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LIGHT METAL PRODUCTION AND DEVELOPMENT FOR AIRCRAFT I.G. FARBENINDUSTRIE, BITTERFELD

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

LIGHT METAL PRODUCTION AND DEVELOPMENT FOR AIRCRAFT
I. G. FARBENINDUSTRIE, BITTERFELD, GERMANY

Reported By

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COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
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Fig. 2 - The lay-out of the North Works.

Fig. 3 - The lay-out of the South Works.

Fig. 4 - The 30,000 ton press for fabrication of aluminium and magnesium.

SUMMARY

In general the advance in the light metal divisions of this company have not been revolutionary. The pressure of the Ministry for Aircraft Production and the Luftwaffe in Berlin tended to retard the development and production of aluminium, and especially magnesium in favour of steel, allegedly because the necessity for strict control and utilization of electricity. From the stand point of corrosion this company considered magnesium wholly adequate for aircraft use. These plants for all practical purposes remain unbombed.

LIGHT METAL PRODUCTION AND DEVELOPMENT FOR AIRCRAFT
OF I. G. FARBENINDUSTRIE, BITTERFELD, GERMANY.

1. Production

(a). There were two (2) plants located in Bitterfeld under the direction of I.G. Farben. The North plant melted, extruded, and pressed magnesium and aluminum. Only sections of the works were devoted to light metals with the balance concentrating on chemicals The main offices also were located in the North Works.

(b). The South Works was devoted strictly to the electrolytic manufacture of aluminum and produced only about 15 percent of Germany's aluminum or 48,000 tons per year.

(c). The total production of magnesium in 1934 was approximately 3400 tons in Bitterfeld. Just before the out-break of war a plant was built in Aachen and in 1939 it produced a total of 1000 tons of magnesium. Then in 1943 a plant in Stassfurt came into operation so that by 1944 total German production was at the rate of 2000 tons per month which was subsequently reduced to 1400 tons after transportation became difficult and coal less available.

Capacity.	Tons/Month
Stassfurt	800/900 max 1000
Aachen	800/900 max 950
Bitterfeld	300/325 max 400

(d). Most secondary aluminum and magnesium was melted at Aachen although some was melted in Bitterfeld.

(e). When magnesium became a "tight" item almost all magnesium sheet was displaced by aluminum. Approximately 80 percent of all magnesium made in Germany was cast. I.G. Farben only maintained a development foundry and all magnesium was sold to outside foundries to meet production requirements. Their costs of manufacture was stated to be one mark, eighty pfennig per kilo when the exchange value of the dollar equalled two marks, fifty pfennig. Most shipments were by rail with trucks being used for short hauls. Prices were set or frozen by Berlin and audit by trained engineers were made. All magnesium was allocated by Ministry of Production, Dir. Speer (formerly an architect) and shipments down to one kilo were checked and audited.

(f). Some of the products press forged at this plant were propellers, impellers, cannon frames and aircraft engines mounts.

(g). The press shop was equipped with one 30,000 ton press (Fig.4) which is the largest in the world. Its over-all height from base below floor level to top was 86 feet. It was projected late in 1939 and took three years to build and install. It is said to have cost 12,000,000 marks (or 4,800,000 dollars) with cast iron dies costing 30,000 marks. The dies wore out but there was little or no breakage. A 15,000 ton and a 7,000 ton press were also located in the same building. It is noteworthy to mention here that aluminum aircraft propellers were pressed to finished size on the large press eliminating many complicated machinery processes. 80 to 100 propeller blades could be manufactured in eight (8) hours on the 30,000 ton press using two dies. 100,000 blades were obtained from one die. Propeller blades were made for the Ju 213, D.B. 603, and BMW 801. The largest forging of magnesium ever made in Germany weighed 40,000 kilograms. Supercharging impellers were pressed from a cake to finished size in one step on a 6,000 ton press.

(h). The estimated consumption of magnesium per month for aircraft engines at BMW was 80 tons; Junkers, 100/120 tons; and Mercedes 60/70 tons. Among aircraft companies Junkers was the largest user of magnesium with Messerschmitt favoring steel.

(i). The monthly production of semi-fabricated stock (extrusions, tubes, bars, etc.) was at one time 200 tons per month but in the later part of the war was reduced to 90 ton per month. Quarterly estimates of production were forwarded to Berlin and allocations were received 60 days in advance of actual delivery.

2. <u>Development</u>

(a). Aluminum Alloys

With regard to high strength aluminum alloys the efforts have been along the lines of an aluminum-zinc-magnesium alloy, the nominal composition of which was 4.5 percent Zn, 3.5 percent MG, 0.3 percent Mn, 0.15 to 0.20 percent Cr or 0.04 percent Va. The Chronium or vanadium was used to overcome the tendency toward susceptibility of this alloy to stress corrosion. It was considered that chromium was in general the better agent for this purpose. The minimum specified physical properties for this alloy in extruded form were:

Ult.Tens. Str.	50 Kg/mm^2	(71,120 psi)
Proof " "	42 Kg/mm^2	(59,730 psi)
Elongation	8%	

The average physical propeerties were:

Ult. Tens. Str.	52-55 Kg/mm^2	(73,940-78,210 psi)

Proof Tens.Str.	43-46 Kg/mm^2	(61,150-65,410 psi)
Elongation	12-14 %	

These values are inferior to those currently being guaranteed for the United States for this type alloy, Army-Navy Aeronautical Specification An-A-11 (T.S.-78,000 psi, Y.S.-70,000 psi, elong 6%).

(b). It was stated that I.G. Farben's experience has been that their Al-Zn*Mg alloy forged quite readily and that a forging pressure about 15 percent less than that used for duralumin type alloys was required. Forging of this alloy was generally done at 420 to 460 degrees centigrade.

(c). The production of this Al-Zn-Mg alloy during the war has been very limited because of the control of the use of virgin aluminum. Only about 5,000 tons of extrusions, 1000 tons of forgings and 100 tons of sheet were produced during the war. The sheet was bare material; no clad material in this alloy has been made.

(d). I.G. Farben classified their Al-Zng-mg alloy as being as good, if not better than duralumin type alloys from a stress corrosion consideration. It is considered to be a little more notch sensitive than duralumin. Heat treatment consists of water quench from 450 to 480 degrees centigrade, four days room temperature aging followed by 8 to 36 hours of artificial aging at 120 degrees centigrade.

(e). It was the opinion of the I.G. Farben representative that the zinc type aluminum alloy offered most promise for high strength aluminum alloy development.

(f). Magnesium Alloy

It had been learned that some investigational work had been carried out in Germany on aluminum clad magnesium alloy with a view to developing a corrosion resistant alloy. According to information available at U.S. Naval Technical Mission in Europe, samples had been made by Blanke-Metallwerke, Merseburg (formerly Deutsche Zinkan-Gesselschaft) and tested for loss in strength after corrosion. Further information on this material had not been obtainable to date. I.G. Farben representatives did not admit any knowledge of the work and were of the opinion that aluminum clad magnesium alloy would not be a serviceable material because of susceptibility to dissimilar metal contact corrosion at the exposed area. I.G. Farben has produced a contact corrosion at the exposed area. I.G. Farben has produced a Mg alloy material clad with a Mn-Mg alloy material. This material had a core composition of 7 to 8 percent Al, 0.5 percent Zn, 0.2 percent Mn, remainder Mg and a cladding composition of 1½ to 2 percent Mn, remainder Mg, and had an ultimate tensile strength of 28 Kg/mm (39,800 psi). The cladding process required more care than does the similar process of cladding aluminum alloy. Surface condition of the slabs before cladding was considered very critical for good adherence.

(g). A 5 to 6 percent CE-Mg alloy has found some application and has given satisfactory results in certain high temperature applications. The developmental work on both CE-Mg and Zn-Mg alloys was said to have been slowed down because of demands by the war machine on other investigations more closely related to increased production of the more commonly used materials needed for the war effort. Prof. Sauerweld of I.G. Farben had made some experience with Zn-Mg alloys but no alloy of this type has been made on a production basis.

(h). The permanent mold light metal casting industry produced about 30 percent of the aluminum alloy castings produced and less than 3 percent of the magnesium alloy castings. T he magnesium alloy used for permanent mold casting is a 9 percent Al, 1 percent Zn, remainder Mg alloy. It is case at 680 to 730 degrees centigrade depending on shape of the casting.

(i). In magnesium sand casting practice the "Elfinal" process is used for grain refinement. This consists of a treatment with iron chloride. This treatment reduces the amount of superheating necessary to obtain the desired grain refinement. Chlorine gas treatment is not used. Natural sand of relatively light texture which are available in abundance in Germany are used. For molds, sulphur and boric acid are added to the sand for protective atmosphere.

(j). No plaster mold magnesium castings are made to the knowledge of the personnel present.

(k). It was learned that the leading die casting producer, Mahle Connstadt, has developed a new die casting machine which is more refined than the Pollack type machine which is in most common use for aluminum magnesium and zinc alloy die casting. Only one magnesium alloy is used commercially for die casting. This ia a 9 percent Al, 1 percent Zn, remainder Mg alloy. Some difficulty has been experienced with cracking of certain castings made of this alloy but no development of a new alloy less susceptible to this cracking has been forthcoming. Where cracking is experienced it is eliminated as far as possible by control of design and by careful temperature control during casting process.

(l). In German production no special effort is made to control the iron content of magnesium alloys. The applicable specifications do not specify any maximum for iron. Where low iron had been desired for experimental purposes the iron has been reduced by Beck's process. This process consists of keeping the melt at a temperature just above the melting point for a long period of time during which the Mn and Fe settle down to the bottom of the melt. Iron content can be reduced to 0.005 percent by this treatment, whereas commercial castings contain about 0.05 percent Fe. Cast steel pots are used for large melts (2 tons and over) and welded iron sheet pots are used for smaller melts. Magnesium chloride is used in melting.

(m). In German practice, the only magnesium alloy that is heat treated is the 9 percent Al-Mg casting alloy. This is mostly due to to the fact that a large part of the magnesium industry in Germany is made up of about 60 to 80 small license foundries which do not want to be concerned with heat treatment. In the heat treatment of the above alloy casting a furnace atmosphere of SO_2 is used.

(n). For surface treatment of magnesium alloys, it waw the opinion of the I.G. Farben representatives that the commonly used nitric acid etch, potassium dichromate soak followed by water rinsing drying and one coat of any of a number of good commercial varnishes generally gave adequate protection for aircraft applications. However, there are in existance a number of commercial anodic treatment processes used, examples of which are "Flussal" which utilizes a fluoride bath to produce a film of magnesium fluoride, "Elomag" (developed by Langbein Pfanhauser Leipzig) utilizing a sodium or potassium hydrozide bath, and "Seomag" (developed by Siemens) utilizing a sodium or potassium hydrozide bath with a few minor additives. The "Flussal" process is the one commonly used on magnesium cases for binoculars etc. It is the most expensive of the known processes for protecting magnesium from corrosion. It has been used in German sea planes and was patented in the United States. In 1937 the sole licensee being the Aluminum Company of America.

(o). I.G. Farben had made several hundred Mg alloy propeller blades before the war but not much information was available on their serviceability. The opinion of the representatives was that they would be suitable for commercial airplanes but not for military aircraft because of susceptibility to serious damage as a result of gun fire. They had also made some large Mg alloy propeller blades for Hamilton Standard prior to outbreak of the European War.

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The Rail Road Yards adjoining I.G.F. in Bitterfeld

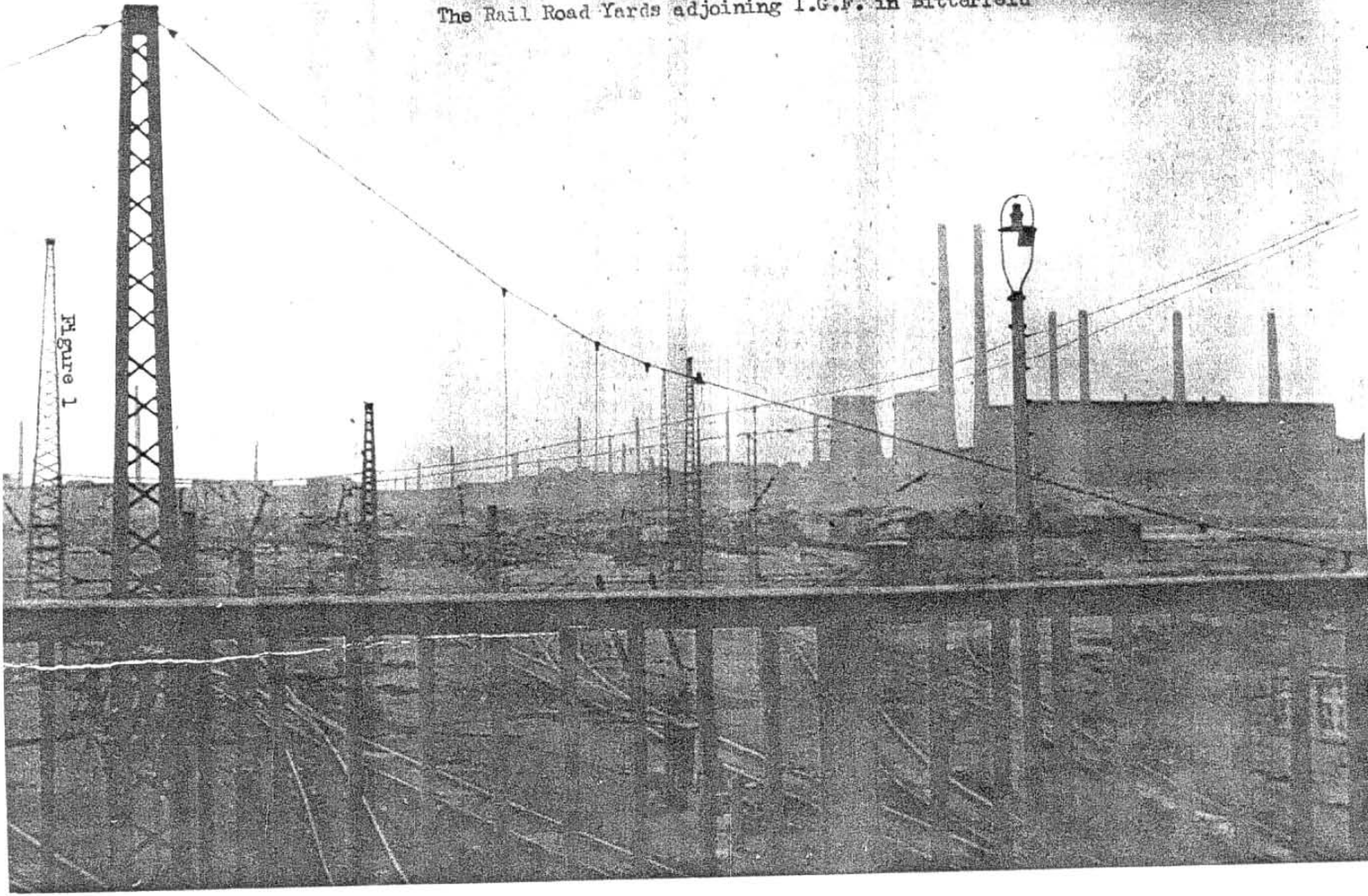


Figure 1


I.G. Farbenindustrie Aktiengesellschaft
Bitterfeld
Werk Nord M. 1:2000

Figure 2

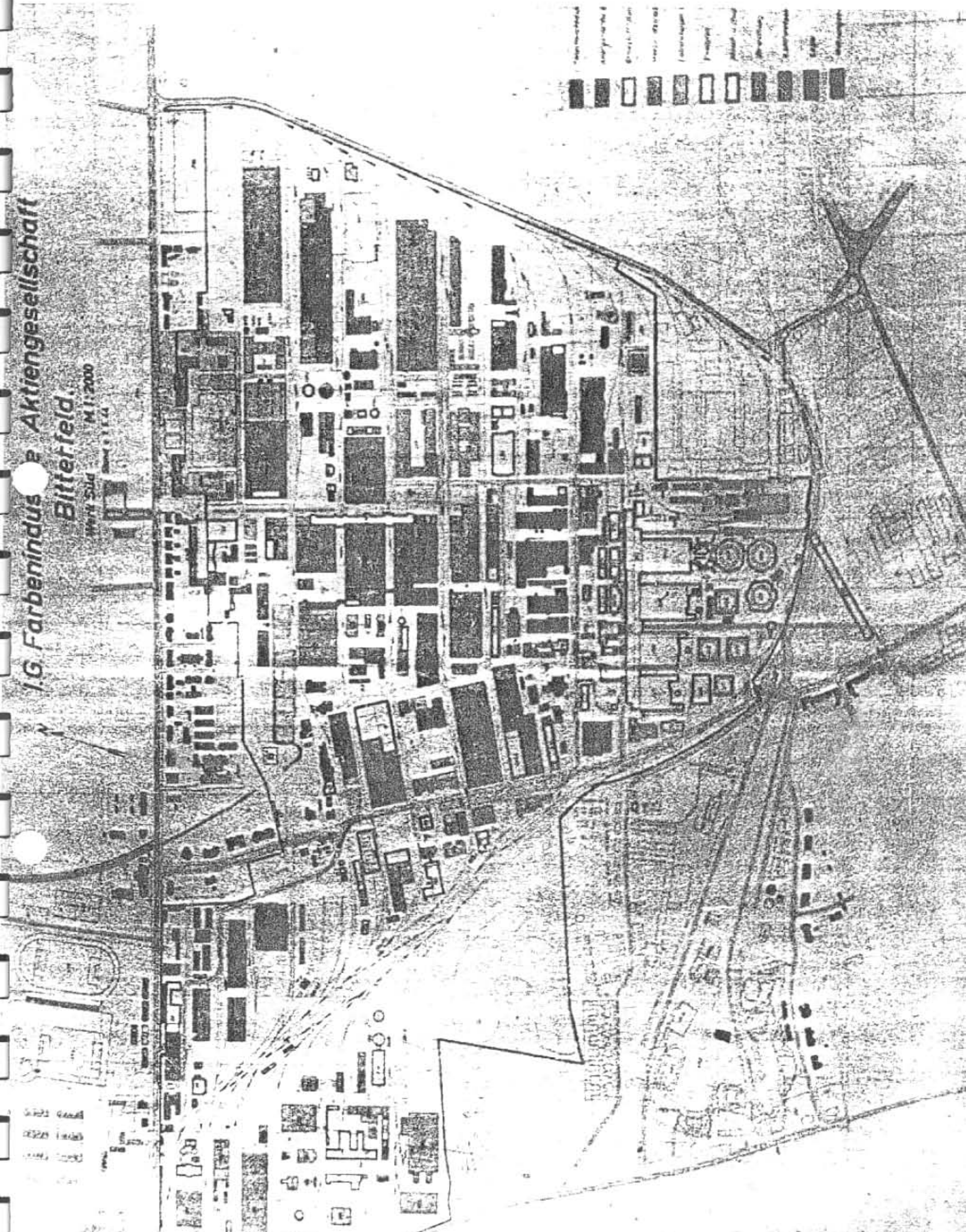
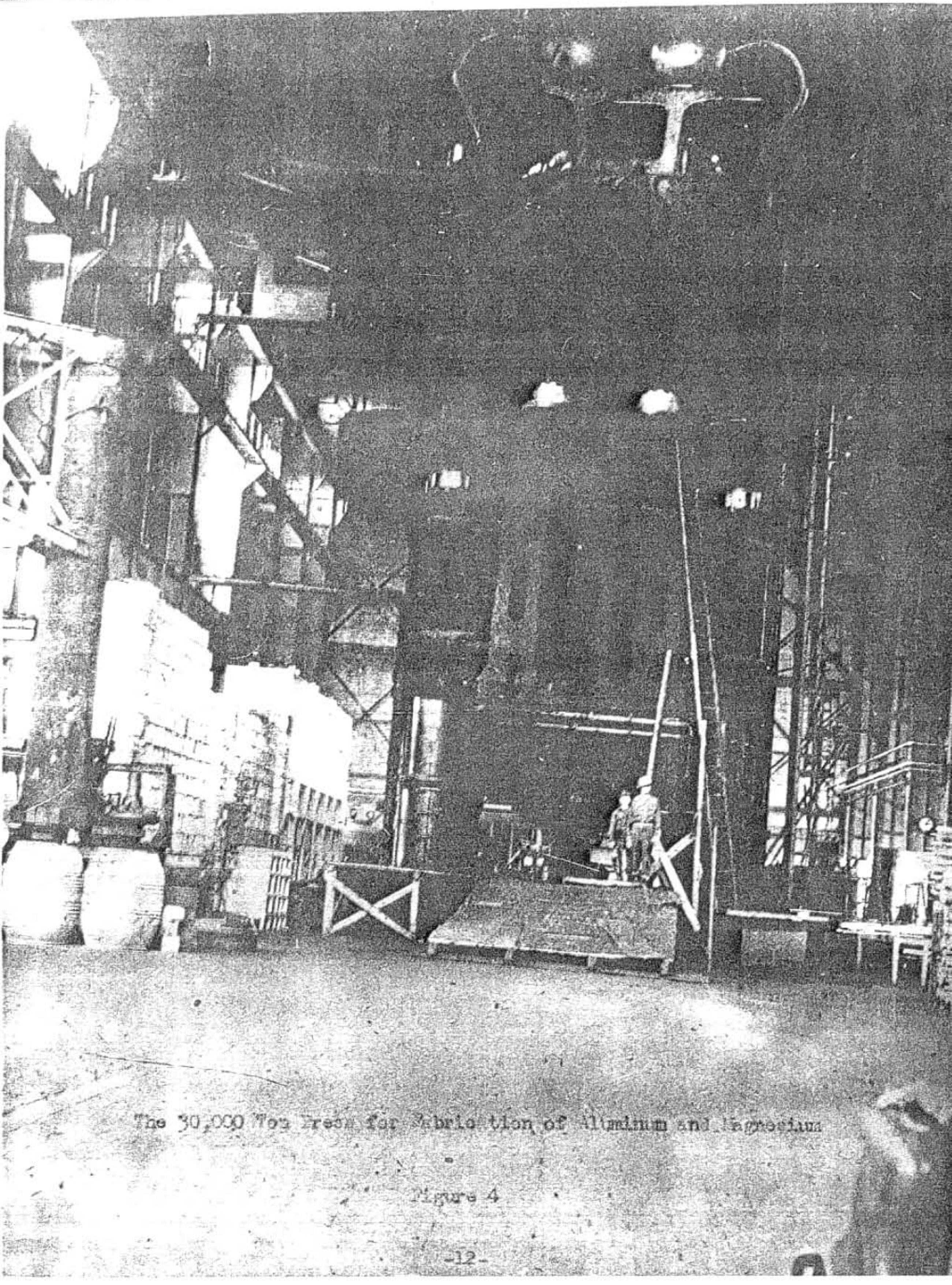


Figure 3



The 30,000 Ton Press for Fabrication of Aluminum and Magnesium

Figure 4