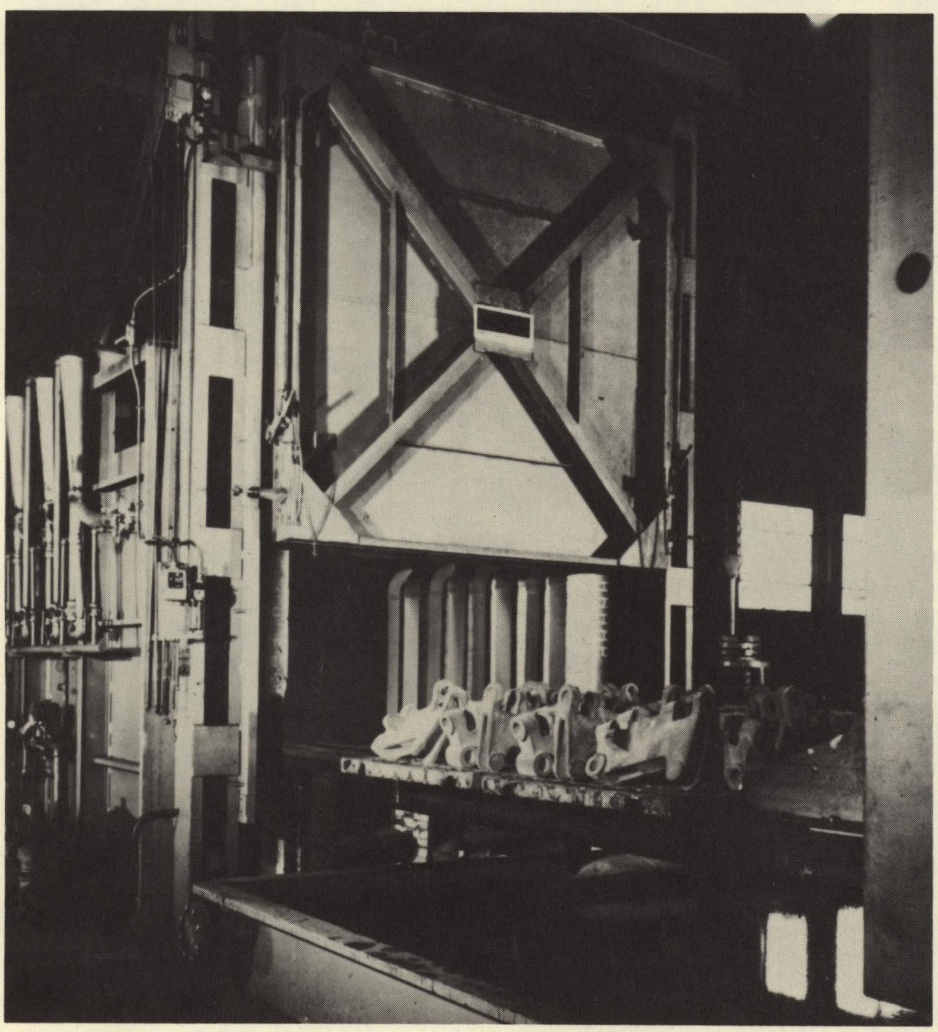
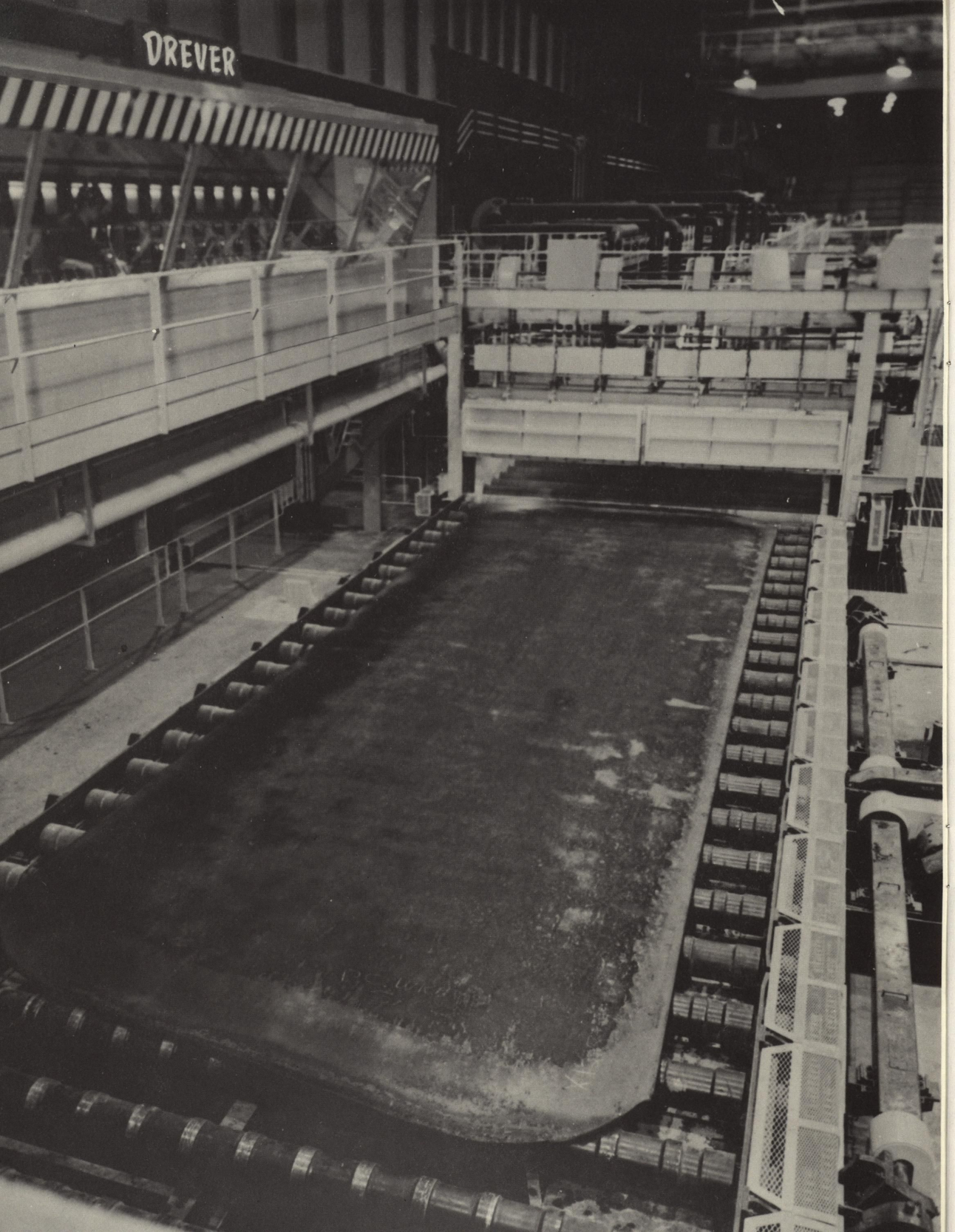
U.S. DEPARTMENT OF COMMERCE / Business and Defense Services Administration

THE INDUSTRIAL HEATING EQUIPMENT INDUSTRY IN 1965





Quench hardening and tempering furnace for steel plate

THE INDUSTRIAL HEATING EQUIPMENT INDUSTRY IN 1965

BDSA

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FOREWORD

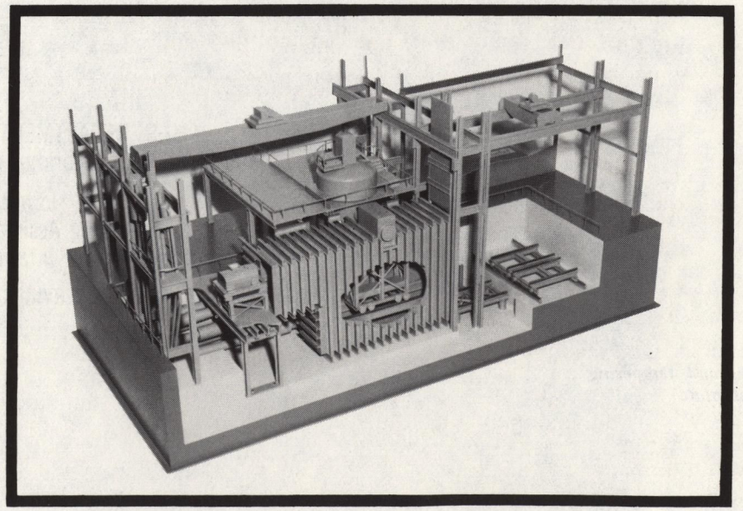
This report summarizes the unclassified results of a survey of 1965 shipments of industrial heating equipment conducted by the U. S. Department of Commerce for defense mobilization purposes. All known manufacturers of industrial heating equipment were surveyed, resulting in 296 establishment reports. The survey was conducted by the Metalworking Equipment Division, Business and Defense Services Administration.

Data collected by similar surveys in 1958 and 1960 are included for comparative purposes.

In addition to data collected by these surveys, the analysis of industry structure, cost structure, prices, and foreign trade is based on Bureau of Census and Department of Labor data, as well as on data collected by personal visits to selected manufacturing establishments representing a cross section of the industry. Technological information included was gathered from trade publications and from interviews with both manufacturers and users of industrial heating equipment.

The report was prepared by Robert A. Ricciuti and Robert B. Grant.

Rodney L. Borum
Administrator
Business & Defense Services Administration



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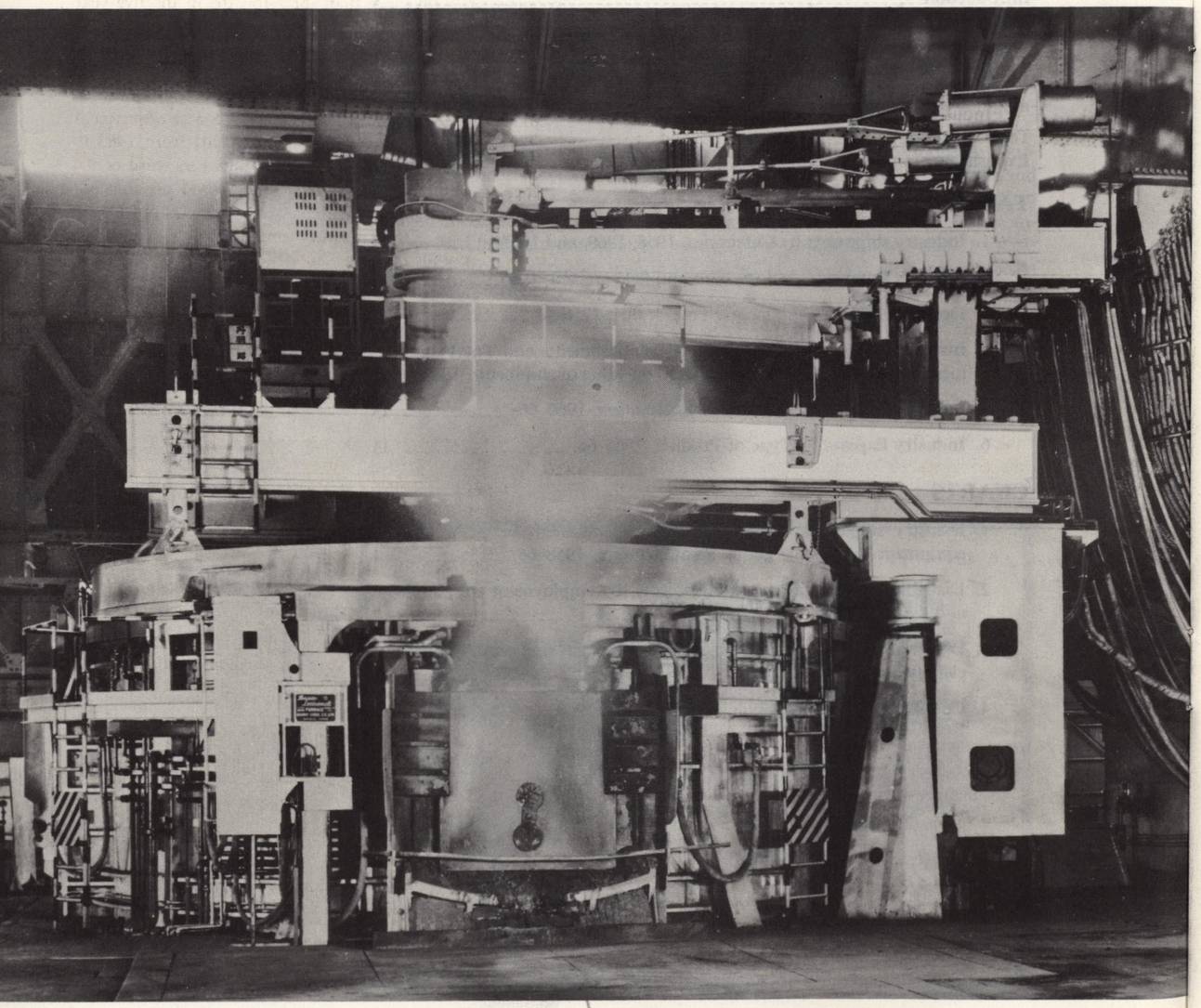
250 ton electric melting furnace



THE INDUSTRIAL HEATING EQUIPMENT INDUSTRY

Introduction

Many industries are dependent upon the scientific application and control of heat to change the physical and metallurgical characteristics of materials. This science has evolved to a point where it is essential to the economy and defense of the nation; without it, metals could not be melted, their inner structure could not be altered, and protective coatings could not be applied. The industrial heating equipment industry, through research in methods and equipment, has developed a technology to meet the demands of American industry, and has often shown the way to more profitable operations through the scientific control and application of heat.

With the expanded use of exotic metals and new applications for conventional metals new and different problems have arisen at a more accelerated rate than in previous periods. New equipment must constantly be designed and redesigned to meet these new requirements. The exotic metals now being used in missile and aircraft production require newer and different heat treating procedures. Not only do the end products made of these new metals require the industrial heating equipment industry to develop new and different equipment for the proper heat treatment of the items, but also the processing of these new raw materials into usable shapes requires an advanced technology in melting and hot forming equipment and methods. Even in the use of conventional metals in military and defense items there is an entirely new level of requirements on the industrial heating equipment industry.

The new critical factor is extreme flexibility in design and engineering and the ability to quickly provide new types of equipment and installations. Thus, while the industrial heating equipment industry still has the same essentiality, the capability and flexibility of the manufacturers of industrial heating equipment is far more important than in any previous mobilization period.

Summary

In 1965 the value of shipments of industrial heating equipment amounted to a record $514 million, an increase of 32 percent over the estimated $382 million shipped in 1964 and 67 percent over 1960 shipments of $302 million. Production increases have been exceptional in the most recent years with more than three-fourths of the five-year gain occurring in 1964 and 1965. Although part of the increase in value was due to increases in prices, which rose six percent from 1963 to 1965 following a period of stability from 1960 through 1962, the increase in output of industrial heating equipment from 1960 to 1965 with adjustment for price changes was close to 57 percent; from 1963 to 1965, 44 percent. With an average annual increase of 9.4 percent during the 1960–1965 period (based on constant dollars), shipments of industrial heating equipment exceeded the 4.7 percent average annual growth rate of the Gross National Product, and the 6.7 percent average annual growth of the durable goods industries combined for the same five year period.

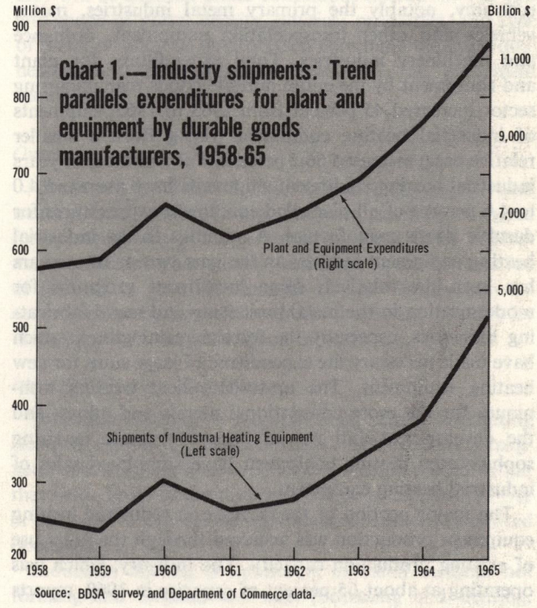
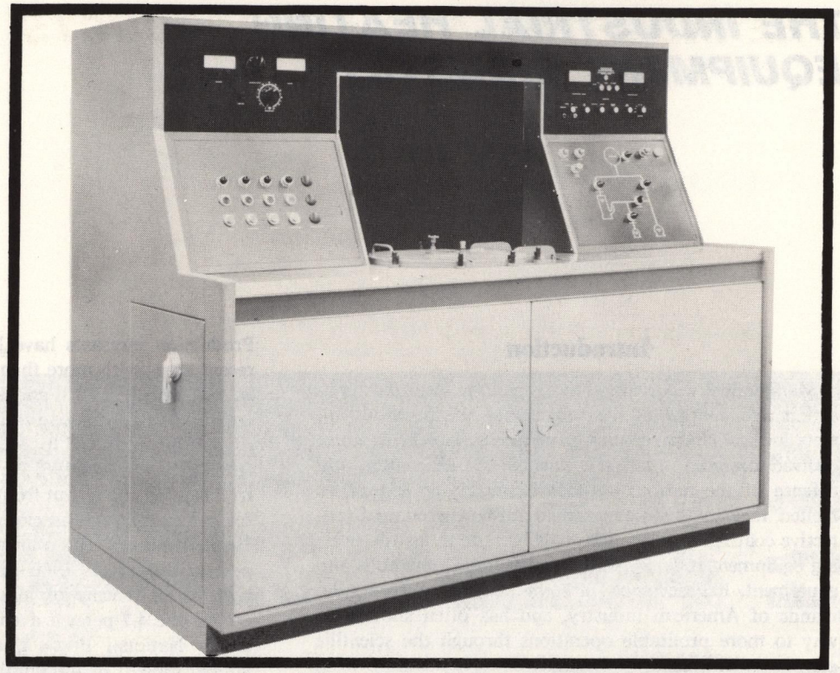


Chart 1.— Industry shipments: Trend parallels expenditures for plant and equipment by durable goods manufacturers, 1958-65

Source: BDSA survey and Department of Commerce data.



High temperature vacuum furnace for sintering reactive metals

The level of activity in the industrial heating equipment industry is largely dependent upon the investment expenditures of the durable goods manufacturing segment of the economy, notably the primary metal industries, motor vehicles and other transportation equipment, ordnance and machinery industries. Total expenditures for plant and equipment by the entire durable goods manufacturing sector increased 45 percent from 1963 to 1965; shipments of industrial heating equipment (rising from a smaller relative base) increased 66.2 percent. For a number of years industrial heating equipment shipments have averaged 4.0 to 4.6 percent of all plant and equipment expenditures for durable goods manufacture. A stimulus to the industrial heating equipment industry in the past two or three years has been the relatively large investment programs for modernization in the metal processing and metal fabricating industries, especially the ferrous metal group, which have made necessary the expenditure of large sums for new heating equipment. The up-to-date heat treating techniques for the more conventional metals and alloys, and the development and use of "newer" metals requiring sophisticated heating equipment have stimulated sales of industrial heating equipment.

The major portion of the increase in industrial heating equipment production was achieved through the fuller use of existing production capacity. The industry, which was operating at about 65 percent of capacity in 1960, reports that in 1965 it was operating at 85 to 90 percent of capacity. New entries and expanded production facilities in the industry are estimated to have amounted to about a 25 percent increase in capacity over the entire five-year period. Demand for industrial heating equipment continues to increase; net new orders (current dollars) in 1966 were more than 21 percent greater than 1965 net new orders. The industry's backlog of unfilled orders has been steadily rising for the past three years and averaged about 10 months as of December 1966, according to data collected by the Industrial Heating Equipment Association.

Improvements in applied technologies both internal and external to the industrial heating equipment industry have strongly affected the economies of production and utilization of industrial heating equipment. Technical innovations have shifted demand from one type of industrial heating equipment to another rather than changing the overall relationship of industrial heating equipment to the durable goods sector. The resulting variations in growth rates for different products and product classes have significant impact on individual firms in this industry where firms tend to specialize in rather narrow product lines. The BDSA survey indicates that two hundred and twenty five (three-fourths) of the establishments manufacture fewer than four specific types of equipment. Of these, one hundred and eighteen firms, make only one particular type of product.

THE INDUSTRY AND ITS PRODUCTS

Scope of Industry

The industrial heating equipment industry as referred to in this report is defined as including establishments engaged in the manufacture of any production items used for the melting, refining and heat processing of ferrous and nonferrous metals and certain non-metallic materials and heat-treatment of products made from them; also engineering firms which design industrial heating equipment. Included in the term industrial heating equipment are furnaces, ovens, heaters, heating machines, kilns, induction and dielectric apparatus, industrial combustion equipment, and accessories for all the foregoing; also included are auxiliary equipment such as quenching apparatus, atmosphere generators, heat exchangers, and washers. Excluded are processing equipment for food: kilns for cement, brick, clay, tile, grain, fertilizer, and wood; coke ovens, tanks for melting glass, steam and hot water boilers and their accessories, prime power equipment, comfort heating equipment, and oil, chemical and petro-chemical processing equipment. This definition is somewhat broader than that used by the Bureau of the Census in the Census of Manufactures for industry 3567, Industrial Furnaces and Ovens, under the Standard Industrial Classification (SIC) system. The latter classifies an establishment in a particular industry according to the value of production of its specific primary product or products; hence, the SIC 3567 may not cover those manufacturers of industrial heating equipment which on this basis could be classified in some other SIC industry, nor does it include engineering firms which are not manufacturing establishments.

Metal melting, refining, and holding furnaces

Melting is the first step in processing through which almost all metals must pass before being in their usable form. These processes range from smelting in huge blast furnaces to melting in miniature crucibles which are often designed to use the type of fuel most available at the plant location. This fuel may be solid, liquid, a gas, or electricity.

Hot Forming, Forging, Rolling, Piercing, and Extruding Heating Equipment

Equipment used for hot forming, forging, rolling, piercing and extruding of metals and non-metallic substances is basic to industry. This equipment ranges in size from large billet and slab reheating furnaces used in steel mills turning out hundreds of tons of steel per hour, to low-temperature ovens used for heating plastic sheet that is formed under very high pressures. Practically all of it is custom equipment engineered to suit a specific purpose. Many of today's materials require not only very special heating equipment prior to forming by any one of several methods, but, also may require very special atmospheres or a vacuum.

Heat Processing and Metal Treating Equipment

Heat processing and metal treating furnaces and related equipment are the machines which "form" and alter the micro structure and change metallurgical properties of metals, as other machines form or shape metals to change their outward appearance.

Heat treating is essential to give metal parts the characteristics needed to withstand the environment to which they will be exposed under continuous operation. The size and shape of parts, density, physical properties, and type of metal or alloy to be processed determine the individual heating and cooling cycles used and the equipment required.

Ovens

Ovens are used for drying, dehydrating, curing, heat treating, and stress relieving. They are generally designed for operating only at temperatures up about 1200° F. Heat may be derived from steam, electricity, or the combustion of fuel oil or gas. The transfer of heat energy may be accomplished by convection from circulating hot air, by radiation, or by a combination of both.

Induction Heating Equipment

Induction heating is accomplished when alternating electrical current is passed through a coil creating a magnetic field which induces a current in a metal placed within that field. These induced currents cause a temperature rise in the metal which can be accurately controlled for desired operations.

Induction heating is applicable in metal melting, hot forming and forging, and heat processing and treating.

Each application calls for different type furnaces, but all operate on the same basic heating principle.

Dielectric Equipment

Dielectric heating is a precise, high speed, heating process for drying, curing or preheating non-metallic material for a variety of requirements. Any material which is a non-conductor of electricity can be heated dielectrically by using it as the dielectric component of a simple capacitor arrangement. The heating occurs simultaneously throughout the mass and drying takes place essentially from the inside out, permitting processing at extremely rapid rates.

Auxiliary Industrial Heating Equipment

This section comprises a wide variety of standard equipment such as washers, quenching apparatus, calciners, etc., which are generally utilized in connection with industrial heating processes.

Combustion Equipment

Combustion equipment includes systems and system components required to convey, measure, control, mix and burn the fuel and air or oxygen required for the production of usable heat in industrial processes. This equipment can be used for combustion of both gas and oil and is adaptable for a variety of heat applications.

Atmosphere Generators

These units produce hydrogen, nitrogen, carbon monoxide, lithium gas, and other such gaseous substances which are used to provide the proper atmosphere in the interior of furnaces to prevent such undesirable effects as scaling, pitting, discoloration, and decarburization of the metal. For example, if metal parts are heat treated in a normal atmosphere, the gases present in the air can create a scaling condition on the surface of the metal. These undesirable effects are eliminated by substituting a suitable atmosphere in the furnace chambers.

Table 1.—Industry Shipments, by Categories, 1958, 1960, 1965

[In thousands of dollars]

Item	1965	1960	1958
Grand total	514,078	302,390	238,955
Cupolas and blast furnaces	66,549	n.s.a.	n.s.a.
Molten metal melting, refining, and holding furnaces (excluding blast furnaces and cupolas), total	58,924	21,113	22,909
Electric (except induction)	15,222	5,628	10,205
Ferrous	12,557	4,446	9,507
Non-ferrous	2,665	1,182	698
Fuel Fired	15,003	5,497	6,069
Ferrous	5,710	n.s.a.	n.s.a.
Non-ferrous	9,293	n.s.a.	n.s.a.
Induction	24,713	7,478	4,446
Ferrous	17,875	n.s.a.	n.s.a.
Non-ferrous	6,838	n.s.a.	n.s.a.
Vacuum	3,986	2,510	2,189
Ferrous	3,092	1,774	n.s.a.
Non-ferrous	894	736	n.s.a.
Hot forming, forging, rolling, piercing, and extruding heating equipment, total	33 108	17,668	18,804
Electric (except induction)	876	n.s.a.	n.s.a.
Fuel fired	28,570	n.s.a.	n.s.a.
Ferrous	23,742	14,433	15,859
Non-ferrous	4,828	n.s.a.	n.s.a.
Induction	3,662	2,596	2,407
Ferrous	2,301	1,609	1,752
Non-ferrous	1,361	987	655

Shipments in 1965

Two major product categories, metal melting equipment ($125 million) and heat processing and metal treating equipment ($159 million) accounted for more than half of the $514 million total of shipments of industrial heating equipment in 1965. Shipments by product category and product are summarized below. (The dollar values for 1965 shipments compared with 1960 and 1958 are presented in Table I).

Metal Melting, Holding, and Refining Furnaces

Shipments of metal melting, holding, and refining furnaces, except blast furnaces and cupolas, amounted to $58.9 million in 1965 or almost three times greater than 1960 shipments of $21.1 million. They accounted for 12 percent of 1965 total shipments of industrial heating equipment as compared to 7 percent in 1960.

Shipments of blast furnaces and cupolas amounted to $66.5 million in 1965. No comparable data are available for previous years.

Induction furnaces made the most significant percentage gain during the 1960–1965 period with 1965 shipments of $24.7 million, compared to $7.5 million in 1960. They now account for 42 percent of all the metal melting, holding, and refining furnaces (excluding blast furnaces and cupolas) as compared with 36 percent in 1960.

While 1965 shipments of electric furnaces (other than induction) amounted to $15.2 million as compared to $5.6 million in 1960, their share of the metal melting furnace market decreased only fractionally from 27 percent in 1960 to approximately 26 percent in 1965.

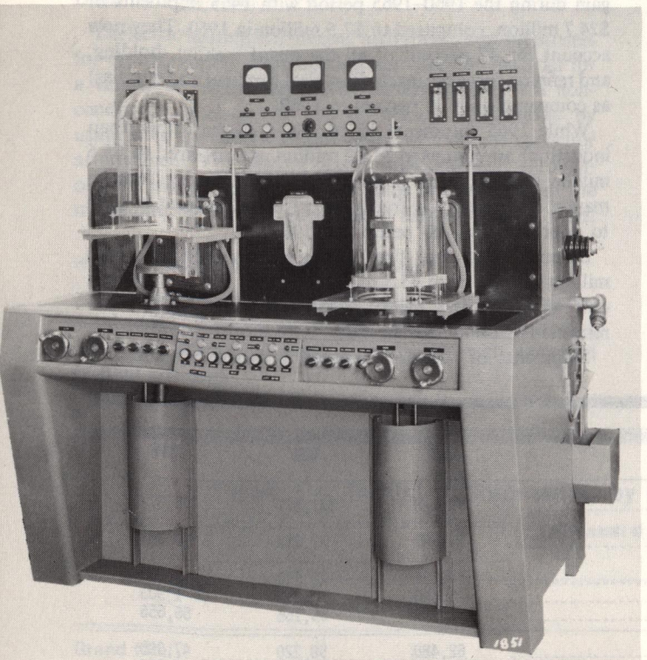
Shipments of fuel fired furnaces increased to $15.0 million in 1965 from $5.5 million in 1960, but their 20 percent share of the metal melting furnace market also remained virtually unchanged.

Shipments of vacuum furnaces, both electric and fuel

Item	1965	1960	1958
Heat processing and metal treating equipment, total	159,118	131,871	95,877
Electric (except induction)	24,687	22,915	12,257
Ferrous	18,381	19,873	10,354
Non-ferrous	6,306	3,042	1,903
Fuel Fired	72,947	65,166	56,656
Ferrous	62,480	58,220	47,090
Non-ferrous	10,467	6,946	9,566
Induction	15,780	13,580	10,436
Ferrous	13,290	9,682	7,410
Non-ferrous	2,490	3,898	3,026
Vacuum	9,641	2,674	1,262
Laboratory furnaces	3,521	3,763	n.s.a.
Bath type furnaces	3,175	1,908	1,384
Heating equipment without furnace chambers	665	1,087	142
Glass and ceramic equipment	17,383	17,355	9,771
Cellulose processing equipment	1,415	198	n.s.a.
Miscellaneous metal processing and heating equipment	9,904	3,221	3,969
Industrial process ovens, total	59,179	35,968	32,576
Electric	11,940	8,245	6,736
Fuel fired	45,735	25,853	24,664
Steam	1,504	1,870	1,180
Dielectric heating equipment	7,268	3,005	2,521
Auxiliary industrial heating equipment	33,826	n.s.a.	n.s.a.
Components			
Combustion equipment	40,330	21,721	15,277
Atmosphere gas generators and control equipment:			
Gas generators	6,980	5,366	4,115
Control equipment	1,365		
Regenerative and recuperative heat exchangers	3,978	n.s.a.	n.s.a.
Replacement and repair parts sold separately	43,453	45,209	24,283
Cost of sub-contracting	26,808	n.s.a.	n.s.a.

n.a. Not separately available.
Source: BDSA surveys.

Induction brazing unit for exotic metal combinations



fired, amounted to $4.0 million in 1965, decreasing to seven percent of the metal melting furnace market compared with 1960 shipments of $2.5 million which were 12 percent of the 1960 market.

Hot Forming, Forging, Piercing, Rolling, and Extruding Equipment

In 1965, the value of shipments of heating equipment used for hot forming, forging, piercing, rolling, and metal extruding processes amounted to $33.1 million, an increase of 85 percent over shipments of $17.7 million in 1960. Despite this gain, shipments by this segment of the industry have not grown as rapidly as shipments of industrial heating equipment as a whole.

Because this type equipment is incorporated with forging presses, rolling mills, and extruding equipment, the greater part is field erected (69 percent in 1965).

The breakdown by type of heat source for this equipment has changed little since 1960. Eighty-five percent of equipment shipped in 1965 was fuel fired, 13 percent was induction, and 2 percent was electric other than induction. High temperature requirements normally make the use of electricity uneconomical, thus the high degree of usage of fuel fired equipment. However, induction equipment does offer some advantages and is becoming more widely used for heating steel slabs before rolling, and in certain hot forming operations.

Heat Processing and Metal Treating Equipment

Shipments of heat processing and metal treating equipment were valued at $159.1 million in 1965, a 21 percent increase over 1960 shipments of $131.9 million. This segment of the industry, while accounting for the largest percentage of total industry shipments, has not shown the same high growth rate as other segments. In terms of value, shipments by this segment accounted for 31 percent of the total industry in 1965 compared to 44 percent in 1960.

Value of shipments of fuel fired equipment amounted to $72.9 million, or 46 percent of the entire group, as compared to $65.2 million or, 49 percent, in 1960. Shipments of electric equipment other than induction type were valued at $24.7 million, 16 percent of the entire group, a slight drop from their 17 percent of market share in 1960 when shipments amounted to $22.9 million. Shipments of induction equipment increased from $13.6 million in 1960 to $15.8 million in 1965; the market share for this equipment as a percent of the entire group remained at approximately 10 percent. Vacuum equipment showed the greatest increase with 1965 shipments amounting to $9.6 million as compared with $2.7 million in 1960 and its market share increased from 2.9 percent in 1960 to 6 percent in 1965.

Glass and ceramic processing equipment, cellulose equipment, bath type furnaces, laboratory furnaces and miscellaneous heat processing and metal treating equipment accounted for the remaining 23 percent of the value of shipments in this group.

Industrial Process Ovens

Shipments of industrial process ovens were valued at $59.2 million in 1965, an increase of about 65 percent over the $36.0 million shipped in 1960.

In 1965 and in 1960 industrial process oven shipments accounted for 12 percent of total shipments of industrial heating equipment.

Fuel fired ovens accounted for $45.7 million, or 77 percent of total 1965 oven shipments, as compared with $25.9 million in 1960 when shipments accounted for 72 percent. Shipments of electric ovens amounted to $12.0 million, as compared with $8.2 million in 1960, and shipments of steam ovens amounted to $1.5 million compared to $1.9 million in 1960.

Dielectric Heating Equipment

Dielectric heating equipment continued to account for only a small share of the total market for industrial heating equipment. In 1965, shipments of $7.3 million represented 1.4 percent of the total market as compared with 1960 shipments of $3.0 million, which represented 1 percent of the total market.

Auxiliary Industrial Heating Equipment

Shipments of auxiliary industrial heating equipment amounted to $33.8 million in 1965 or 6.7 percent of total shipments of industrial heating equipment in that year. No comparable data are available for previous years but this segment of the industry has probably grown at the same rate as the entire industry since its products are complementary to industrial heating equipment.

Components

Shipments of industrial heating equipment components such as combustion equipment, atmosphere gas generator and control equipment, and heat exchangers amounted to $52.7 million in 1965. Shipments of combustion equipment, amounted to $40.3 million; atmosphere gas generators and control equipment, $8.3 million, and heat exchanger shipments, $4.0 million.

Replacement and Repair Parts

Total shipments of replacement and repair parts sold separately from original equipment amounted to $43.5 million, in 1965. This was a decline of 3.8 percent from 1960 shipments of $45.2 million. Industry sources state that with large scale modernization programs under way, and with the technological improvements in industrial heating equipment, users tended to replace entire units rather than repair existing ones, and therefore the decline in shipments of replacement and repair parts is not surprising.

Industry Structure

Size of Establishments

Although the scope of the industrial heating equipment industry as used in this report is somewhat broader than that under the Standard Industrial Classification system, the structure of the industry is reasonably indicated by Bureau of Census data for SIC industry 3567, Industrial Furnaces and Ovens. In 1965, according to the BDSA survey, there were 296 establishments in the industry, with estimated employment of 15,851 persons and value of shipments amounting to $514 million; in 1958 there were 201 establishments with total employment of 10,288 persons and having value of shipments amounting to about $205 million. A comparison of the distribution of establishments by size of employment shows an increase in the predominance of smaller establishments. In 1958, 55 percent of the total number of establishments employed less than 20 persons; in 1965, 60 percent employed less than 20 persons. Chart 2 shows the percentage distribution of establishments by employment size in 1965 compared with 1958.

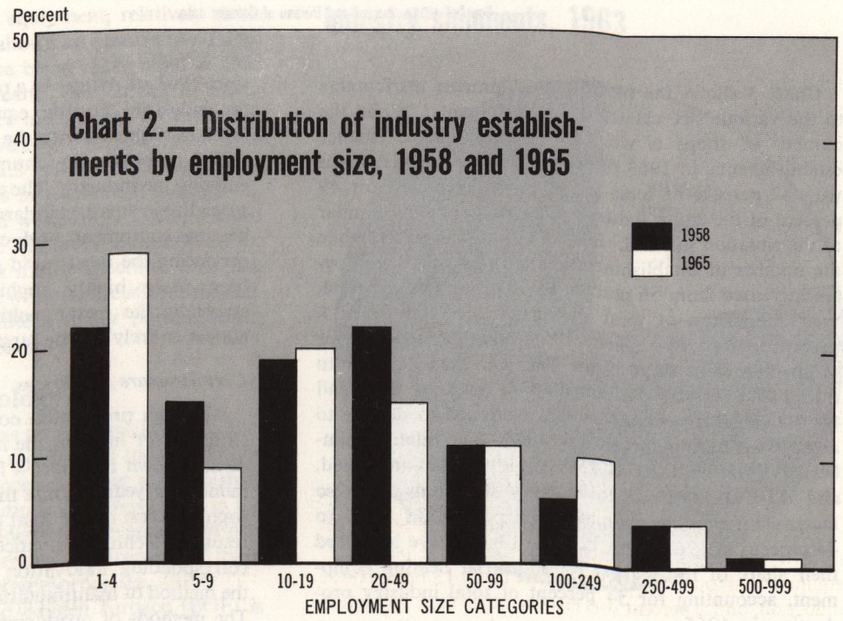


Chart 2.— Distribution of industry establishments by employment size, 1958 and 1965

Source: BDSA survey and Bureau of Census data.

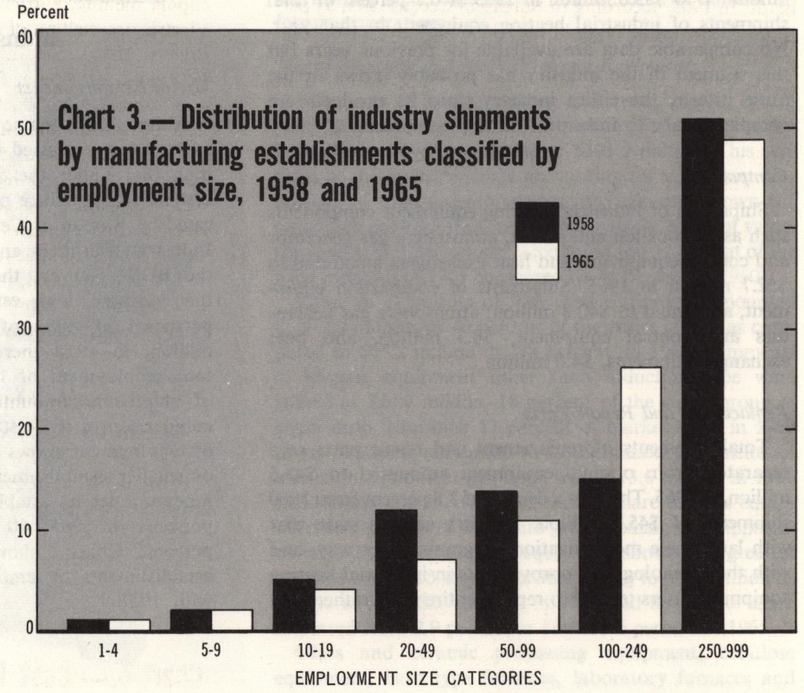


Chart 3.— Distribution of industry shipments by manufacturing establishments classified by employment size, 1958 and 1965

Source: BDSA survey and Bureau of Census data.

Chart 3 shows the percent of shipments attributable to the various size classes of establishments. While the number of shops is weighted heavily toward smaller establishments, in 1963 the twelve largest establishments with 42 percent of total employment accounted for 49 percent of the entire industry value of shipments, similar to the situation in 1958. Between 1958 and 1963, while the number of establishments with 19 or fewer employees increased from 56 percent to 62 percent of the total, their proportion of total shipments decreased from 8 percent to 7 percent. Since 1958, however, the number of medium and large firms has increased relative to the smaller shops. The contribution made by the small firms to industry shipments has continued to decline to about 6 percent of the total in 1965. The relative number of firms with 20 to 250 employees has increased, and their contribution to industry shipments has also increased from approximately 41 percent in 1958 to 44 percent in 1965. The 12 largest firms have increased their share of the market for industrial heating equipment, accounting for 54 percent of total industry production in 1965.

The reasons for the structural changes in the industry since 1963 are many. As a result of the high level of demand for industrial heating equipment, many of the smaller firms have grown into the next larger size category without a corresponding number of small new enterprises entering the industry. The majority of small establishments specialize in small, standard, and relatively unsophisticated heating equipment and components. The products experiencing the most rapid growth from 1963 to 1965 have been those highly sophisticated types of equipment, especially the metal melting types, which are produced almost entirely by the larger establishments.

Cost Structure and Prices

Although production costs have risen, the general cost structure for firms in the industrial heating equipment industry shown in Chart 4 has remained fairly stable for a number of years. While the modern nature and increased sophistication of the final products of the industry are the results of technical advances, there generally have not been corresponding innovation and technical improvement in the method of manufacturing industrial heating equipment. The methods of producing a furnace or oven in 1966 are almost identical to those of the late 1930's. In the area of product standardization and its resulting mechanization and mass production techniques, little progress had been made. In 1963, according to Bureau of Census data, 51 percent of the value of industrial heating equipment shipments was directly attributable to the costs of materials, parts, supplies, energies and fuels, and contract work. This has been a fairly consistent ratio for a long number of years. Labor costs accounted for about 28 percent of the 1963 value of shipments as they did formerly. Because of the nature of this industry, there is little expectation for any radical labor-saving innovations in this area. The relationship of labor costs and material costs to total costs and prices is likely to remain fairly constant.

Prices of industrial heating equipment are very closely related to the costs of purchased material and labor costs. To a large extent, the "value added" by the industrial heating equipment firms is in the area of engineering and assembly functions and few of the components and materials incorporated in their final product are produced by the industry. Thus increases in materials and components costs are usually directly reflected in prices of heating equipment.

In recent years and particularly in 1966, the industry has been faced with rising prices of three of its main materials: refractories, which account for 10 to 35 percent of total costs of furnace installations; instrumentation and control units for heat treating furnaces, which account for 5 to 15 percent of the total equipment cost; and copper components, an important item in electric industrial heating equipment. Labor costs also have risen as a result of increased overtime work and a higher wage rate.

Prices of industrial heating equipment, relatively stable from 1960 through 1962 have shown an upward trend since 1962, with the rate of increase being more rapid in 1965 and 1966 than in previous years. The Bureau of Labor Statistics (BLS) wholesale price index series for the industrial process furnaces and ovens group rose from 108.8 (1957–59 = 100) in 1962 to 121.3 in 1966, total increase of 11.8 percent; percent increases in the annual averages for successive years in this period were 1.8, 1.5, 2.8, and 4.5 respectively. According to the BLS subgroup indexes, the largest price increases were in motor generator induction heaters, which have been faced with rising costs for the electrical materials which constitute a major portion of the materials used in their production.

Technology

The art of heat application as an industrial manufacturing technique has advanced so rapidly that today's innovations are tomorrow's basic processes. After a long history of gradual technological evolution, there have been in the last few years a sudden and widespread acceptance of new techniques and a highly accelerated replacement of traditional methods by new or alternate processes.

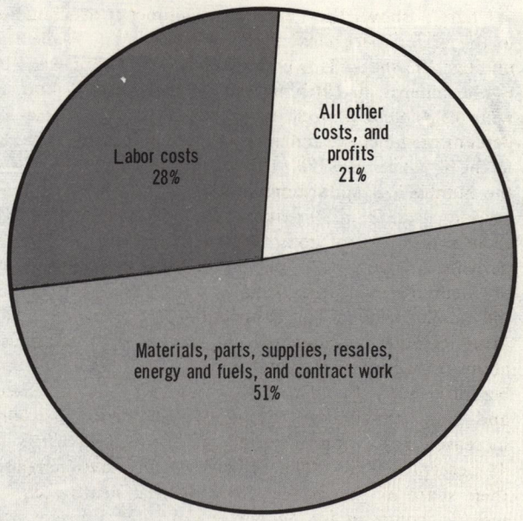
In metal melting, the basic oxygen furnace (BOF) is melting more steel at less cost than the open hearth process. Electric arc melting of steel is developing to meet the challenge of the BOF process. Induction melting in foundries in some instances has proven better and less costly than cupola melting, and gives a dividend of no air pollution. Electric arc melting of ductile and malleable iron in foundries is also successfully challenging the cupola process. In rolling, extruding, forging, and forming, the methods and volume of production are now far less restricted by heat equipment limitations and capabilities. The present technology of heat treating, atmosphere control, and combustion engineering has developed to such a point that many companies engaged in the use of these processes must reassess the techniques they are currently using and make decisions based on advantages to be gained from the more recent developments.

Some of the more recent developments in industrial heating equipment and their advantages to modern industry are mentioned and discussed below:

Metal melting, holding, and refining equipment

Steel making methods have been changing radically and no one technique has been unaffected by developments in industrial heating equipment. Often improved techniques have been dictated by competition from other methods.

Chart 4.— Cost factors in value of industry shipments, 1963



Source: 1963 Census of Manufactures.

Beginning with the blast furnace, the primary step in steel making, fuel injection systems have cut coke requirements 25 percent and dynamic controls measure furnace conditions, anticipate changes and automatically make adjustments to produce desired results.

The oxygen furnace is perhaps the most significant development in recent years and each year accounts for a larger percentage of steel production. However, electric arc furnaces, constantly being improved, are becoming more competitive with even the basic oxygen process. The traditional open hearth process can be improved by conversion to a dual melting system, whereby a furnace is split in two sections each of which is operated separately; the gases from metal being refined in one section preheat the scrap in another. With this method a charge is heated in 4–5 minutes as opposed to 45 minutes in conventional open hearth furnaces.

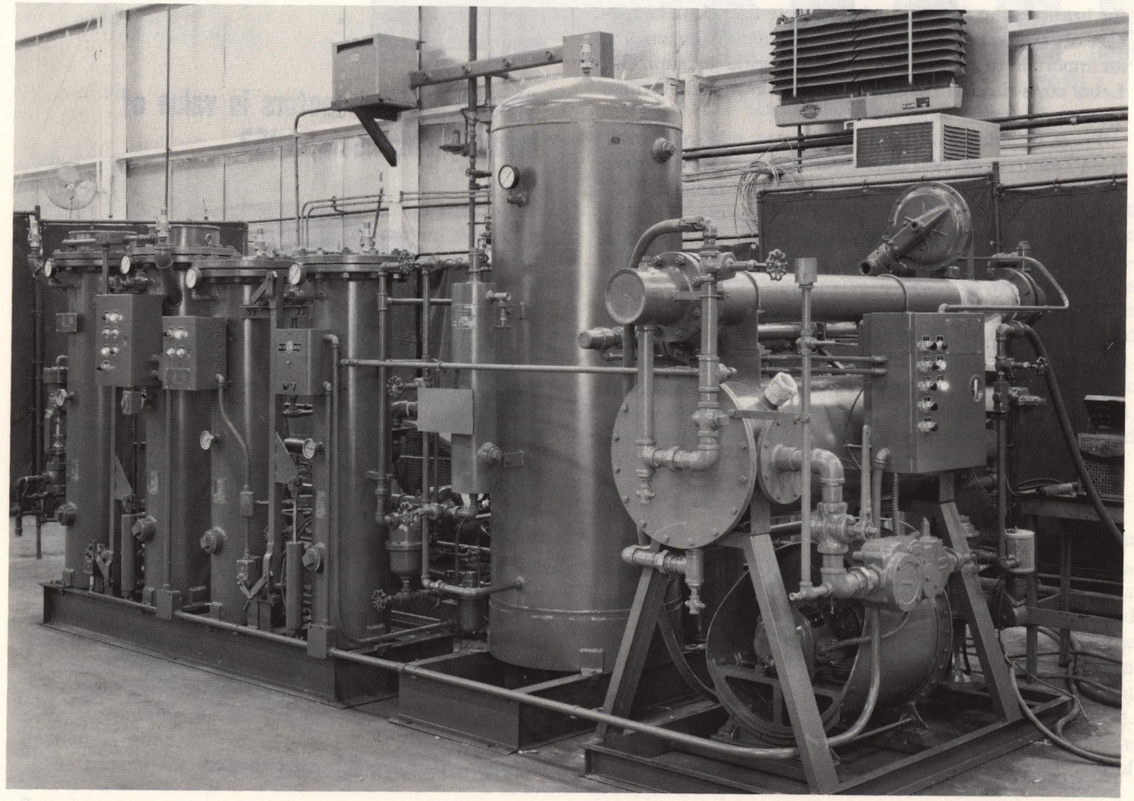
Improvements in electric arc furnaces are causing steel makers to consider this equipment for making low carbon steel whereas formerly they were used almost exclusively for alloy steel. Increased power capabilities, relatively low capital cost, and the ability to produce carbon, alloy, and stainless steel all have contributed to increased use of electric arc furnaces.

Vacuum steel making techniques are becoming more sophisticated and have many advantages. Vacuum arc-furnace degassing provides for lower tapping temperatures which result in longer refractory life in both the furnace and the ladle; shorter furnace time results in increased furnace output; ability to charge larger amounts of alloy scrap permit higher alloy melts and better yields.

The vacuum steel making technique is expected to become increasingly popular as the demand for special steels of the properties produced by vacuum degassing increase to meet the advanced metallurgical requirements of all metalworking industries. While the cost per ton of vacuum degassed steel is relatively high at the present time, continued research by furnace builders, together with increased production to meet increased demands will result in cost reductions.

As in steel making, technological developments in iron melting methods have revolutionized that industry. Never

Atmosphere gas generator



before has the foundryman benefitted to such an extent by developments in melting techniques. With the induction furnace becoming competitive with and offering advantages over the cupolas and with the electric arc furnace becoming more and more competitive with both methods, foundries can choose a method of melting tailored to fit their metallurgical and production requirements. Perhaps the most significant development in this field in recent years has been the widespread acceptance of the induction furnace which formerly was generally restricted to non-ferrous work. Induction melting enables accurate temperature control, faster and more uniform melting, higher yields, and an added dividend of less air pollution. The advantages and economies of induction melting, not only in iron foundries, but also in non-ferrous foundries, are such that continued developments are tending to making this process also more competitive for foundry melting.

Electric arc melting of iron is challenging the induction furnace method and proponents claim it can surpass induction melting in many areas.

Despite the rapid advances of electric induction and electric arc melting furnaces, cupola melting is expected to continue to be the leading method for melting, particularly in large foundries. Since it is a continuous melting furnace, whereas induction and arc are batch types, once control is achieved it provides for a constant and uniform melt. Computerized controls of charging and melting processes enable closer control of these operations and result in more refined melts; also developments such as down draft cupolas to combat air pollution will contribute to the cupola furnace holding its position.

Hot Forming, Forging, Rolling, Piercing and Extruding Heating Equipment

Developments of industrial heating equipment for hot forming, forging, and extruding have enabled producers of both ferrous and nonferrous items to manufacture better products at less cost.

Requirements for slab reheating furnaces have developed to such an extent that furnaces are designed for a specific job rather than being produced in standard types. Undesirable skid marks and water cooling problems are being prevented by using top fired furnaces. Control of scale, desirable in some instances and undesirable in others, is now possible. Computers are being utilized to solve design problems and to predict temperature variations. Conventional furnaces such as roller hearth and walking beam furnaces are being redesigned to meet specific needs when newer alternatives fail to solve particular problems.

Induction furnaces also contribute to advances in technology in this area. Induction heating offers advantages of controlled heat penetration, and less waste by reducing scale. Further economies are realized in that there is uniform heating throughout the entire workpiece, lower energy consumption, application of power only when desired, and reduced heat loss in moving the workpiece from furnace to mill. Certain disadvantages are encountered. for example a single system may not be suitable to a wide range of sizes, and cost of electrical energy may be high, but when other savings are considered they may outweigh the disadvantages thus making induction heating the most economical method.

Heat Processing and Metal Treating Equipment

More and more attention is being paid to getting the most out of metals by heating treating, and continuing demands are being placed on equipment builders for sophisticated equipment. Self-generating atmosphere furnaces for deep drawn steels, rapid plate quenching, and high speed heating for galvanizing lines are examples of some of the recent developments in heat treating equipment.

Vacuum treating of steel is becoming more acceptable to industry. Once used solely for heat treating titanium and other exotic metals as the only method suitable, new developments have made it more economical for use in heat treating stainless and tool steels. While this method is still more expensive than heat treating in controlled atmospheres, certain advantages such as better control of carburization, the elimination of surface hydrogen to improve ductility, and better elimination of oxygen bearing contaminants, tend to reduce costs by eliminating other operations and prolonging the life of end products.

The recent development of continuous vacuum furnaces has been so successful for annealing flat rolled titanium coil that this process is now being considered for use in annealing steel.

Exports and Imports

The export market is an important and expanding outlet for sales of industrial heating equipment. According to preliminary data from the Bureau of Census, export in 1966 amounted to $53.4 million as compared with $42.2 million in 1965.

Because of the high cost of electricity in most foreign countries, fuel fired equipment has accounted for a larger percentage of exports than has electric equipment. For instance, in 1966, fuel fired exports amounted to $31.0 million while electric equipment amounted to $22.4 million.

Canada has been the principal country customer, usually taking far more equipment from the United States than any other country. Other consistantly large customers of U. S. industrial heating equipment are Mexico, India, and Japan. When a country embarks on a large scale expansion of its steel making capacity, exports of U. S. industrial heating equipment to that country normally increase proportionately.

Imports of industrial heating equipment are relatively small and normally account for only a small percentage of domestic consumption.

Table 2.—Industry Shipments, Factory Built and Field Erected, 1965

[In thousands of dollars]

Type of equipment	Factory built	Field erected
Molten metal melting, holding and refining furnaces	37,894	87,489
Electric	2,909	12,313
Fuel fired	2,230	12,773
Induction & vacuum	(1)	(1)
Blast furnaces and cupolas	(1)	(1)
Hot forming, forging, rolling, piercing, and extruding equipment	7,354	25,754
Electric, including induction	3,716	912
Fuel fired	3,638	24,842
Heat processing and metal treating equipment	85,011	74,107
Electric, including induction and vacuum	42,724	7,384
Fuel fired	17,381	55,566
Glass and ceramic	12,212	5,171
All other	12,694	5,986
Ovens	23,813	35,356
Electric	9,346	2,594
Fuel fired	13,638	32,097
Steam	829	675

[1] *Disclosure may reveal individual company data.*
Source: BDSA 623A.

Table 3.—Industry Shipments, Total Value, 1956-65

[Millions of dollars]

Year	Value
1956	258.3
1957	307.8
1958	252.9
1959	236.6
1960	302.4
1961	263.4
1962	278.5
1963	333.9
1964	382.1
1965	514.0

Source: For 1956–58 and 1960 data, BDSA surveys; for 1959 and 1961–64 data, BDSA estimates based on Bureau of the Census and Industrial Heating Equipment Association data.

Table 4.—Industry Structure: Distribution of establishments and total shipments by size of establishment based on value of shipments, 1965

Shipment Category, based on value ($1,000)	Establishments		Shipments	
	Number	Percent of total	Value ($1,000)	Percent of total
Up to 500	162	54.7	27,306	5.4
500–5,000	108	36.5	177,711	35.2
Over 5,000	26	8.8	309,061	59.4
Total	296	100.0	514,078	100.0

Source: BDSA surveys.

* U.S. GOVERNMENT PRINTING OFFICE: 1967—251-027/117

Table 5.—Industry Exports by Country of Destination, 1960-66

[Thousands of dollars]

Country of destination	1966	1965	1964	1963	1962	1961	1960
Canada	14,426	9,736	6,961	3,078	5,941	2,331	5,292
Mexico	5,636	6,710	3,219	2,030	1,643	1,344	2,506
Venezuela	1,023	1,181	1,204	426	900	847	516
Argentina	1,434	854	802	1,048	1,434	1,881	1,873
United Kingdom	1,971	1,955	1,010	785	649	1,067	772
West Germany	1,686	1,695	1,473	236	726	801	819
France	2,266	1,422	678	432	948	691	326
Italy	1,560	1,406	1,951	3,528	2,185	2,406	648
Spain	5,840	573	753	774	880	90	109
India	3,262	1,753	3,542	2,000	823	1,397	1,151
Japan	1,842	2,661	2,355	1,969	4,806	4,890	3,471
Other countries	12,550	12,324	8,881	15,510	7,034	8,148	6,352
Total	53,496	42,270	32,829	31,816	27,967	25,893	23,835

Source: Bureau of Census Report (FT 410).

Table 6.—Industry Exports by Type of Product, 1965-66

[In thousands of dollars]

Product	1966	1965
Electric melting and refining furnaces	3,737	2,334
Electric heat treating furnaces	2,776	3,477
Electric ovens, n.e.c.	3,379	3,165
Induction & dielectric equipment	3,871	4,008
Parts & attachments for electric furnaces and ovens	4,541	3,836
Electric lab furnaces	4,186	2,949
Fuel-fired lab furnaces	5,682	4,048
Parts & attachments—fuel fired furnaces and ovens	10,155	7,797
Fuel-fired metal melting furnaces	7,041	669
Fuel-fired metal processing furnaces	1,460	1,860
Fuel-fired hot metal forming, forging furnaces	590	249
Fuel-fired ovens	222	759
Fuel-fired parts & attachments, n.e.c.	5,856	7,119
Total	53,496	42,270

Source: Bureau of the Census Report (FT 410).
Because of a change in nomenclature effective January 1, 1965, the 1965–66 data cannot be compared with data for pre-1965 years.


DEPARTMENT OF COMMERCE
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