aluminum Company of America, 801 Gulf Building, Pittsburgh, Pennsylvania.
The following free charts give valuable information on the composition and the working of cast aluminum.

Chart on Chemistry and History of Aluminum. The chemistry and history of aluminum is given by photographs, drawings, and description of the mining and manufacturing of raw materials. Samples of these materials are mounted on the chart. 18 x 27½ inches.

Machining Chart. Proper feeds and speeds, correct rake angles for cutting tools, and types of cutting compounds are given for machining aluminum. Illustrations show types and uses of numerous tools used in machining aluminum castings. 14 x 20 inches.

Welding and Brazing Chart. Color illustrations and written instructions are given for welding and brazing aluminum castings for both oxyhydrogen and oxyacetylene.

The Summary Sheet for Foundry Work

The summary sheet contains a list of the units of instruction which are recommended for inclusion in the course. The work experiences and related units of instruction are listed in two parallel columns, the first of which includes the manipulative operations in which the student should have experiences and the second contains units of informational material which should be studied in this basic industrial arts subject.

The summary sheet may be used as an individual progress chart on which the record of the student may be entered. It may provide a check list for the instructor to guide him in the selection of teaching lessons. The summary sheet may be used as a diary of lessons and subjects taught during any single semester course.

SUMMARY SHEET OF UNITS OF INSTRUCTION

Manipulative Units	Information Units
1. Shop organization.	1. The development and characteristics of aluminum.
2. Making a pattern with hand tools.	2. Specifications for pattern-making.
3. Use of machinery in pattern-making.	3. Technical terms applied to patternmaking and foundry work.
4. Preparation of sand for molding.	4. Selection of molding sand.
5. Ramming a mold.	5. Types and uses of molding tools.
6. Melting and casting aluminum.	6. Safe practices in foundry work.
7. Finishing castings.	7. Files and abrasives for finishing aluminum.
8. Making core prints.	8. Pattern materials and accessories.
9. Making core boxes and cores.	9. Composition of core sand.
10. Making a casting with cored holes.	10. Identification of metals.

The Course of Study Outline

In the following outline "A" in each unit of instruction indicates the manipulative work to be performed, "B" designates the accompanying informational material, and part "C" suggests projects or exercises.

The numbers in the outline at the left designate the book number in the list of reference books. The columns at the right are numbered to correspond to the book and page numbers of the following list of text books.

1. Lewis and Dillon - Instruction Sheets for the General Shop Foundry.
2. Richards - Principles of Pattern and Foundry Practice.
3. Smith - Units in Pattermaking and Founding.
4. Stimson, Gray, and Grennan - Foundry Work.

THE COURSE OUTLINE FOR FOUNDRY WORK

Outline of Instructional Units:	1 L & D	2 Richards	3 Smith	4 Stimson
Unit 1 - <u>Shop Organization</u>				
A. Students shall check equipment for the foundry units.				
B. Methods of procedure to be followed in the foundry shop, the development and characteristics of the working material, aluminum, can be discussed.	68-70	3-4	45-47	102-103
C. Checking of types of castings used in the whole industrial arts shop.				
Unit 2 - <u>Making a Pattern With Hand Tools</u>				
A. Forming proper draft on a simple pattern with a plane, try square, and other hand tools.		5-7	7-9	
B. Specifications for pattern making.		58	10-21	

	1	2	3	4
Outline of Instructional Units	L & D	Richards	Smith	Stinson
C. Select or design a pattern	57			
Unit 3 - <u>Use of machinery in pattern making.</u>				
A. The student will have learned the general uses of the machines in a previous woodworking course. He will now learn the method of cutting the proper draft with a jig saw or a band saw and a wood turning lathe.		33-34		
B. Technical terms applied to patternmaking and foundry work.			4	
C. Turn a pattern for a gear blank or a pulley on a wood-turning lathe.	35-47			
Unit 4 - <u>Preparation of sand for molding.</u>				
A. Dampening, mixing, and sifting of molding sand.			33	
B. Selection of molding sand.			29	2-5
C. Prepare sand for ramming.				
Unit 5 - <u>Ramming a mold.</u>				
A. Ramming a mold, removing the pattern, and backfacing.	1-9		35-38	22-33
B. Types and uses of molding tools.	2		31	8
C. Make a mold for a name plate.				

Outline of Instructional Units	1 L & D	2 Richards	3 Smith	4 Stinson
<u>Unit 6 - Melting and casting aluminum.</u>				
A. Using flux, melting aluminum, and casting at correct temperature.	10		44	106
B. Safe practices in foundry work.			4	125-152
C. Cast name plate, skillet, or other project of which the mold has been made.	57			
<u>Unit 7 - Finishing.</u>				
A. Removing gates and cleaning castings.			45	156
B. Files and abrasives for finishing aluminum.				
C. Give project desired finish.				
<u>Unit 8 - Making core prints.</u>				
A. Calculating height of print and turning to correct dimensions.		71-74	21	65
B. Pattern materials and accessories.		58-62	6	
C. Make a core print for the base of a photo-enlarger.				
<u>Unit 9 - Making core boxes and cores.</u>				
A. Making cylindrical forms	46-51	94	24-28	
B. Composition of core sand	45		30	
C. Cast a cone core.		69	40	79

Outline of Instructional Units :	1 : L & D :	2 : Richards :	3 : Smith :	4 : Stinson :
Unit 10 - <u>Making a casting with cored holes.</u>				
A. Making a mold with cored holes, inserting core, pouring metal, and cleaning cored hole.	54-56	63	41	41
B. Permeability of molds for non-ferrous metal castings. Identification of metals.			43	180-197
C. Cast the base and arm support for a photo-enlarger.				

An Equipment List for a Work Area for Your Pupils in Aluminum Founding

Specifications for Equipment: The list of foundry tools and equipment is given for aluminum which has a melting point of 1218 degrees Fahrenheit. The furnace and crucible or melting pot require no blower and can be constructed in the school shop. Most schools in Oklahoma have natural gas which may be used as the fuel for the melting furnace. Where this is not available, an oil or gasoline burning equipment may be secured for the furnace. The following list includes approved standard brands and the prices given represent the approximate cost of the equipment. A furnace and crucible of sufficient size will serve several work areas.

Quantity	Tools	Size	Retail Distributor	Price
1	Bellows	10"	Stevens	\$3.00
4	Bench ramers	3 1/2"x14"	Cast in shop (aluminum)	*
1	Bench rammer	3 1/2"x14"	Made in shop (wood)	*
1	Bulb sponge	3/4 pint	Brodhead Garrett Co.	1.35

Quantity	Tools	Size	Retail Distributor	Price
				\$
1	Draw pin	1/8" dia.	Made in shop	*
4	Flasks	10"x14"x20"	Stevens (steel)	31.60
1	Furnace	10 lb. metal pot capacity	Made in shop (steel or cast iron)	*
1	Gate cutter	3" x 4"	Made in shop (sheet metal)	*
1	Heart spoon	1"	Brodhead Garrett Co.	.60
1	Hub lifter	3/4"	Brodhead Garrett Co.	.90
1	Metal pot	Cap. 10 lbs.	Made in shop (steel or cast iron)	*
4 sets	Molding boards	1" x16"x22"	Made in shop (waterproof plywood)	2.50
1	Molding sand bin	1 barrel cap.	Constructed of concrete	8.50
1	Muslin bag	1 lb. cap.	Local	.20
2 ea.	Riddles	14 and 20 mesh	Stevens	8.00
2	Molders shovels	28"	Obermayer Co.	3.00
1	Slick & spoon	1 1/8"	Brodhead Garrett Co.	.70
1	Sprinkle can	1 gal.	Local	.75
8	Sprue pins	3/4" minimum dia. x 10"	Made in shop (maple)	*
1	Trowel	1 1/4"	Brodhead Garrett Co.	1.00
1	Venturi tube	1/2" throat dia.	Made in shop (sheet metal)	*
Total cost of equipment for four pupils in aluminum foundry				\$62.10

* Make from scrap or materials available at little or no cost.

Optional Equipment

If non-ferrous metals with a melting point of 1600 degrees Fahrenheit or more are to be melted a fire clay lined furnace with air blower and a graphite crucible are necessary. Brass and nickel-silver may be melted in a furnace of this type. These items of equipment are listed here for the benefit of instructors desiring this information.

Crucible No. 10, cap. 10 lbs. aluminum, 35 lbs. brass.	Johnson	\$6.00
Furnace with blower No. 500	Johnson	\$63.00

Materials Needed: A foundry unit costs relatively little. Materials needed for one semester are also comparatively inexpensive and limited in quantity.

Quantity	Materials	Size or Kind	Distributor	Price
1 bag	Core sand	50 lbs.	Stevens	\$ 1.50
1 bag	Flour	10 lbs.	Local	.65
1 pkg.	Flux	4 lbs. Cryolite	Brodhead Garrett Co.	1.00
1 pkg.	Parting compound	10 lbs.	Brodhead Garrett Co.	.70
4 bags	Fine molding sand	125 lbs. No. 00	Stevens	15.00
200 lbs.	Scrap aluminum		Local	14.00
Total cost of materials for foundry unit.....				\$ 32.85

A List of Firms Providing Tools, Equipment, and Supplies for Aluminum Founding.

This list will aid instructors in finding equipment and materials for the foundry. Catalogues and trade publications secured from these firms should be kept in the shop so that students can examine them and become familiar with the various materials used in the trade.

The first section lists manufacturers of foundry supplies. The second section lists recommended retail distributors. The latter source should be used on all small orders.

Manufacturers

Aluminum Company of America, 801 Gulf Building, Pittsburgh, Pennsylvania, pig aluminum, charts and other trade publications concerning the characteristics of aluminum.

The K. H. Hummert Co., 152 W. Walton St., Chicago, Illinois, furnaces.

Johnson Gas Appliances Co., 616 E. Ave., N.W., Cedar Rapids, Iowa, gas furnaces and blowers for melting non-ferrous metals.

Revere Copper and Brass Incorporated, 230 Park Avenue, New York 17, New York, copper and copper alloying metals.

Stromberg Furnace & Engineering Co., 300 W. Adams St., Chicago 6, Ill. stationary and manual tilting crucible furnaces for non-ferrous metals.

Distributors

Combined Supply & Equipment Co., 215 Chandler Street, Buffalo, N. Y.,
foundry equipment and supplies.

Beals, McCarthy & Rogers, Buffalo, N.Y., foundry equipment and supplies.

Broadhead Garrett Co., Inc., Cleveland, Ohio, foundry equipment and
supplies.

Metal Goods Corporation, 19 East Cameron, Tulsa, Oklahoma, and 5239
Brown Avenue, St. Louis 19, Missouri, sales agent for Aluminum
Company of America, carries a full stock of aluminum, copper, and
other non-ferrous metals.

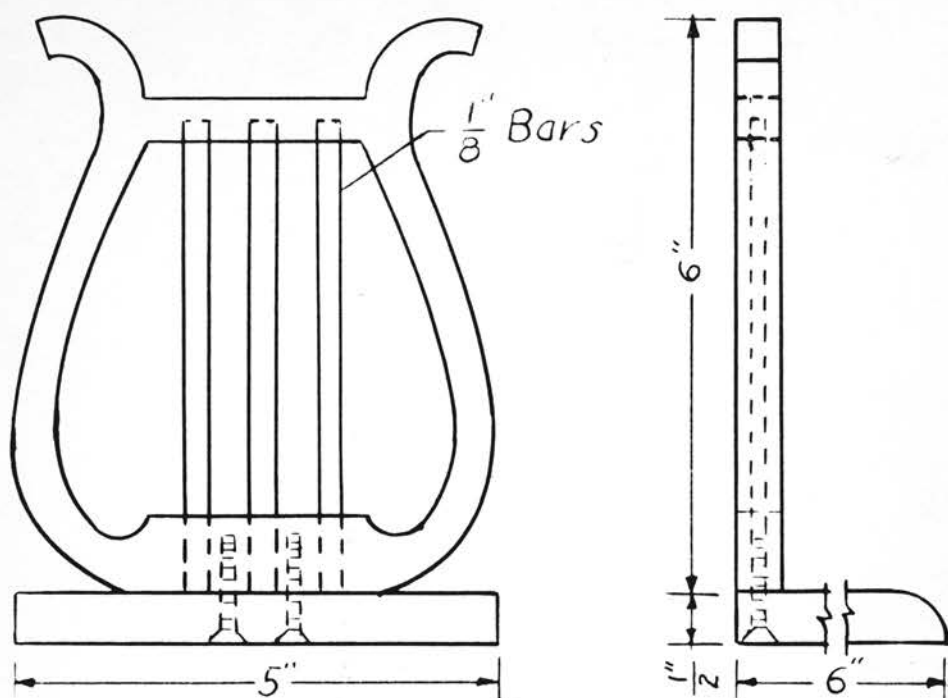
The S. Obermayer Co., 2563 W. 18th St., Chicago, Illinois, foundry
equipment and supplies.

Stevens Co., Inc., Detroit, Michigan, foundry equipment and supplies.

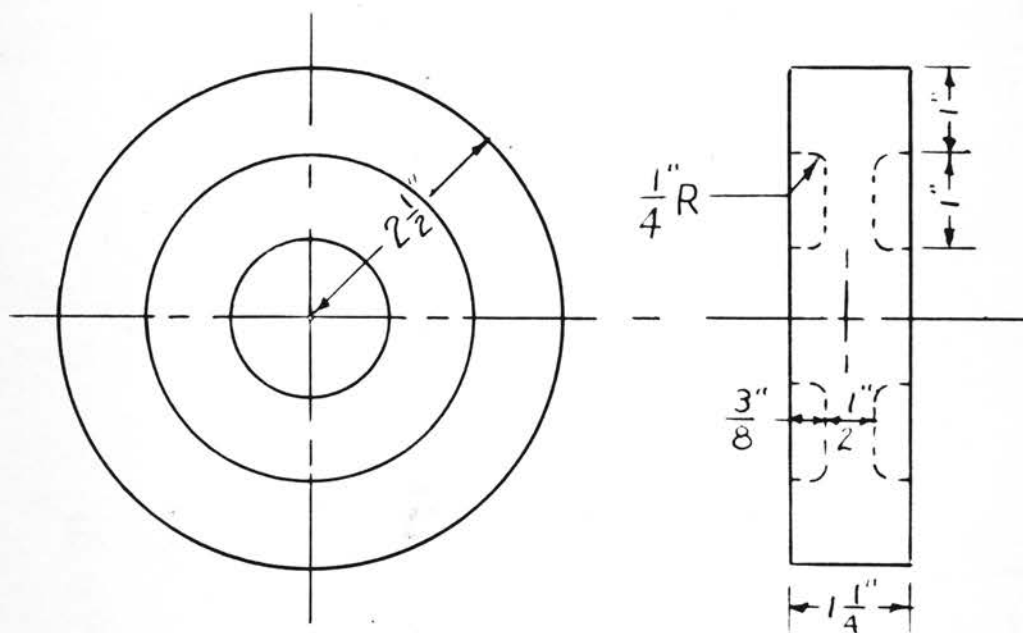
Projects for Foundry Work

Aluminum cast projects can be both utilitarian and artistic. Many articles, such as a skillet, can be cast using an originally finished piece for the pattern. The following drawings are of a gear blank and hook ends. These projects are appropriate to the ability of the high school student and give him an understanding of basic processes involved in foundry work.

Aluminum Book End Casting

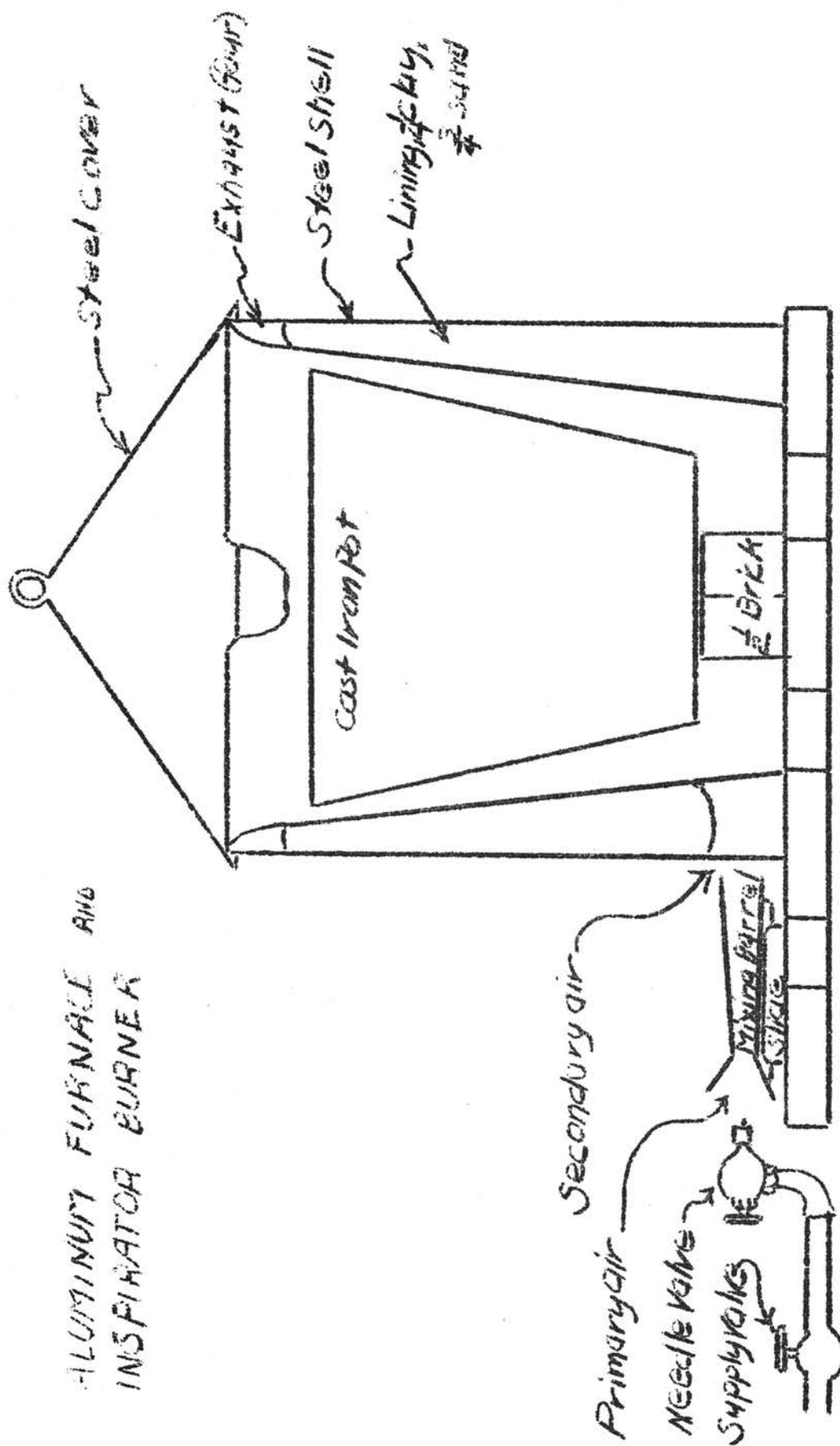


Aluminum Gear Blank Casting



B. Helm

ALUMINUM FURNACE AND INSPIRATOR BURNER



Typist: Evelyn D. Calhoun