NATIONAL HISTORIC

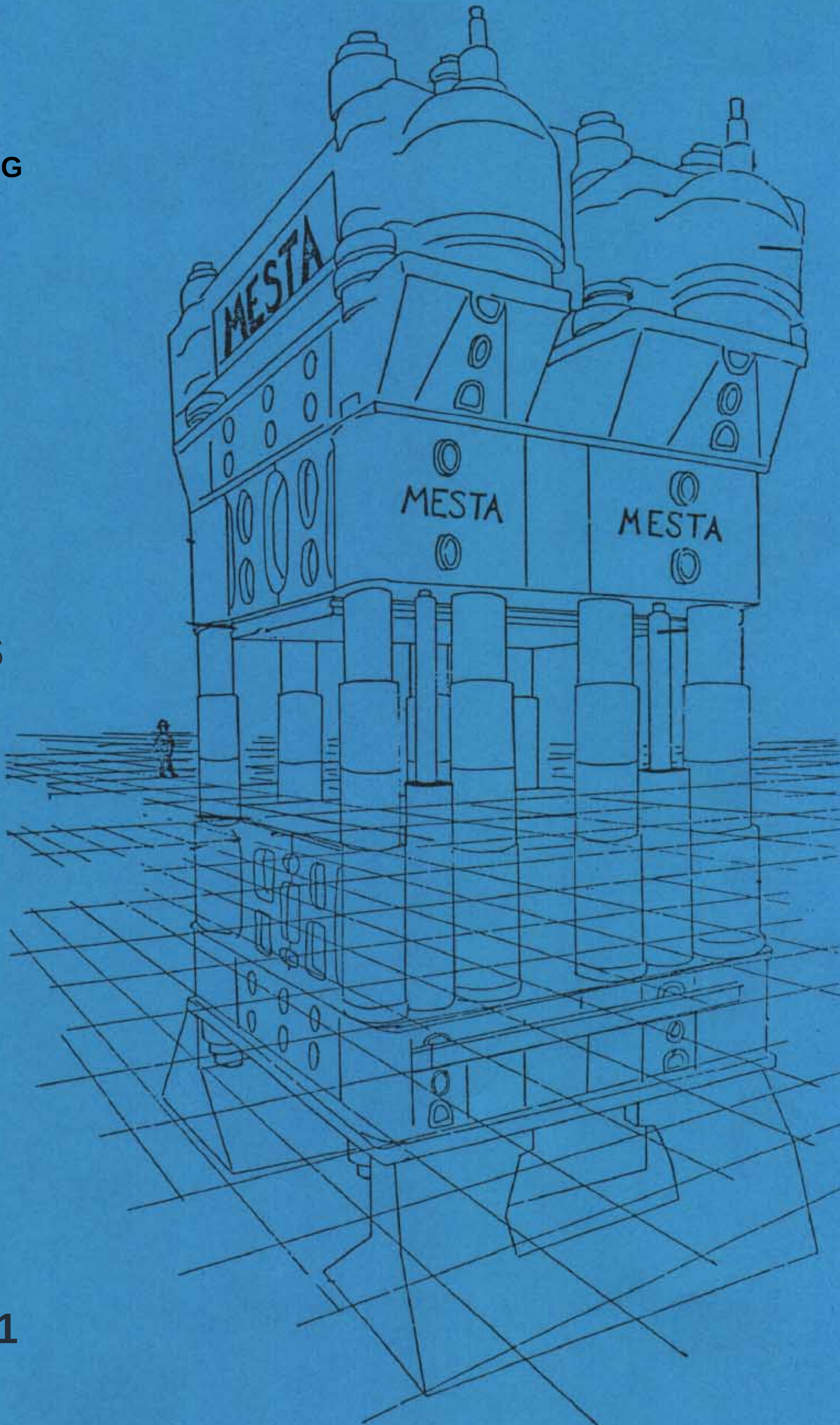
MECHANICAL ENGINEERING

LANDMARK

50,000 Ton

Closed Die

Forging Press



UNITED STATES
AIR FORCE PLANT 47

Operated by

Aluminum Co. of America
ALCOA Forging Division
Cleveland, Ohio

THURSDAY,
SEPTEMBER 24, 1981

The American Society of Mechanical Engineers

DEDICATION CEREMONY

50,000 TON CLOSED DIE FORGING PRESS
1981 SEPTEMBER 24

PESANO'S RESTAURANT

6:30 p.m. Dinner	
7:15 p.m. Welcome	Donald R. Akers, Chairman Cleveland Section, ASME
Introduction of Honored Guests	Leroy S. Harris, Vice President, Region 5
ASME Landmark Program	Prof. J. J. Ermenc, Chairman National History & Heritage Committee
Keynote Address	Dr. Robert B. Gaither, President ASME
History of 50,000 Ton Closed Die Forging Press	Ralph H. Heller, Engineering Manager Alcoa Forging Division

ALCOA PLANT

8:00-8:15 p.m. Travel to Alcoa Plant, 1600 Harvard Ave.	
8:15-9:00 p.m. Plant Tour	
9:00 p.m. Presentation of Plaque	Dr. Robert B. Gaither, President ASME
Acceptance	Col. Melvin F. Brown, Commanding Officer DCASR - Cleveland
Final Remarks & Closing	Clyde R. Gillespie, General Manager Alcoa Forging Division

ACKNOWLEDGMENTS

The Cleveland Section of the American Society of Mechanical Engineers acknowledge the efforts of those members who organized the dedication of the 50,000 ton Closed Die Forge Press program. The Cleveland Section also recognizes the efforts and cooperation of personnel from Wright-Patterson Air Force Base and Aluminum Company of America.

The American Society of Mechanical Engineers:

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Leroy S. Harris	Vice President, Region 5
Robert A. Woodward	Chairman, ASME Region 5 History & Heritage Committee
Dr. Burke E. Nelson	Executive Director, Region 5

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R. H. Heller	Engineering Manager, Alcoa Forging Division

The 50,000 Ton Closed Die Forging Press is the 64th landmark designated by the Society. For a complete listing of landmarks, please contact the Public Information Dept., ASME, 345 East 47th Street, New York, N. Y. 10017.

50,000 TON CLOSED DIE FORGING PRESS

The Mesta 50,000 ton hydraulic closed die forging press, this country's largest forging machine, is currently producing the largest light metal forgings in the world.

This massive forging tool actually had its genesis during the days of World War II. Allied intelligence teams inspecting German aircraft downed behind our lines discovered that they contained extremely large and complex major structural elements. Our appraisal of the situation, confirmed immediately after the end of the war, was that the Germans had produced these aircraft components with the aid of huge forging and extrusion presses possessing capabilities far in excess of those in our own industrial complex.

The implications were far-reaching. If forgings and extrusions large enough to comprise key aircraft structural elements could be produced in this country, not only would fabrication time be reduced greatly, but costs would be lowered. In addition, such a technique held the promise of forging materials with greater strength-weight ratios, an extremely desirable attribute from the standpoint of aircraft design.

Just before the conclusion of the war, the United States embarked upon an urgent program to build a press able to match our estimates of the productive capability of the German equipment. The Mesta Machine Company of Pittsburgh was awarded a contract to construct an 18,000 ton forging press, and the Wyman Gordon Company of North Grafton, Massachusetts, was selected to operate it. Since the press was so enormous, a pattern to be followed when the press program went into full swing was established — a plant had to be built around the press to house both it and its supporting equipment. The war ended, however, before the project was fully completed.

When our technical/industrial teams visited Germany after the cessation of hostilities, they found that the Germans had indeed developed and learned successfully to operate presses ranging up to 30,000 metric tons. In all, three heavy die forging presses, two with a capacity of 15,000 metric tons and one with a 30,000-ton capacity, were discovered in more or less useable condition. Three extrusion presses in the 5,000 metric ton category were also located. As part of the post-war settlement, the United States acquired the 15,000 and 5,000 metric ton presses which were channeled into the Air Force Heavy Press Program. The 30,000-ton press, however, was seized by the Russians. With the Soviets in possession of so large a press, our Heavy Press Program received added impetus.

The Heavy Press Program Gets Underway

The Heavy Press Program actually got underway in 1950. This marked the culmination of many months of work by top planners, in government and industry, who had conducted extensive industrial surveys in an effort to shape a successful Heavy Press Program. At the heart of these studies was the belief that heavy presses could make vital contributions to the defense effort by producing a capability for the production of large structural members for advanced aircraft and other systems at an unparalleled rate, at low cost, and with a high strength-weight ratio. Congress was informed of the program, and the requisite approvals and funds were obtained.

The Concept of the Heavy Press Program

The Heavy Press Program was unique. To supply defense contractors, particularly those in the airframe industry, it was necessary to establish a heavy press capability for the production of larger forgings and extrusions with greater definition than was available in this country. While the Defense Department policy was then, as now, that contractors, provide their own plant, facilities, and equipment, an exception is warranted in the case of special facilities to produce goods for which there is no commercial market. Since there was no commercial requirement for presses of this size, the government undertook the sponsorship and support of the Heavy Press Program.

It was desirable to establish a self-sustaining industrial base for these heavy presses. To achieve this objective, industry had to be educated and encouraged to design products suitable for the special productive capabilities of the presses and to be assured of their continued availability on an economic basis. It was essential, therefore, to have a sufficient number of qualified heavy press operators in the program so that we could provide a competitive climate upon which industry could rely for quality, price, and product availability. The heavy press industry was at first hesitant to enter the program since there was no assurance that it would be profitable as a source of either defense or commercial business. Moreover, the government's program, which was predicated on a "strictly business" rental arrangement with the contractor assuming normal overhead and maintenance costs, could, in fact, entail a financial risk. A representative, select group of operators, however, was finally persuaded to participate.

Some Facts and Figures

Air Force Plant 47 was authorized to be constructed in 1952 at Cleveland, Ohio adjacent to the Aluminum Company of America plant. The 50,000 ton Mesta press is the larger of two heavy presses installed in this facility. Alcoa has been the prime operating contractor for Air Force Plant 47 since it began operation on May 5, 1955.

The operation of this heavy press facility and in particular the 50,000 ton Mesta forge press has been a key element in America's dominant role in commercial aircraft. This heavy press facility has supported the aerospace industries since its conception and aided them in their development of advanced military aircraft and aerospace programs and has been a primary element in the technological lead we enjoy in these fields.

The Mesta 50,000 Ton Hydraulic Closed Die Forging Press

The Mesta 50,000 ton “Super-Giant” forging press is 87 feet high, extending 36 feet below ground level and 51 feet above. (Figure 1.) The total weight of the press is approximately 8,000 tons. That's enough steel to lay 42 miles of modern railroad track. Sixteen huge steel castings poured in the Mesta foundries at West Homestead, Pennsylvania comprise the major elements of the press. Over 350 tons of steel were required to pour some of the largest castings; that is enough steel to supply the needs for 200 passenger cars. There were eight other castings weighing between 215 to 240 tons each. Equipment used to machine the press sections included a Mesta 18 inch horizontal boring and milling machine designed and built especially for the job. (Figure 2.)

Coming up from the subterranean foundation, two cast steel “stools” carry the press proper. Mounted on these are two lower base and two upper base sections, (Figure 2), weighing more than 800 tons, or about as much as 10,000 men.

The movable die table or platen that holds the lower forging die, is attached to the base sections. The die table that is 12 feet wide by 26 feet long is withdrawn only when the forging dies are changed. Forged parts are removed and ingots inserted between the dies by mobile manipulators. The maximum press stroke is six feet. With a working stroke of one foot, the press is designed to operate at 30 cycles per hour.

Above the movable die table are 15 feet of daylight, the opening between the jaws of the monster vise. The upper die is clamped to the upper platen which is attached to the lower moving crosshead. (Figure 3.)

The entire moving crosshead assembly — the upper jaw of the “vise”— consists of eight steel castings totaling almost 1150 tons. (Figure 4.)

Above this assembly are the stationary crossheads (Figures 5 & 6) housing the eight main hydraulic pressure cylinders.

Running through the press from top to bottom are eight massive alloy steel columns manufactured at Mesta forging plants at West Homestead, Pa. Forging ingots weighing as much as 270 tons each were poured by teaming three immense ladles of molten steel in the foundry. (Figure 8.) After forging, each column was heat treated in a special furnace 112 feet long. The forged column was moved by rail from the Mesta forge shop to their machine shops for finishing.

So true were the forgings that a perfect finish was obtained by removing only one inch of stock on the Mesta 96 inch lathe, one of the world’s largest. Each column was trepanned full length, to remove a core 8 inches in diameter the full length of the column. (Figure 9.) The columns were finished to a diameter of 40 inches and a length of 76 feet. Four sections of each column were threaded and fitted with four steel nuts, each 52 inches in diameter. Eight of the largest nuts weigh 55 tons each!

The press force is generated by a hydro-pneumatic pressure system consisting of four pre-filler bottles, two horizontal reciprocating pumps driven by 1,500 H.P. motors, and four forged alloy steel pressure accumulator bottles. (Figure 10.) The hydraulic fluid is water with a small amount of soluble oil added to keep the system rust free and lubricated.

A pressure of 4,500 psi is built up in each accumulator and released to the eight pressure cylinders housed in the stationary crossheads at the top of the press. The combined effort of these cylinders produces 50,000 tons of forging capacity.

Such forging pressure staggers the imagination! Fifty thousand tons is equivalent to the pressure that would be exerted by the weight of a steel ingot 612 feet high, placed on end to cover the entire 26 foot by 12 foot die bed.

At the end of the press cycle, the hydraulic force is reversed and directed to eight pull-back and balancing cylinders that return the moving crosshead assembly to its upper position.

The press was rebuilt in 1974 to provide an advanced hydraulic valve system. The resulting control system, now in operation, provides an almost incredible multiplication of the efforts of its operator, as well as hairline precision. The press, which stands eight stories tall and weighs 8,000 tons, responds instantly and precisely to the lone operator's hand on a lever just three inches long. His slightest touch governs 2100 tons of moving weight and can apply 50,000 tons of forging force.

Vital statistics on the system are staggering. There are 23 major control valves, some of them weighing as much as 12 tons. Fluid flows range from 11,750 gallons per minute (gpm) high pressure to 26,438 gpm prefill pressure — enough to fill a good-sized house to its rafters in less than 60 seconds.

Eight main cylinders-- all 60 inches in diameter -- deliver the press's working force to advancing the press platen. Four filling check valves, weighing about 12 tons each and standing nine feet tall, pre-fill these main cylinders to bring the platen quickly into its first contact with the workpiece. Four pullback cylinders move the platen back through the return portion of its cycle.

The majority of the control valves are driven and synchronized by a camshaft 30' long.

Two closed-loop electronic-hydraulic servo systems work simultaneously as the press operates. One of these systems controls the position of the main camshaft, which through positive linkage actuates most of the system's operating valves. A signal is transmitted from the operator's control lever, through the electronic-hydraulic servo control circuitry, resulting in positive mechanical positioning of all control valves, effecting a corresponding and proportionate speed and position of the press platen. Closed-loop feedback circuits maintain a precise response equal to the movement of the operator's control lever.

In addition to the main drive system, the press has a unique tilt control system. This was designed to compensate instantly for out-of-level conditions caused during the power stroke by irregularly shaped forgings. The eccentric loads would create high stresses in localized portions of the press structure, weakening it and leading to premature failure unless counteracted immediately. The digital analog leveling system uses four encoders to monitor and compare instantly the positions of the moving platen’s four corners. Actual position of the platen is shown on a video display screen at the operator’s station. These signals are also fed through a servo mechanism to two balancing valves to make necessary corrections automatically by directing high pressure fluid to the proper main cylinders.

Conclusion

Credit for the development of this mammoth press must be given not only to the builder but to the United States Air Force, its Air Material Command and, in particular, to its Industrial Resources Division, for their leadership in the development of new manufacturing methods and in the exploration of new ground. They have not hesitated to move ahead when much of industry was satisfied with the available knowledge and know-how. They have urged, implored, and also pushed; they have used candy, and sometimes the whip -- but in all cases they were pointing towards more knowledge, better know-how, new methods, and deeper understanding.

The engineering excellence and creative imagination that is represented in this massive 50,000 ton closed die forge press is a milestone in man's advancement in technology.

From the strong arm and the hammer beating hot metal into durable tools, we have advanced the forging technology, through the use of this complex engineering creation, to forge light metal for space craft that will soon pass out of our solar system and wander through the eons of time exploring our galaxy.

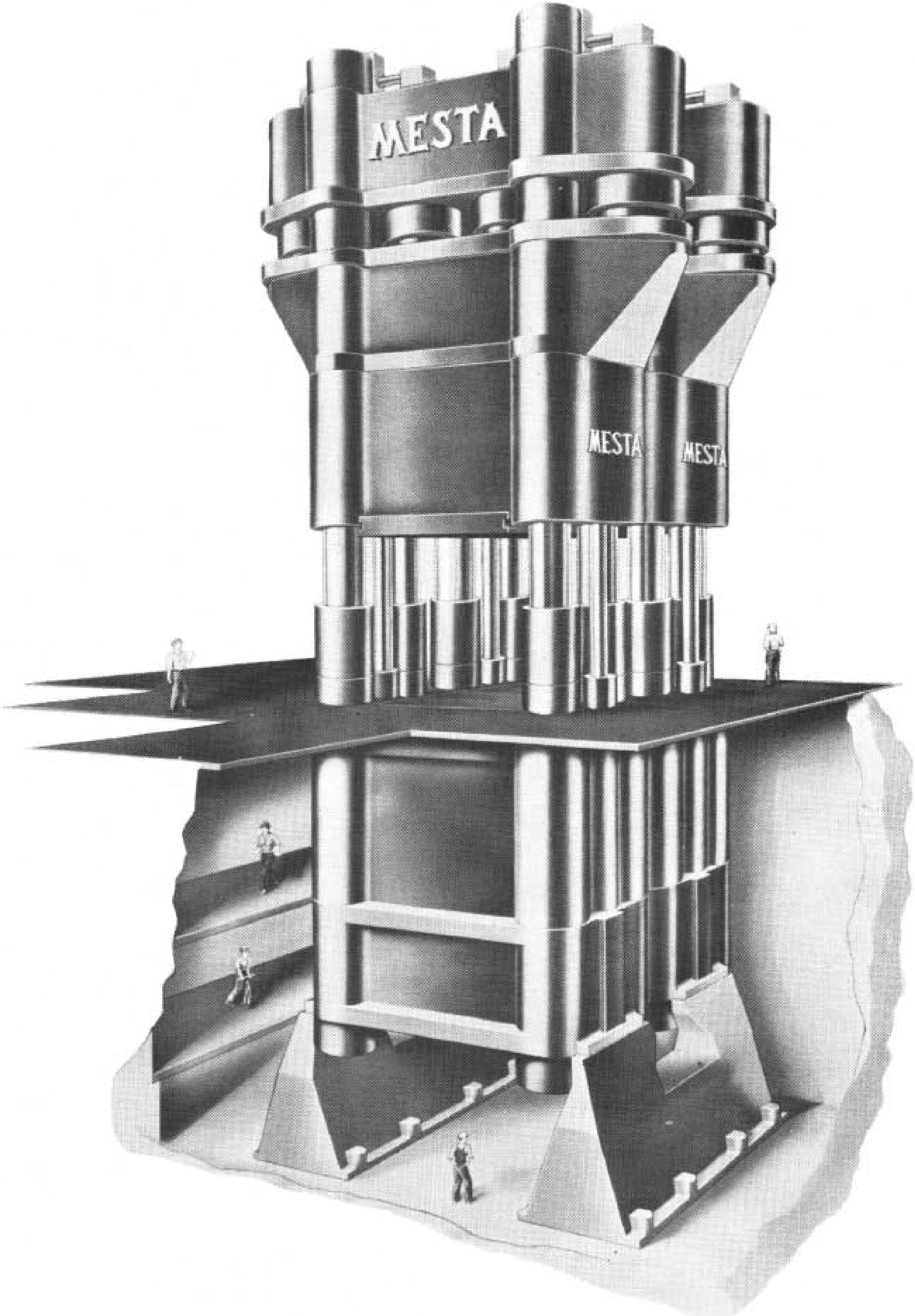

Figure 1

The Mesta 50,000 ton hydraulic closed die forging press.

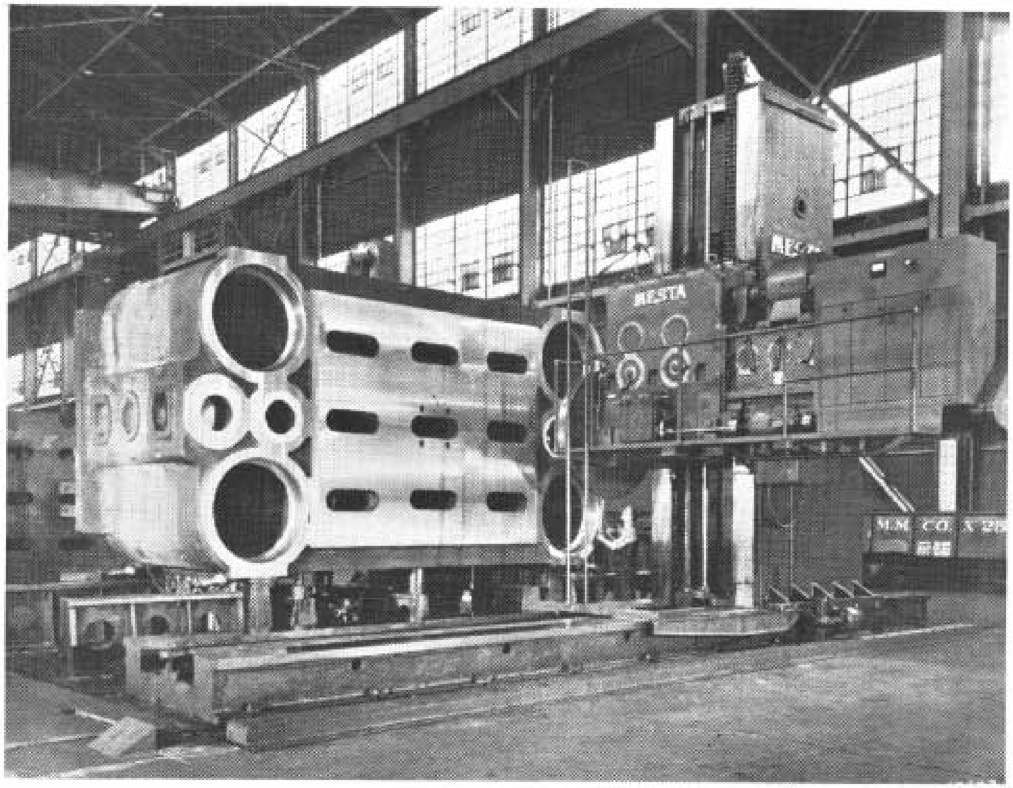

Figure 2

Machining a cast steel base section on a Mesta 18 inch horizontal boring and milling machine.

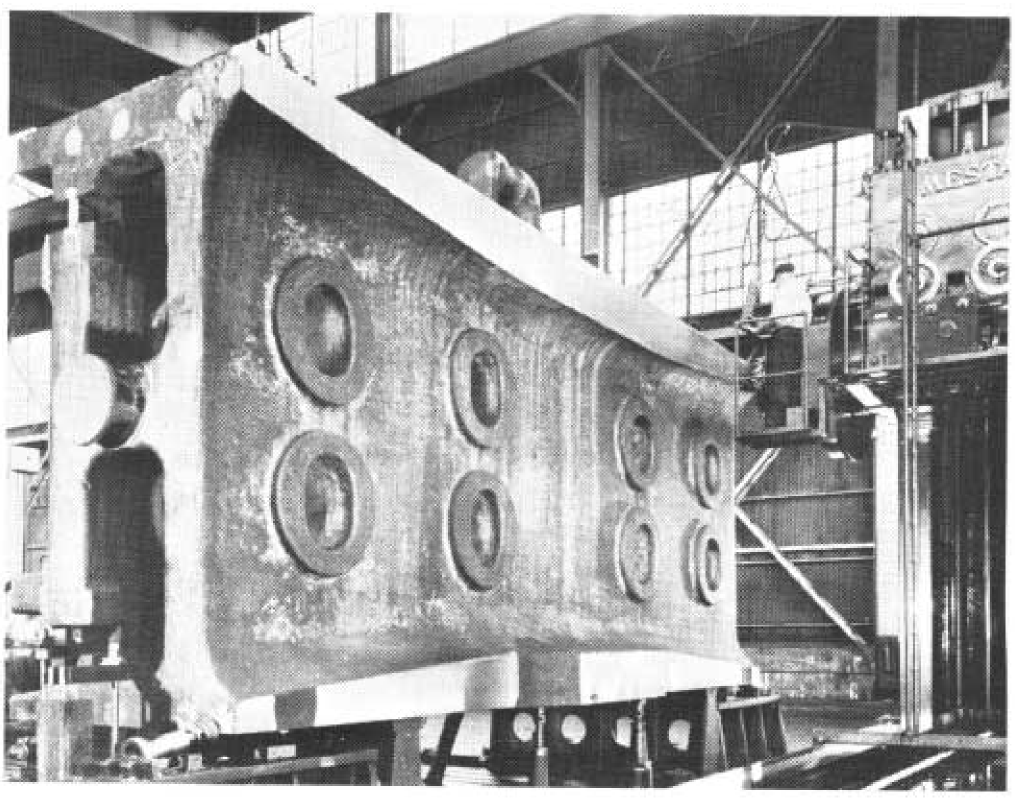

Figure 3

Milling an upper base section. Over 298 tons of steel was poured in the Mesta foundry to make this casting.

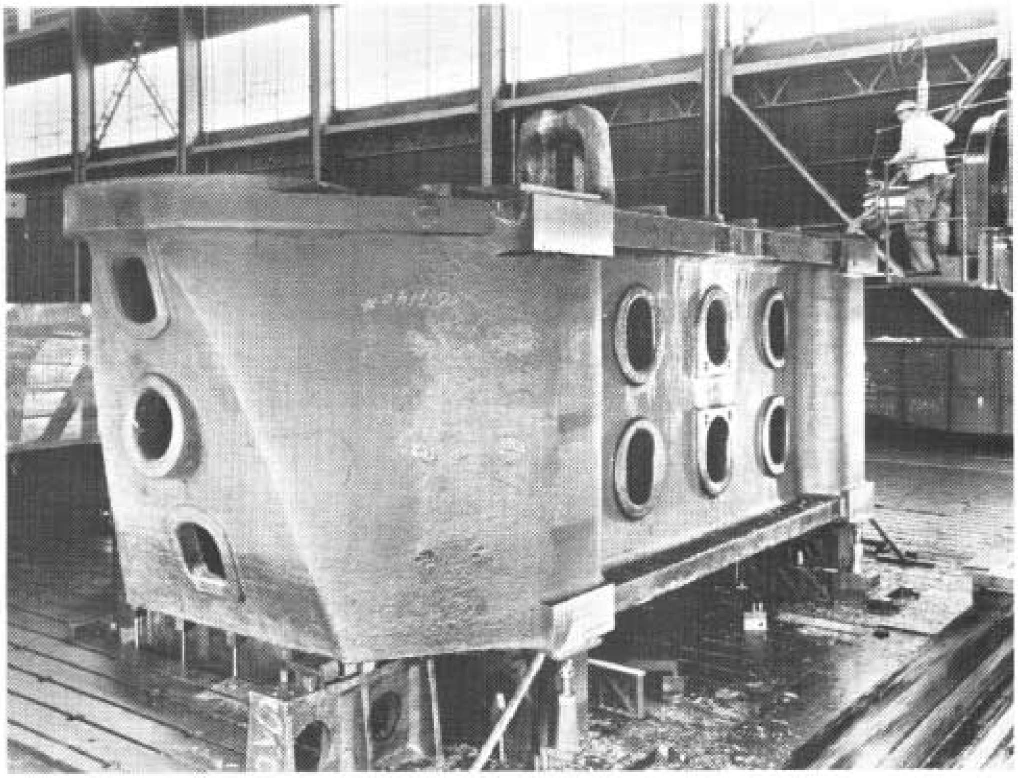

Figure 4

An upper moving crosshead section cast from 657 tons of steel in the Mesta foundry.

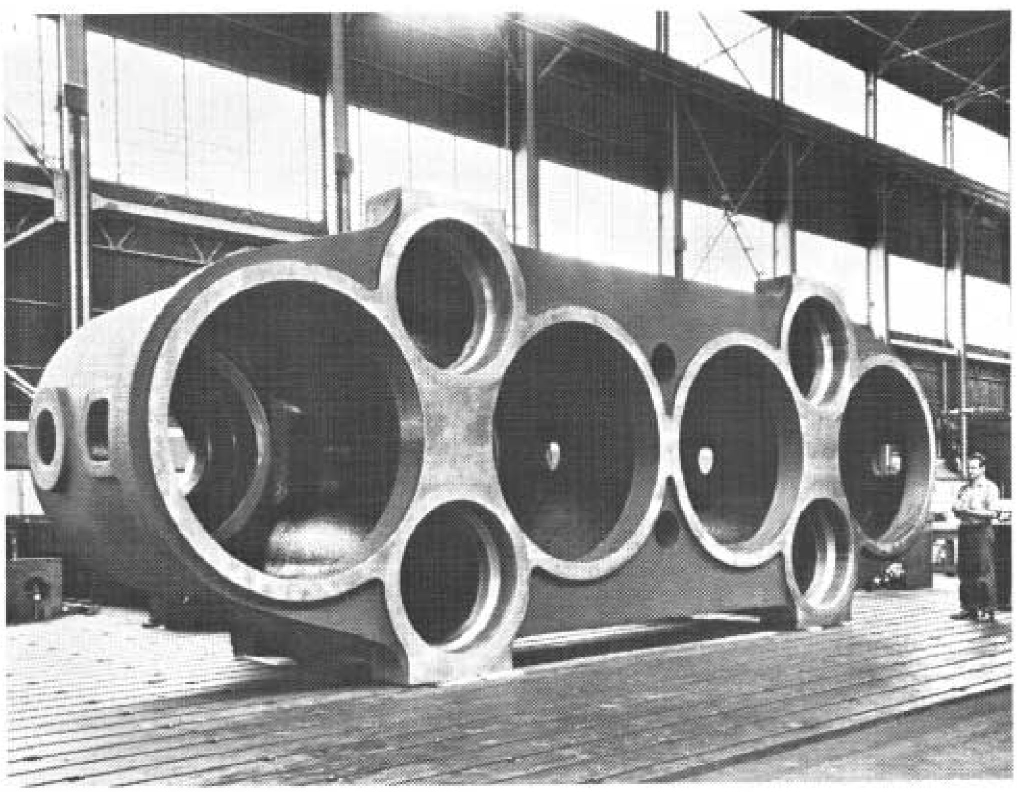

Figure 5

Checking a pressure cylinder port in one of the stationary crossheads with a micrometer.

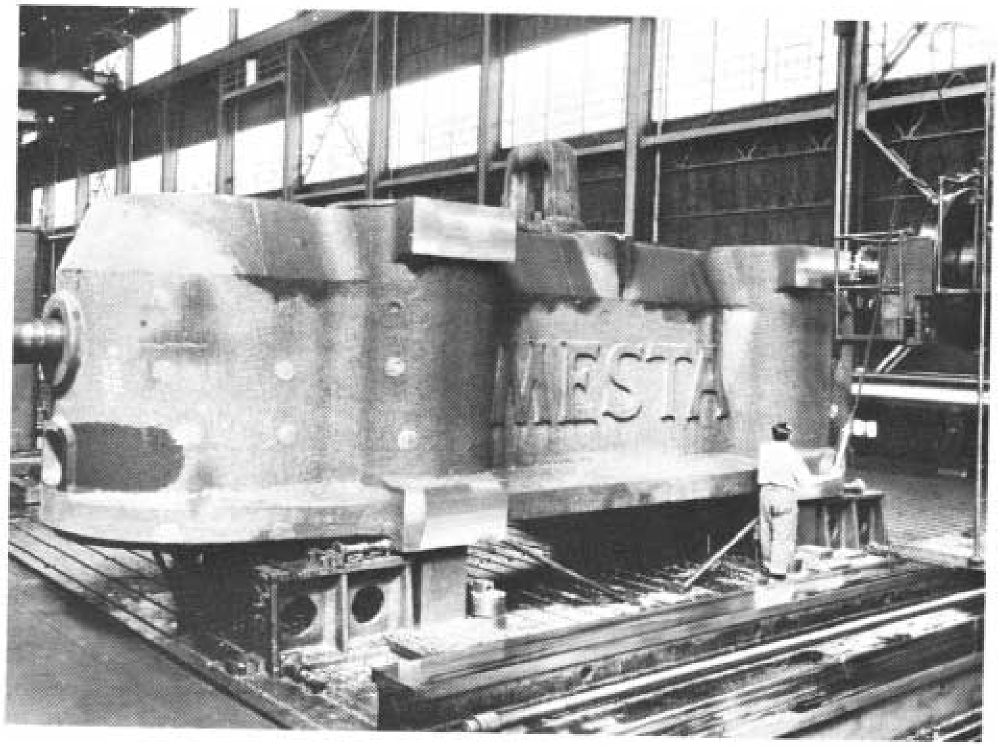

Figure 6

Shipping a stationary crosshead required a flat car with a 250 ton capacity.

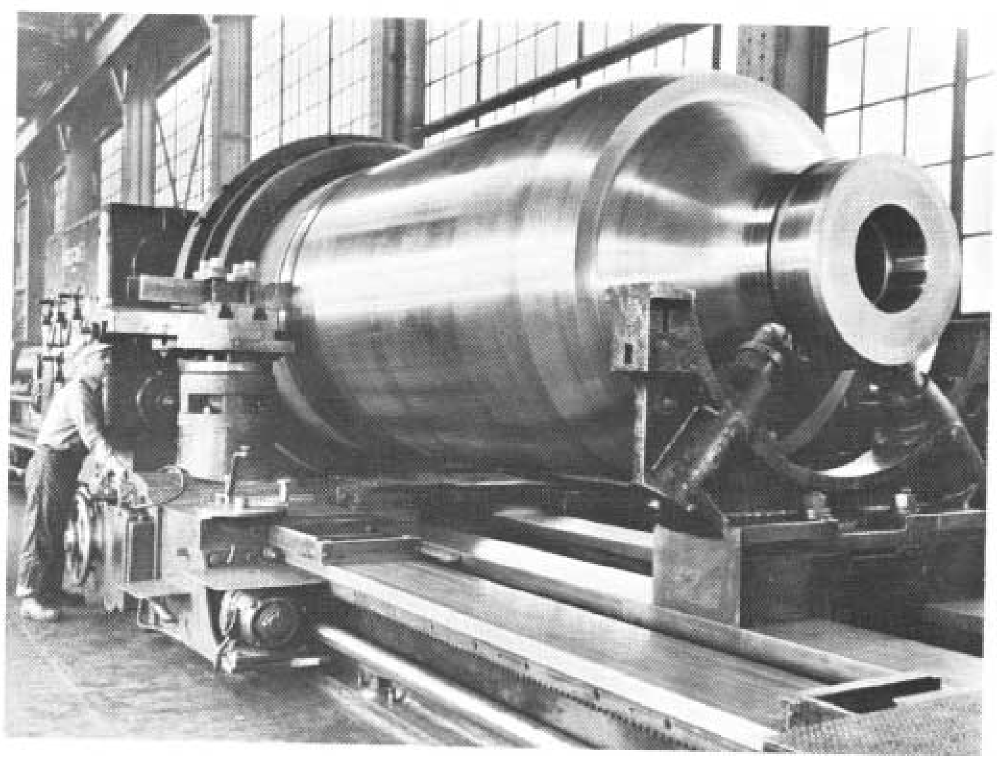

Figure 7

Finishing one of the eight forged alloy steel pressure cylinders on a Mesta 110 inch turning and boring lathe. Each cylinder was machined to an inside diameter of 5 feet 1/2 inch and 11 feet 7-1/2 inch.

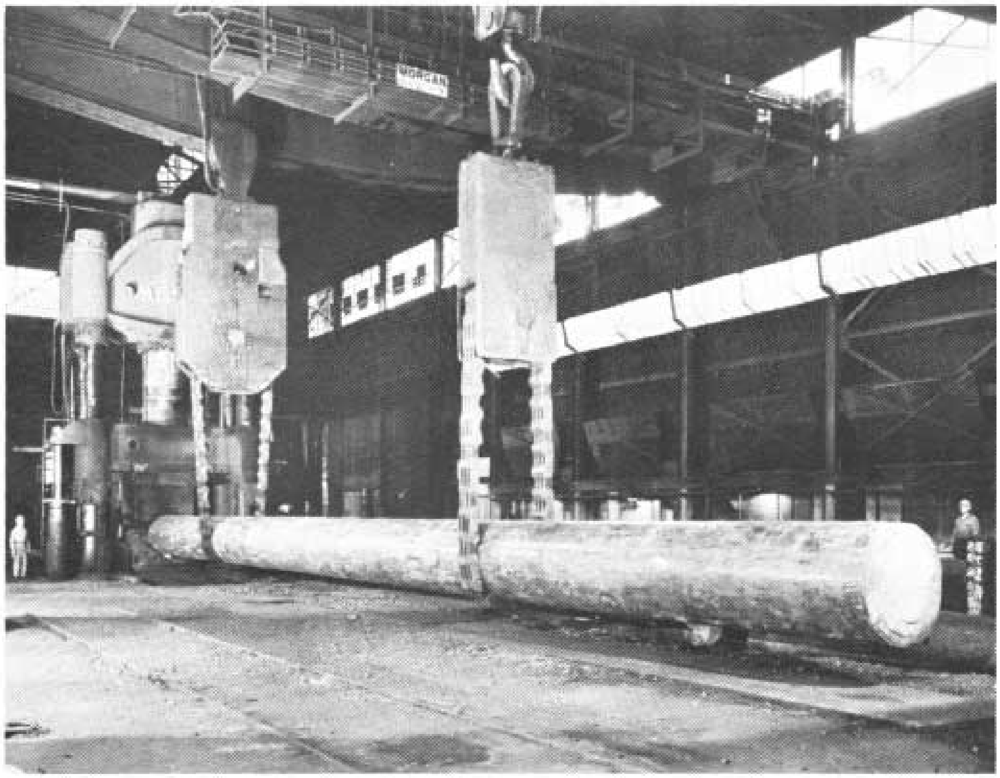

Figure 8

One of the eight alloy steel columns forged from a 270 ton ingot on a Mesta hydraulic forging press.

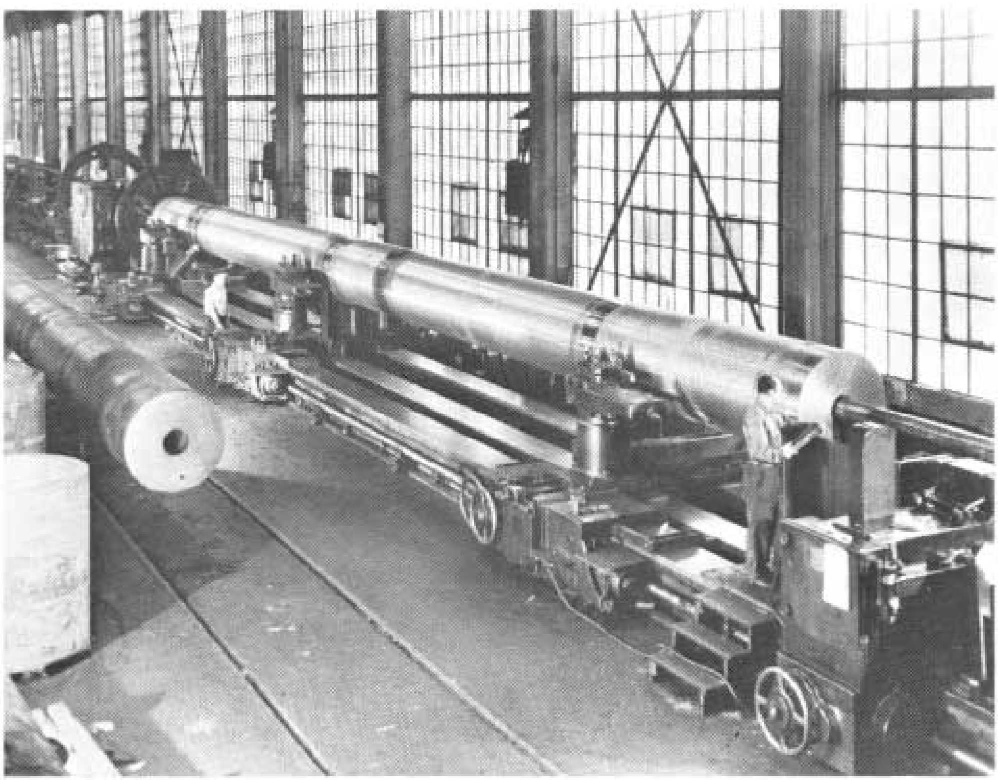

Figure 9

Turning and trepanning a 10 inch diameter hole through one of the press columns on a Mesta 96 inch turning and boring lathe. The eight columns were finished to 40 inch diameter by 76 feet long.

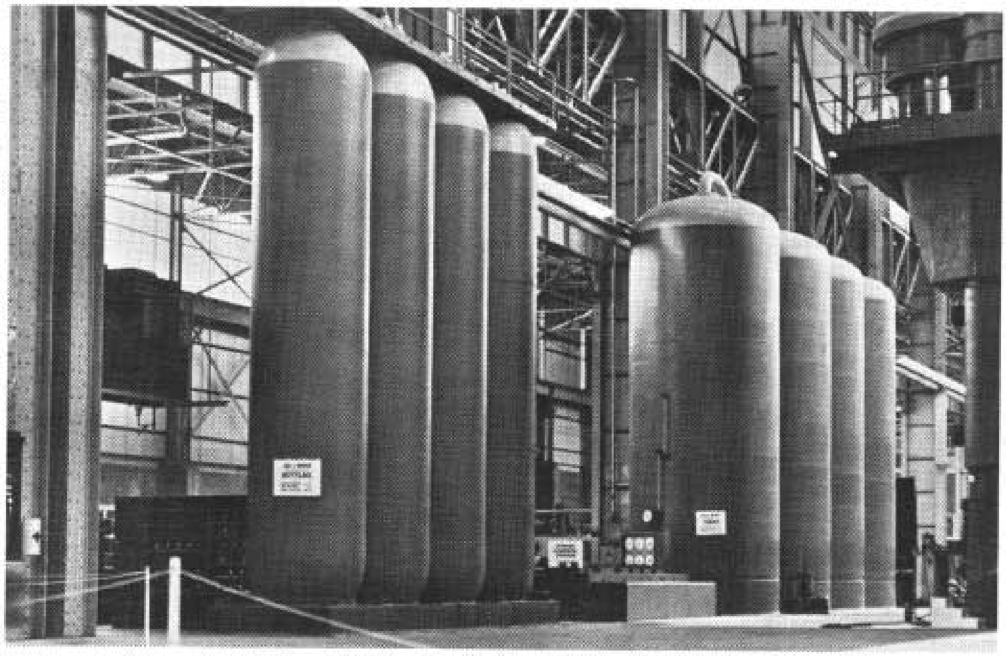

Figure 10

The hydro-pneumatic pressure system contains four accumulator bottles maintaining a pressure of 4,500 pounds per square inch. Each pressure bottle was forged in one piece by Mesta from a 195 ton alloy steel ingot.

Figure 11

Lowering the massive stationary crossheads into position over eight pressure cylinders and eight columns.