PART II—EQUIPPING AND OPERATING THE NEW WIRE MILL

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Alloy and Diamond Dies

The experience gained in operating the older Hawthorne and Point Breeze wire mills demonstrated the importance of providing and maintaining dies of high quality. The hardest materials, alloys such as tungsten carbide and flawless diamonds, are used in these dies.

The alloy dies are used in the No. 1 drawing machine where the wire surface and resulting die wear are relatively small per pound of wire produced.

Diamond dies are used exclusively in the No. 2 machine. Definite problems were solved in maintaining dies to rigid specifications which include correct die contours, a finely polished surface, and definite die pull values.

The cross section of a diamond die, Fig. 17, illustrates the general contour found to be most satisfactory for high speed wire drawing. The approach blends smoothly into the reduction angle where the wire is reduced in diameter one AW gage. The bearing is approximately 40% of the wire diameter. With the use of a contour projector, 100X enlargements of die impressions are periodically made to control the process.

Well graded diamond dust is used to enlarge the hole in the die and for polishing operations. Dust graded by flotation methods, closely checked, offers the best results.

For final polishing 6 micron diameter dust is used. A 30X wide angle binocular microscope is used to check the various stages of die making operations and of inspection as shown in Fig. 18.

The following die pull requirements have been set up for each gage when reducing wire one AW gage size:

AWG Size	Pounds Pull	AWG Size	Pounds Pull
15	75	21	21
16	60	22	17
17	49	23	13.5
18	40	24	11
19	32	25	9
20	25	26	7

After grouping dies of a certain diameter according to the pounds pull required, they are matched into sets for use in the No. 2 drawing machines. Records are kept of the characteristics and output of each die.

The increase in speeds up to 12,000 f.p.m. does not appear to have an appreciable effect on die wear. In other words, the same quality and quantity of wire can be obtained from high speeds as from low speeds if (1) the dies are made to definite specifications, (2) the dies are matched into sets, and (3) the drawing machine factors are the same.

The drawing machines have been designed and are maintained with the view of overcoming some of the serious causes of short die life. Long die life is not only obtained by good die shop practice but also control of the following machine factors; (1) smooth drawing capstans and minimum slip, (2) minimum whip of wire entering dies, (3) adequate lubrication of capstans and cooling of dies, and (4) elimination of foreign particles from the drawing compound.

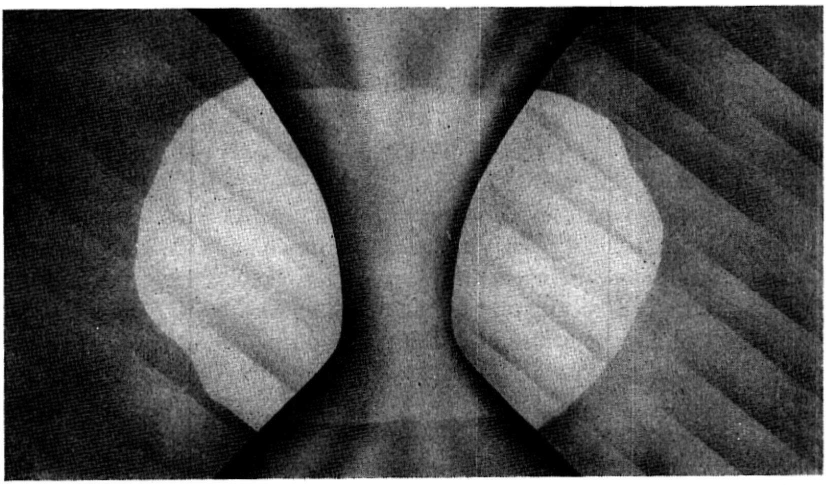

Fig. 17—Schematic showing cross-section of diamond die used in high speed wire drawing

Drawing Compound and Equipment

A one-story building is used for manufacturing wire. In the basement the drawing compound tanks, piping, heat exchangers, pumps, power services and controls are installed. The compound solution used to lubricate and cool the capstans and dies in the drawing machines consists of a homogenized solution of soap, fat and oil mixed with water. This compound returns to a self-cleaning distributing launder in an enclosed steel tank. The launder consists of a pipe with slots evenly depositing the compound over the entire width of the tank. The copper sludge settles to the bottom and the lighter impurities rise to the surface to be held back by a skimmer plate. The clarified super-natant solution rises over a dam into the pump suction chamber to be pumped at the rate of 200 gallons per minute to each No. 1 machine and 100 gallons per minute to each No. 2 machine. The heat from the clean compound is removed in heat exchangers as the compound is delivered to the machines. The compound is maintained at approximately 130°F by a closed recirculating water system thermostatically controlled, Fig. 19.

Layout of Principal Wire Mill Equipment

The building used for wire drawing is ideally situated adjacent to the cable manufacturing unit and has facilities for water, rail and motor truck

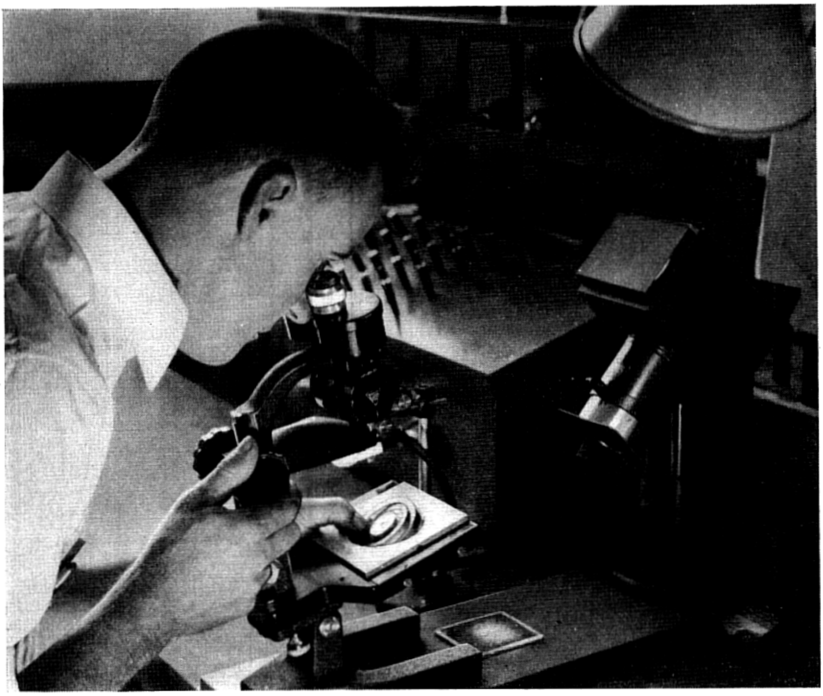

Fig. 18—Microscopic examination of diamond die polish by die maker

deliveries. The area is easily ventilated and has excellent illumination provided by mercury vapor lamps, close to a high ceiling yet providing an average of more than 20-foot candle illumination. Stroboscopic effect is practically eliminated by staggering the lamps over separate phases of the three-phase circuit.

The No. 1 machines are located adjacent to the copper rod receival area. The No. 2 drawing machines, nine of them in a row, are placed in the center of the building. Along the wall, five annealing bases for the electric bell type furnace are located. A bridge type crane handles all the material between the No. 2 machines, annealing and inspection. This layout, Fig. 20, of the equipment makes possible quick and easy transfer of material

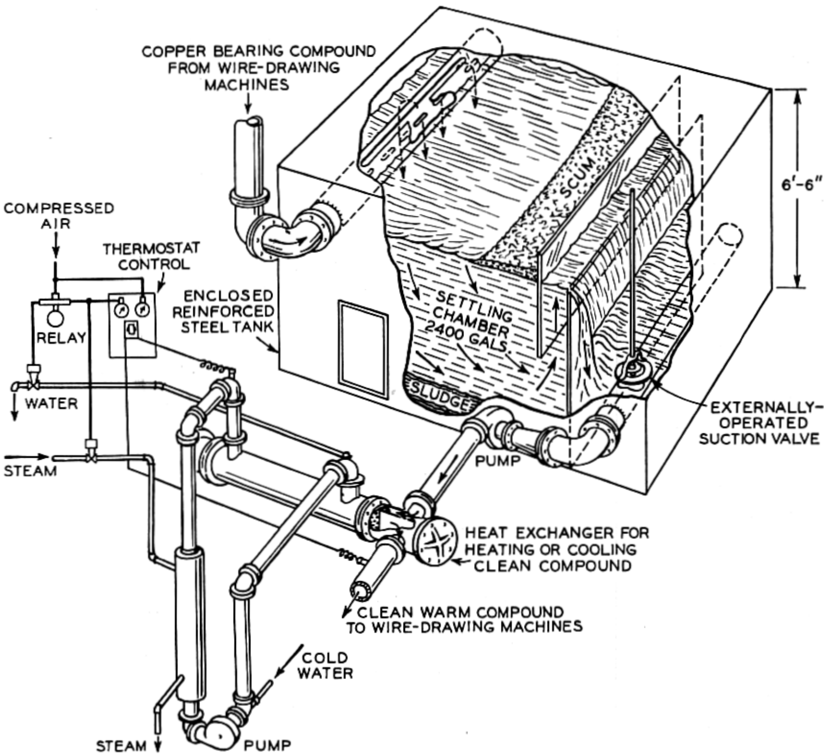

Fig. 19—Sectional sketch of compound system

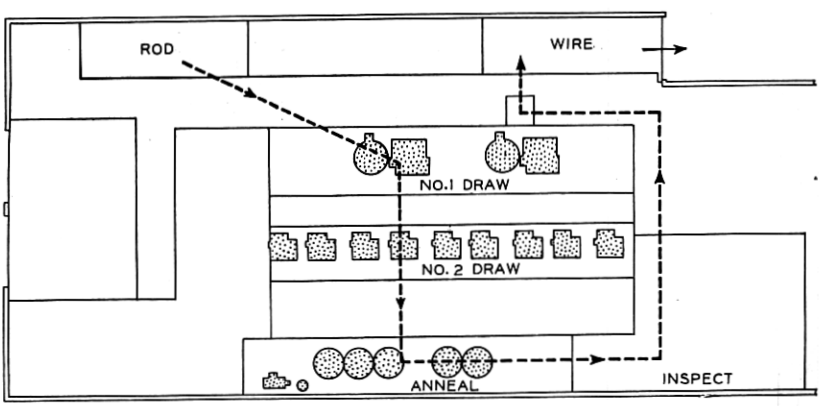

Fig. 20—First floor layout of wire mill

between operations, low inventories and multiple operation of machines by operators. Capacity can be increased without rearrangement. Adequate space has been provided to facilitate maintenance. The entire distance from the receival of rod to the wire shipping area is 100 feet. One electric truck and the crane just mentioned, suffice to handle and transport all materials in the building.

On either side of the main flow of material, space is provided for storage of rod, shop maintenance machines and racks.

Processes in the Wire Mill and Flow of Material

Copper rod is delivered on double prongs of an electric truck, approximately 4,000 pounds at a time, and is placed adjacent to each of the No. 1 drawing machines, Fig. 21. Here each 250-pound coil is placed on the floor of the eight-foot diameter supply table. A maximum of four coils is maintained on the table at a time. The rod ends are electro-welded to form a continuous supply. As rod from one coil is converted to wire, the operator pushes a button and rotates the table 90° to locate the next coil. This process of supplying coils, welding rod ends and rotating the supply table is repeated while the machine continues to fill the 1000-pound reel with 14 gage (.064″) wire at 5000 f.p.m.

When the machine automatically stops, the operator opens the spooler compartment and actuates an air operated mechanism which releases and pushes the two-foot diameter 1000-pound reel off the take-up arbor. An empty reel is placed on the arbor and locked. The guard is closed and the push button starts the machine with no additional attention on the part of the operator, who returns to the welding operation after placing the filled reel in the storage area.

The 1000-pound reel must be up-ended before it can be placed under the supply compartment of the No. 2 machine. The up-ending device, Fig. 22, consists of two floor castings, a pneumatic hoist and cables. The operator first rolls the large reel on the first floor casting and then actuates the pneumatic hoist. The cables hinge upward two castings like covers of a partly closed book, forming 45° angles with the floor. At this position the weight of the reel settles onto the second casting. The operator releases the air and the reel is gently lowered upon floor rollers. The axis of the reel is now vertical.

One end of the copper wire is electro-welded to the wire end of one of the two reels in the supply compartment. As the machine empties the first reel, the operator pushes the second and third reels into the supply position within a compartment. A continuous supply is thereby provided with safety and ease of handling.

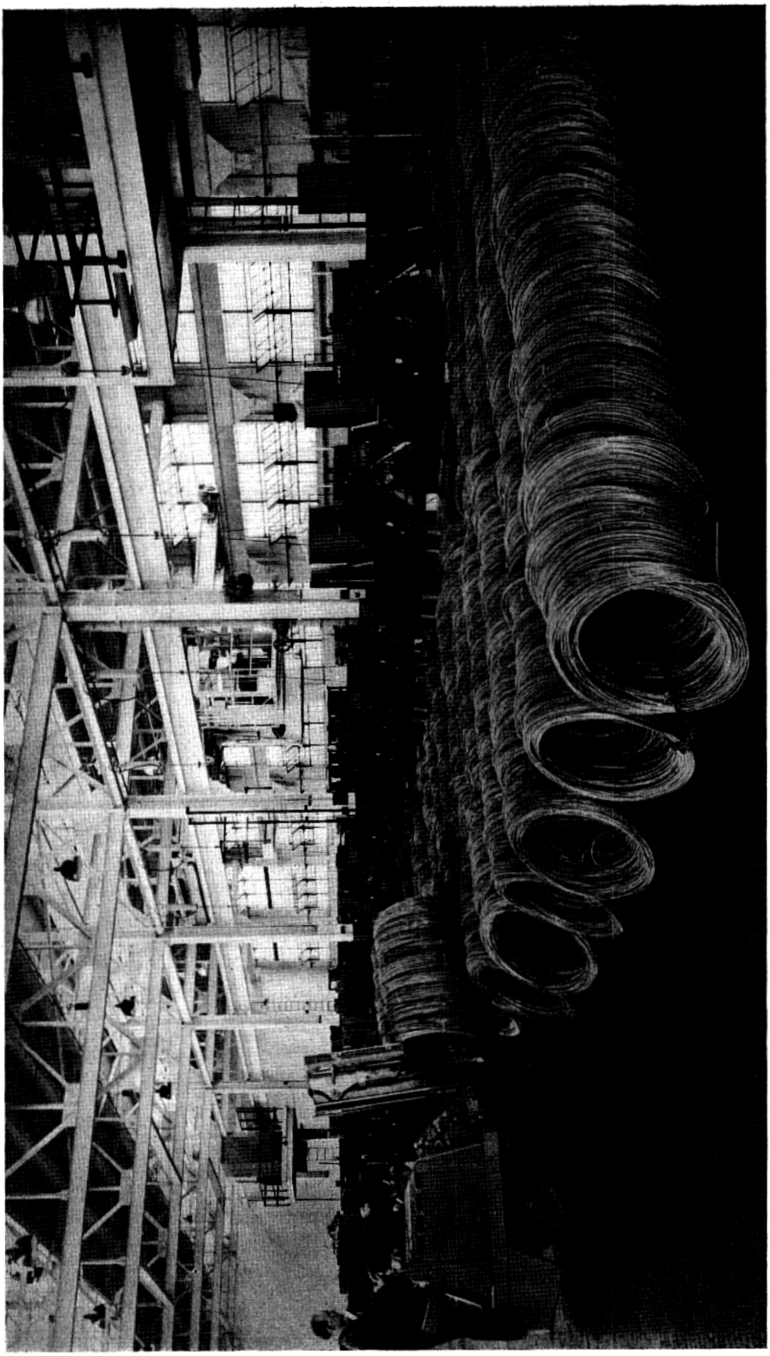

Fig. 21—Electric truck delivering copper rod

The duties of the No. 2 machine operator, Fig. 23, principally consist of furnishing several machines with supply wire, removing filled reels of drawn cable wire, gaging wire, starting the machines and periodically adjusting for tension. Breaks are infrequent as evidenced by the fact that the average weight of reels shipped was over 340 pounds. When these

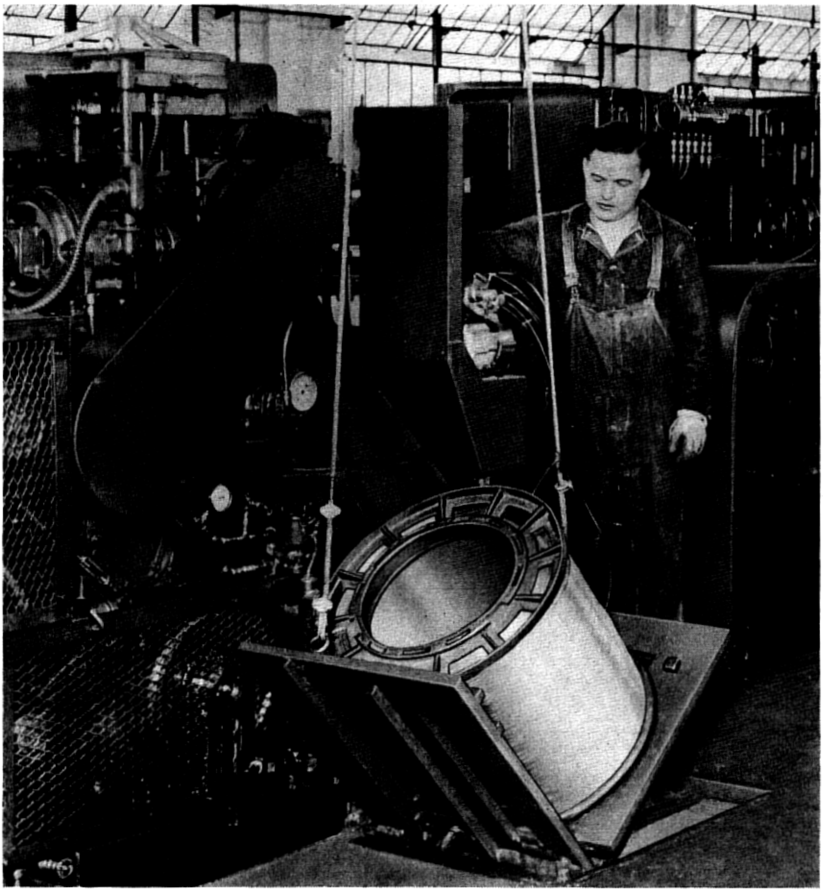

Fig. 22—Up-ending device for 1000-pound supply reel at back of No. 2 machine

breaks occur or when a change is made in the die sets, this operator also strings up the machine.

On these machines wire is drawn at 10,000 f.p.m. The importance of the various mechanical and electrical details mentioned in the first section of this paper can therefore be visualized. One of the No. 2 machine has, for the past year, operated with certain refinements at the finishing speed

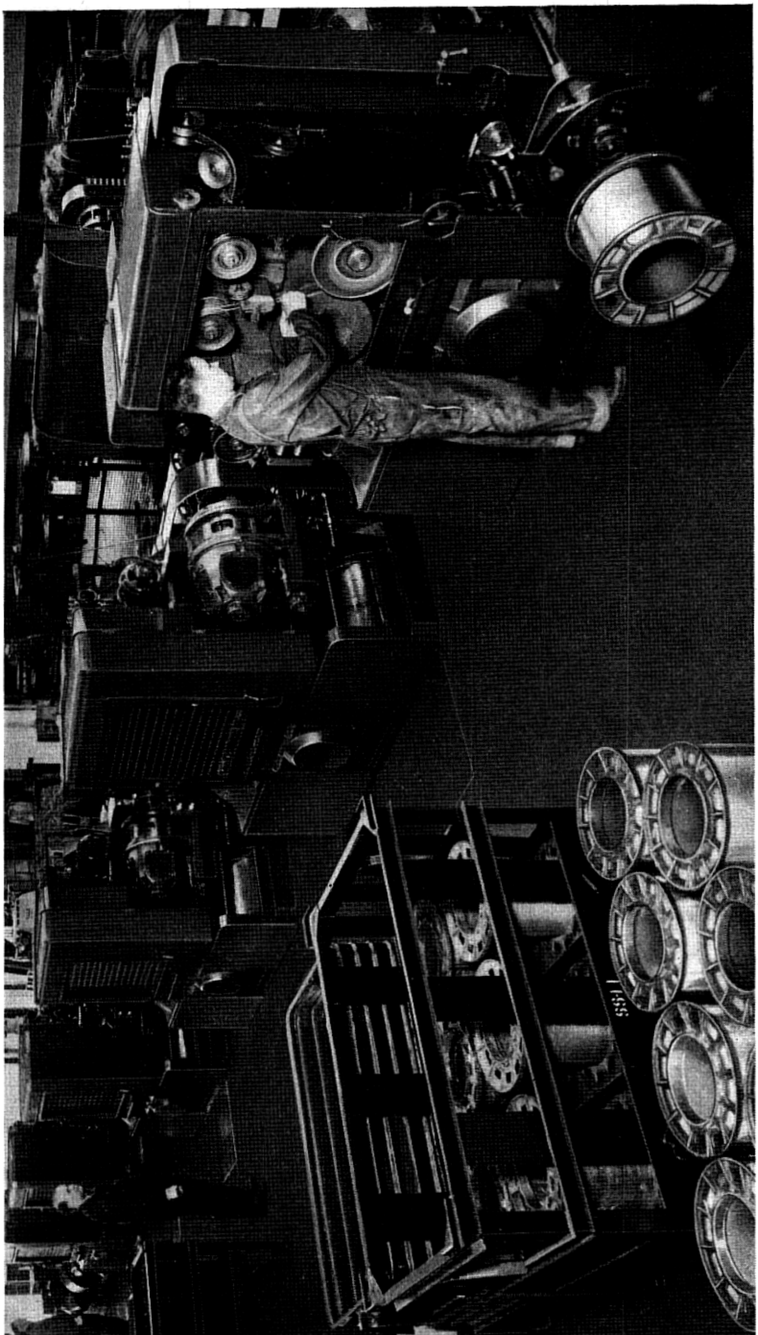

Fig. 23—Line-up of No. 2 machines

of 12,000 feet. The data being collected so far are favorable and it is expected that this study will justify the conversion of additional machines to the higher speed.

After the take-up reel is released and pushed off the arbor by the air operated mechanism, it is rolled to the area below the bridge crane and up-ended by hand.

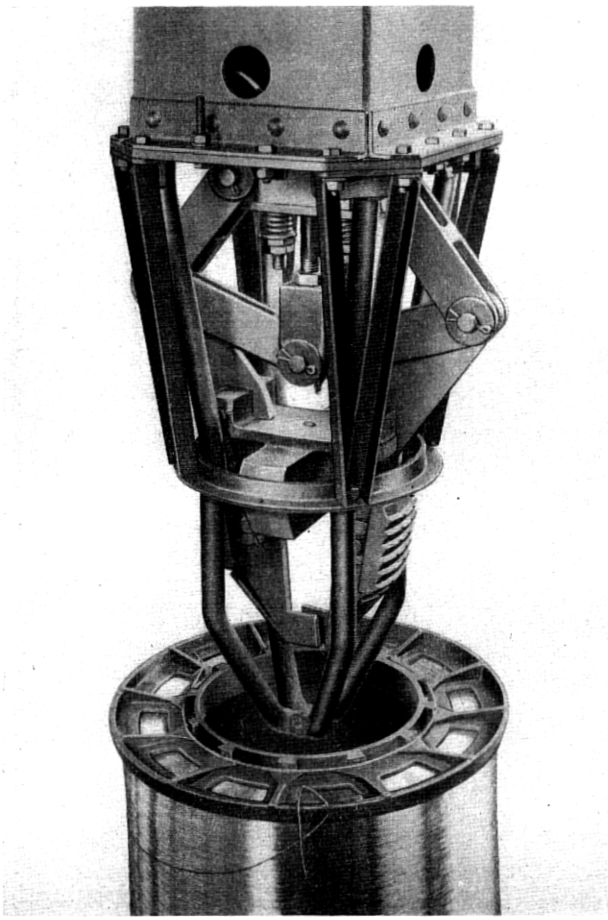

Fig. 24—Solenoid operated chuck grapple being located to lift reel of wire

Multi-Purpose Crane

The movements of the bridge crane and grapples are controlled from the crane cab by the operator. A six-ton grapple handles the baskets of wire, the electric furnace bell and the furnace details. The crane is also equipped with an auxiliary hoist to lift the wire reels into the annealing basket. To this hoist, a locating device has been attached together with solenoid operated, internal expanding jaws which engage in the wire reel core, Fig.

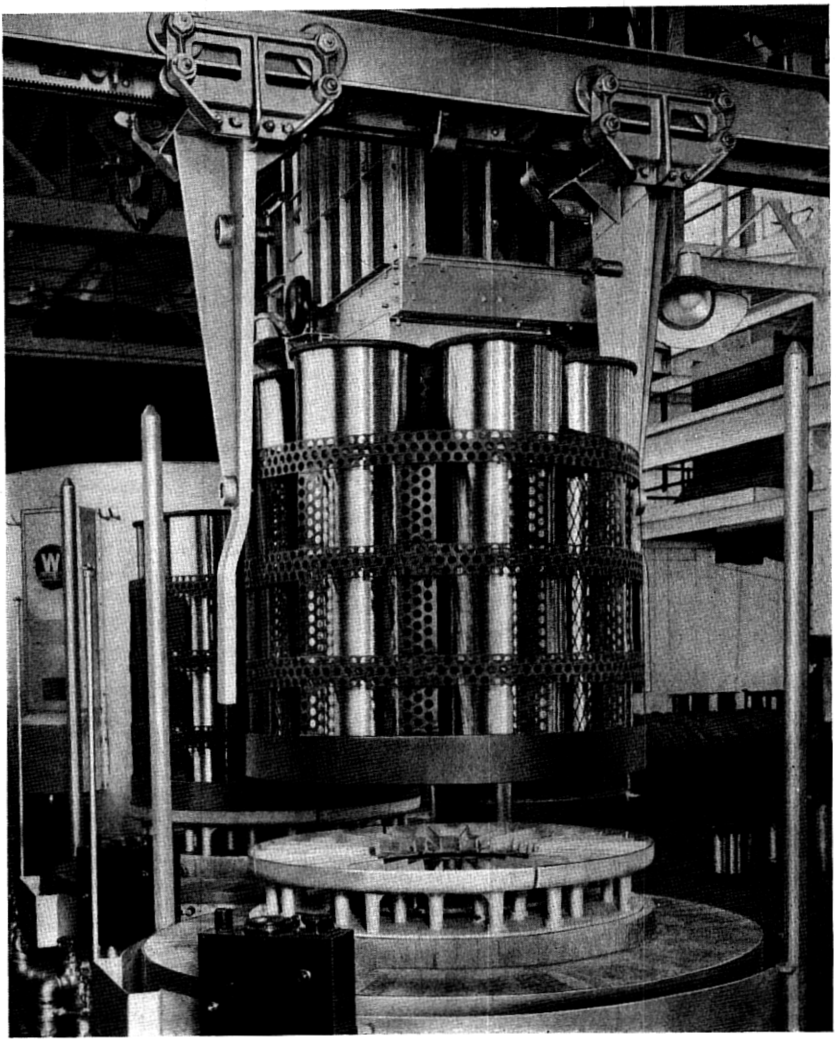

Fig. 25—Six-ton crane grapple placing basket of wire on annealing base

24. With safety and facility of operation, twenty-eight reels, a total of 10,000 pounds of wire, are loaded into a 56″ diameter light-weight perforated steel basket, Fig. 25.

Batch Type Electric Annealing Furnace

The operation of electric batch type annealing furnaces and the use of reducing gas atmospheres, with an average composition of about 1½% CO, 2% H_2 and 14.5% CO_2, produced by combusting city gas, are generally known to the wire industry. Certain provisions in the Kearny installation may be of interest.

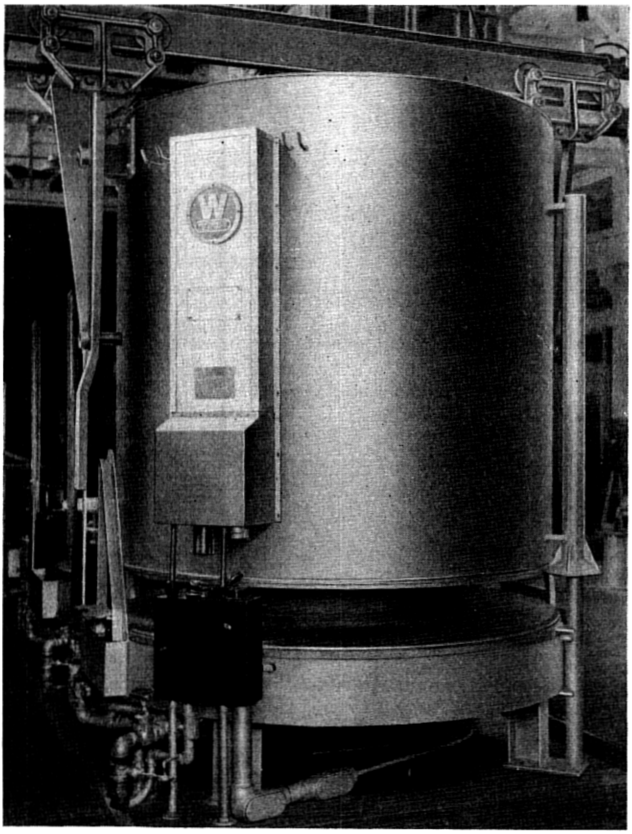

Fig. 26—Electric furnace bell, with automatic plugging equipment, being placed over covered charge

Details of the annealing baskets and bases, the steel alloy retorts used to cover and water-seal the charges, and the electric furnace moved from base to base have been designed so that the arms of the six-ton crane grapple can engage, handle and move all these items.

The electrical connections to the furnace bell are made automatically.

This design consists of control and power plugs located on the exterior of the furnace and a floor stand with positions for electrical receptacles. Two pins align these units, one of which opens the receptacle covers as the furnace is lowered over the retort, Fig. 26.

Features such as these make it possible to perform all the furnace and crane operations, to deliver wire to the inspection area, to load skids for shipment of wire with a minimum of effort on the part of the operator. He attends these operations from a crane cab and as required, operates and adjusts the gas, water and drain valves from floor positions.

In the event of power, gas or generating equipment failure, automatic indicating equipment summons the operator who then connects an 8%

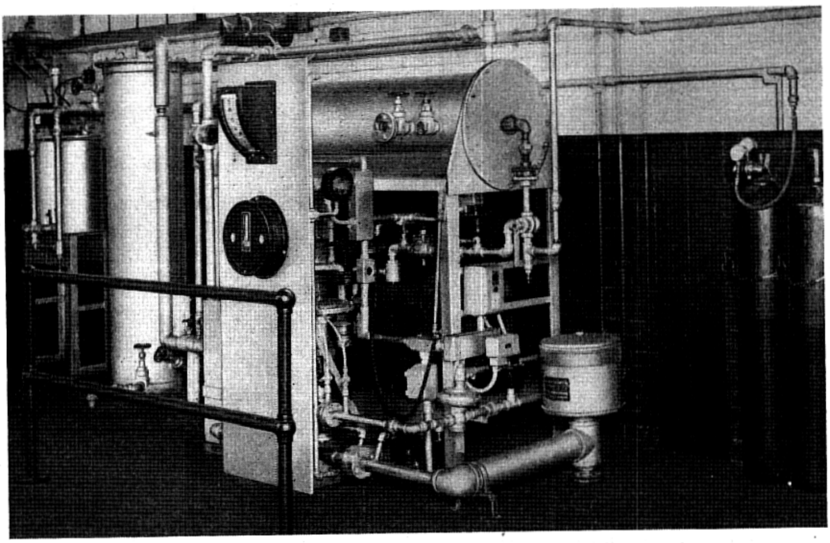

Fig. 27—Gas generator and N_2 tanks used as standby equipment

H_2-92% N_2 mixture into the annealing gas lines. This has provided inexpensive stand-by equipment and constant production of bright annealed copper wire, Fig. 27.

Capacity and Results

This mill is set up to produce wire on a three-shift basis. The equipment of the type described, including space for rod and wire storage, occupies an area of approximately 14,000 square feet. Training time was not excessive for the average operator—efficiencies of 80% to 90% being attained in a few months. Rotation of operators to the next shift every two weeks has worked out satisfactorily.

Periodic checks and maintenance of electrical circuits and apparatus, with adjustments of mechanical assemblies before major repairs arise, have kept repair costs low. Additional training and experience should further reduce maintenance and repair time. The use of diamond dies in diameters

Fig. 28—Inspection and shipping area

up to and including 15 AWG has been found economical for high-speed machines. Cracked dies are negligible when properly mounted clear stones are used. After the first year of operation, the Wire Mill has bettered the anticipated performance objectives.

Acknowledgements

In setting up and operating this project at Kearny, the engineering group responsible was greatly assisted by the Wire Mill experience and developments at the Hawthorne and Point Breeze Works and by the recommendations and designs of the material handling and factory planning engineers at Kearny. This cooperation, together with that obtained from the men on the machines and the maintenance groups, has been reflected in the results.