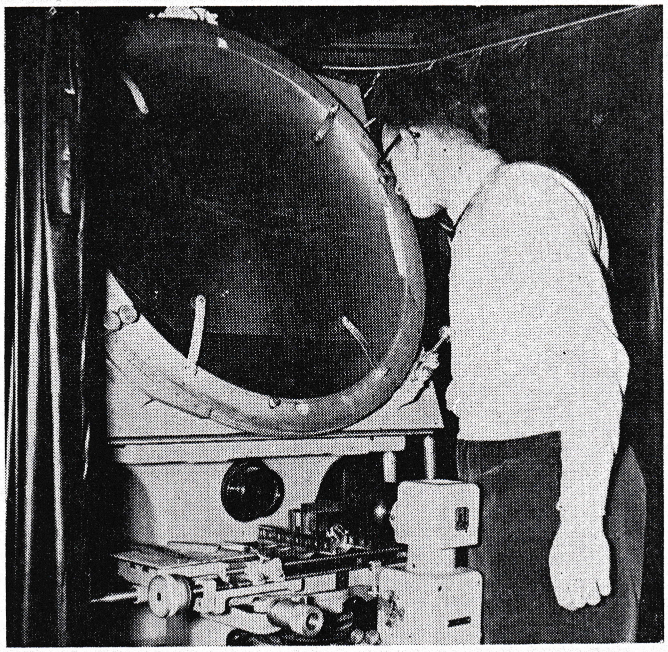
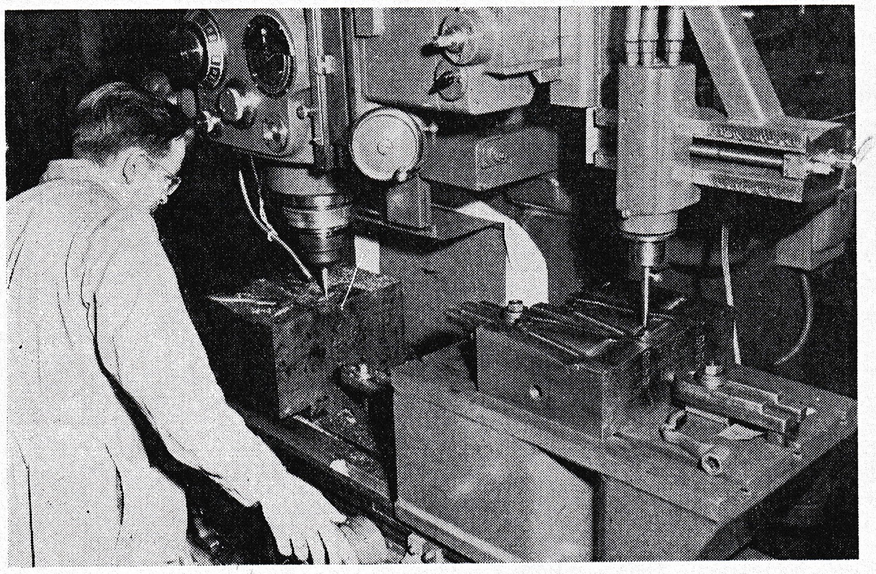


FORGING BLADES FOR AVRO ORENDA PRECISE OPERATION



IN ITS simplest terms, the forging of compressor and turbine blades for jet engines consists of hammering steel or aluminum rods between two molds or dies until they are the right shape. Actually, the production of "buckets" and blades for the Avro Orenda jet engine is complicated by the variety of blade designs and the extreme precision required for each.

The new Canadian Steel Improvement Ltd. plant near Toronto, which was formally opened on Feb. 22 and is now in production, contains the specialized equipment and the skilled personnel essential to this vital assignment. The company was formed in January of last year with government capital assistance and with the background of experience provided

CAPTIONS

TOP—Accuracy of template used in making dies is checked in the Jones & Lampson Comparator. The template outline is magnified and projected on the screen for visual comparison. This comparator gives an accuracy of .2 thou. and, for example, two minutes of a degree.

CENTRE — One of a battery of Cincinnati Hydrotels duplicating a blade forging die from a steel model or master die.

RIGHT — Key plant personnel inspect blade forging dies. Left to right: Robert Stick, plant superintendent; George Mothersill, die shop foreman; and F. W. Stockhausen, chief inspector in the new Canadian Steel Improvement plant.

by the U. S. parent company, Steel Improvement & Forge Company of Cleveland.

Construction of the 50,000-sq.-ft. plant was started in May, 1951 and is now complete. Capacity is being provided to deal with the Avro Orenda program in two stages. The first stage, which comprises the existing buildings, aims at an output of 100 engine sets of aluminum blading and 150 engine sets of both Inconel X turbine buckets and steel compressor blades. The second stage provides an additional forge shop upon which constructional work has just commenced and which will increase the capacity for aluminum blades to 140 sets per month, leaving the remainder of the program as it stands for the first stage.

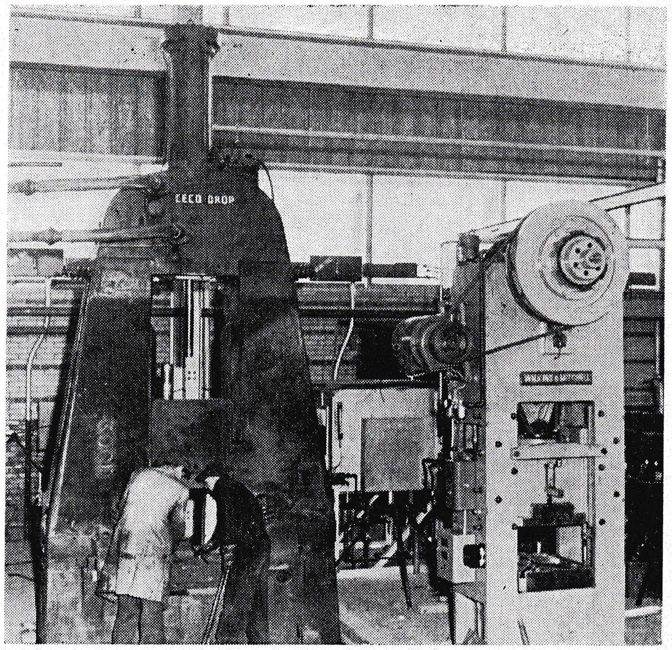
It is estimated that peak production for Stage I will be obtained in April, 1953 and for Stage II in October, 1953. Approximately 340 people will be required for the first part of the program, rising to a total of 380. Present strength is around a 100.

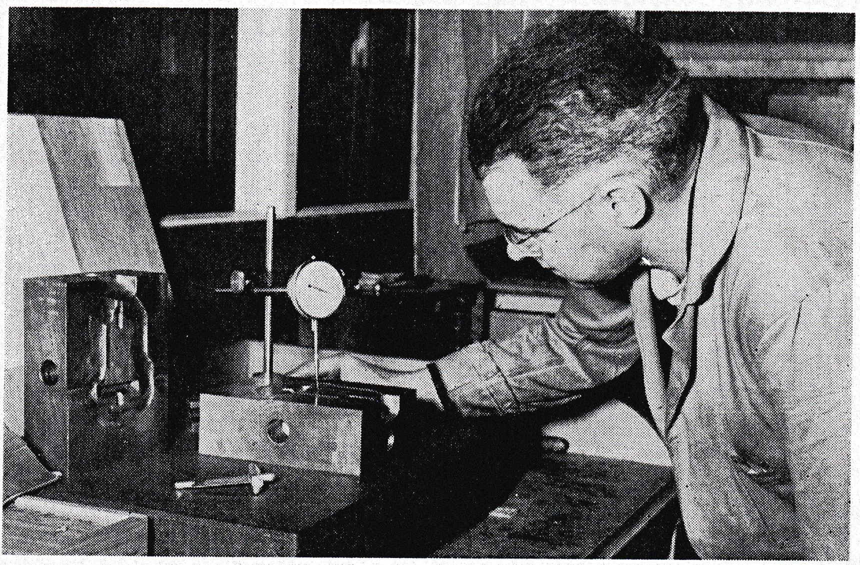
Executive vice-president of the Canadian operation is Cyril J. Luby who has had 24 years' experience with Bristol in England. Before assuming his present position last April, Mr. Luby was in charge of the experimental department at Bristol.

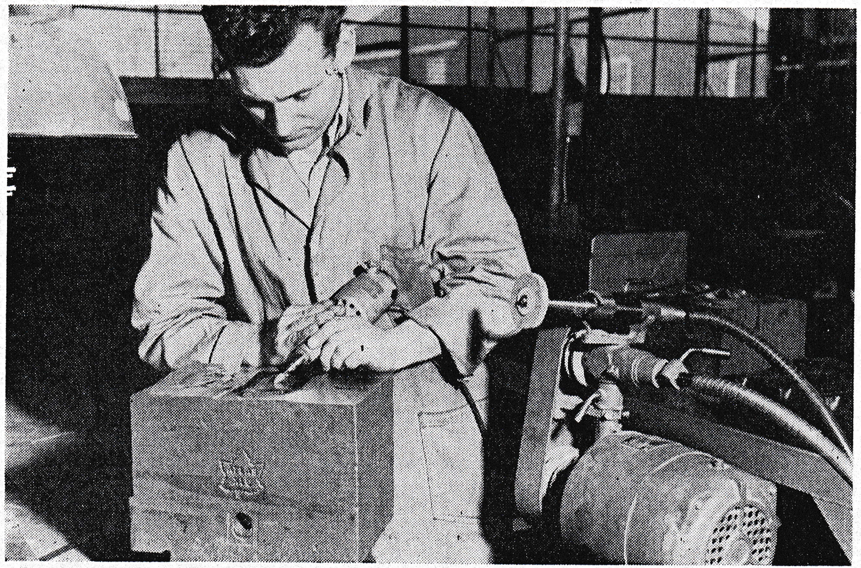
Canadian Steel Improvement Ltd. is a wholly-owned subsidiary of the Steel Improvement & Forge Company of Cleveland, Ohio, and was incorporated under a Federal charter on Jan. 12, 1951. Its objective is to produce turbine bucket forgings in heat-resisting steel, stainless steel compressor blades and also precision-forged aluminum compressor blades; both turbine buckets and steel compressor blades being produced with machining allowances on the airfoil sections.

In the Orenda engine there are 21 rows of forged blades. Each row has a unique blade design, requiring

(Continued on page 50)







TOP—Forge shop trio. The steel or aluminum bars are heated in the Hayes Certain Curtain electric furnace (2,500°F) in the background, then forged in the 2,000-lb. Ceco dro hammer at left. Finally the excess metal or flashing is removed from the forged blade in the Wilkins & Mitchell trim press at the right of the picture.

CENTRE—Inspection of a die model is a most important stage, calling for extreme accuracy.

LEFT—After being duplicated from the die model in the Hydrotel, the forging die is bench finished to close tolerances.

FORGING JET BLADE PRECISE OPERATION

(Continued from page 29)

a special set of blade forgings. Some rows are steel, others aluminum. For each blade design, a highly-accurate set of master dies is made. These form the pattern from which the forging dies are cut on the big Hydrotels (see illustration).

The accuracy required in the die making is in terms of .5 thou. The forged aluminum blades are accurate to 2 thou. Considerable bench finishing and polishing is required to achieve the required accuracy in the dies.

Before going to the forge shop, the aluminum or steel rods are cut into short lengths, then each is "upset." This process consists of applying heat and pressure in order to mushroom or bulge one end of the rod. This onion-shaped bulge eventually becomes the blade root. The upsetting process ensures that the metal grain flows into the root, for strength considerations.

The rods are forged in 2,000-lb. Ceco drop hammers after heating in electric furnaces, then are trimmed in Williams & Mitchell trim presses. Subsequent processes include heat treatment in gas-fired furnaces, sand blasting to remove scale from forgings, etching, anodizing, and final inspection. Etching of the aluminum blades scours the surface so that the

CYRIL J. LUBY, executive vice-president of Canadian Steel Improvement Ltd. now in production of blades for the Orenda jet engine in a new plant near Toronto. Mr. Luby had 24 years' experience with Bristol in England before coming to Canada to assume his present position.

inspector can see if the grain flow in the forging is even.

After delivery to Avro, the steel blade forgings are machined to final dimensions as are the heads of the aluminum blades. The aluminum blade forms are polished.

Installation of the drop hammers is an interesting feature of the forging shop. Each of these big Cecos is mounted on a floating cement block. Three sets of I beams running through the foundation block rest on heavy-duty springs, giving the block a two-inch floor clearance. There is a device for adjusting the level of the foundation block.

This spring mounting absorbs virtually all vibration from the drop hammer action.

The present buildings consist of office block, die shop, forge shop and boiler house, totalling just under 50,000-sq.-ft. and with the completion of the second forge shop the covered area will be approximately 60,000 square feet. The site area is 7.5 acres thus allowing for any future expansion to meet the demands of the defense program.

The parent organization, The Steel Improvement & Forge Company, was formed in 1913 as a small unit for the heat treatment of metals. In 1916 they acquired the assets of an adjoining forge shop. In 1932 the company ceased to do contract heat treatment work and concentrated entirely in the forging field. They pioneered the forging of stainless materials and later had considerable experience with the working of heat-resisting alloys.

One of the principal items which they produced during this period was the Turbo Super-Charger Turbine Wheel forgings for piston engines, and mainly because of the experience thus gained, they were asked by various aircraft engine companies in the U. S. to undertake jet engine wheel forgings and, at the same time, being one of the first companies to do so they commenced forging jet engine blades.

In 1944 the parent organization commenced forging turbine and compressor blades for the Canadian industry, first for the Chinook and later for the Orenda engine. When large scale production of the latter was decided upon by the Canadian Government, Avro suggested that Steel Improvement & Forge should operate a Canadian subsidiary to match the engine program. Informal discussions were taking place

LOCKHEED

SUPER CONSTELLATIONS TO GET TURBO-PROPS

The U.S. Navy has selected the new R7O-1 Super Constellation as ideally designed for vital conversion to turbo-prop power. Only minimum modifications are required, according to BuAer. No structural changes of the empennage, fuselage or basic wing are necessary.

Significance to airline operators is that Super Constellations with Wright 3250-h.p. compound engines can later be converted to turbo-props. This conversion to Pratt & Whitney T-34 Turbo Wasp engines will put the Super Constellation in the 450-mile-per-hour-class.

The Super Constellation offers any airline operator any performance he desires, from high-density coach travel, to luxury over-ocean travel, or it can be used for efficient, economical cargo purposes.

Never before has the basic structure of any aircraft provided so adequately for *growth*, assuring the operator many years of competitive performance. Compared with any of today's certificated aircraft the new Super Constellation is superior in versatility, speed, payload, range and ability to earn greater profit.

NEWS NOTES FROM LOCKHEED

Eight international airlines have now ordered Super Constellations—most recent: Seaboard & Western Airlines and Braathens S.A.F.E. Air Transport ... With Navy and Air Force orders, the total demand now exceeds 200.... A new "White House Squadron" of Lockheed F-94 All Weather Jet Fighters is guarding Washington, D.C. ... Lockheed is occupied with aircraft using six different kinds of power, including reciprocating engines, turbo-props, jets and rocket power.... For pilot comfort every Lockheed jet fighter has a cockpit cooling system equivalent to 100 household refrigerators.... The single Allison jet engine in the Lockheed T-33 jet trainer is more powerful than all four engines of the B-17 bomber of World War II fame.... Pilots of many nations learn jet flying in Lockheed T-33 trainers, and recently when two T-33's were delivered to Turkey they were inaugurated in preflight Mohammedan rites including a lamb sacrifice.

FROM THE WORLD PRESS

Under the headline, "New Facts on Jet Combat," *Aviation Week* reports from Tokyo: "The Lockheed F-80 *(Shooting Star)* still is considered to be the best ground-attack jet in Korea. There is considerable belief here that development of an airplane along the proved lines of the F-80 is the answer to the interdiction-close support requirement." Thus another Lockheed design continues to prove its basic "rightness" even though more modern types have replaced it in Lockheed's production line.

before Korea and in October, 1950, Avro requested the company to put forward a definite proposal, and at about mid-November this was submitted to the Canadian Government, instructions to proceed being given verbally before the end of the year.

The second forge shop as referred to above has been started, steel is due for delivery at the beginning of the second quarter and it is expected that construction will have been completed by September of this year. Equipment deliveries, however, are such that the full benefit of the additional capacity cannot be made available until October, 1953. There will, however, be gradual increases in production from January of that year onwards.

ROCKET PROPULSION PRESENTS PROBLEMS

(Continued from page 27)

haust gases. Thus our best propellant combination will be that which gives the highest flame temperature and the lowest molecular weight of exhaust gases. Unfortunately the optimum theoretical SI is not the only consideration in choosing a rocket propellant. We must think of such things as ease of handling, safety, availability in time of war, and cost; the latter factor would of course have less influence as the other factors became more advantageous.

Liquid propellants are divided into two main classes, monopropellants and bi-propellants. Briefly a monopropellant is a single substance or mixture of substances of which the main bulk can be stored in one tank, and can be squirted into the rocket chamber through one system of holes. The liquid is such that when annoyed in some particular manner it dissociates into a gas or gases with an evolution of heat.

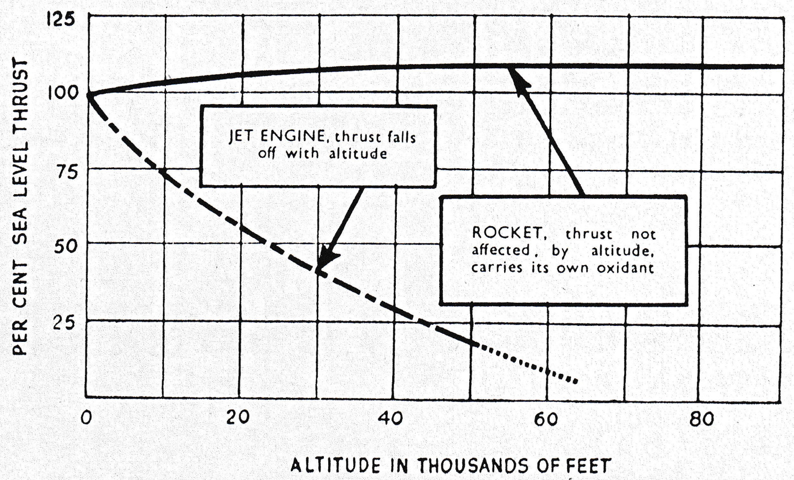
In passing it may be mentioned that the less particular the substance is about the kind of annoyance which starts the dissociation, the less safe it will be, while the more particular it is the more difficult it will be to dissociate it efficiently and rapidly in the rocket chamber.

Bi-propellants usually consist of a fuel and an oxidant, which of course have to be stored in separate tanks and fed to the rocket chamber by separate injection systems. The more amenable and common combinations consist of an oxidant which is very rich in oxygen, and a fuel which is either an alcohol or a hydrocarbon.

The choice of a fuel is fairly easy as hydrocarbons and alcohols are plentiful and comparatively safe and easy to handle. The main difficulty therefore lies in the choice of the oxidant. If all the witches' brews that have been tested and proposed were listed it would fill this paper from end to end. Some are so sensitive that they are liable to detonate if spoken to sharply. Of others, only a few pounds exist in the world.

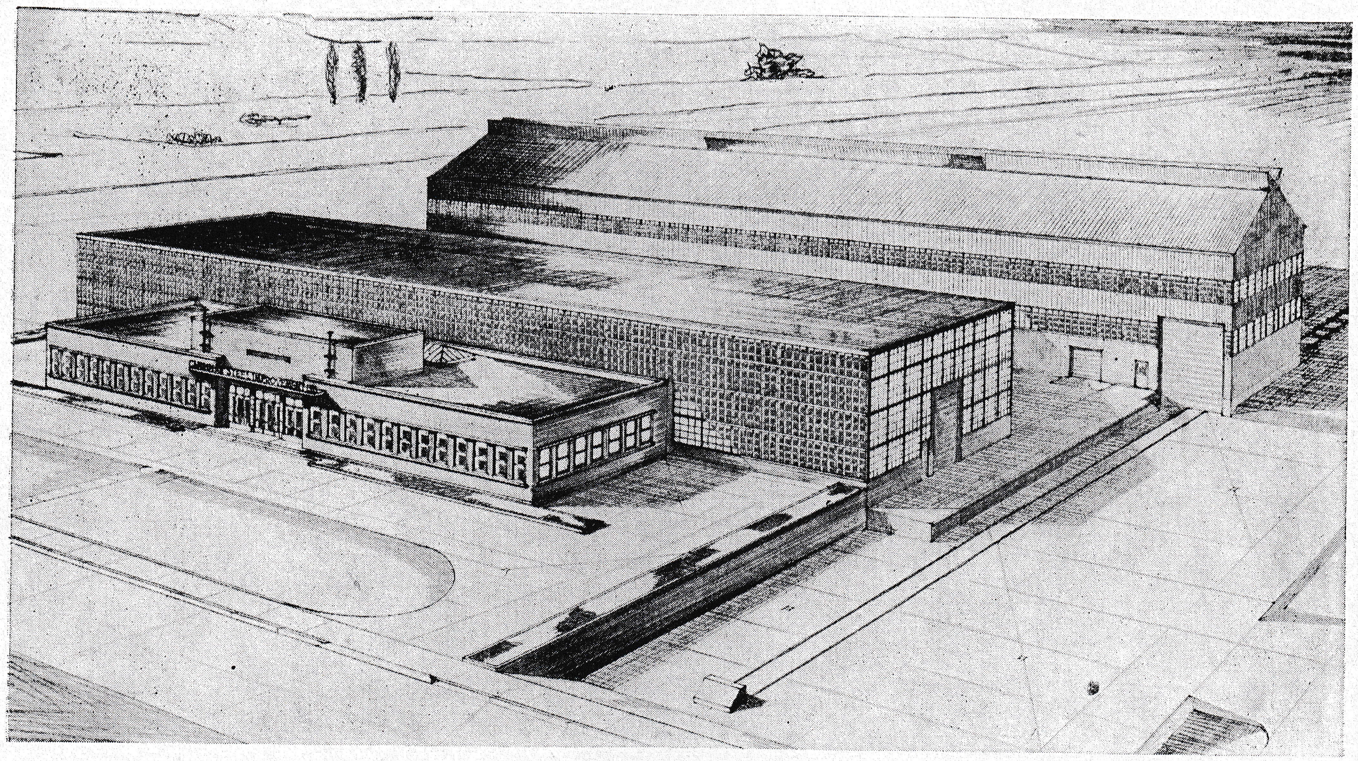
As we are severely practical people, we will confine our consideration to those propellants which are reasonably obtainable, and which could conceivably be handed over to instructed but non-technical personnel to handle. Of the liquid oxidants which fulfill these conditions there appear to be only three — concentrated nitric acid, concentrated hydrogen peroxide and liquid oxygen. Liquid air is ruled out because the amount of oxygen present is insufficient.

The properties of concentrated nitric acid are well known. Most metals are attacked to a greater or

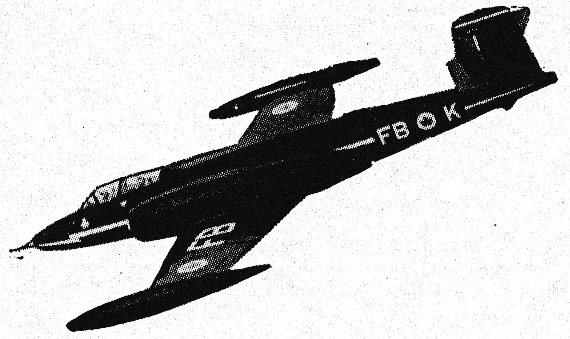


Now In Production . . .

This New Forging Plant Producing Jet Engine Blades



Here is Canadian Steel Improvement's new forging plant — built to forge turbine and compressor blades for A. V. Roe's Orenda Engine. The plant has 60,000 square feet of floor space. This company is a subsidiary of The Steel Improvement & Forge Company of Cleveland, Ohio, who have pioneered the forging of stainless and high temperature alloys for turbo-jet engine blades and buckets, and other forged parts for aircraft.



We are proud to play a part in the defense plans of the Royal Canadian Air Force

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