Jet age

FALL & WINTER 1954

in this issue . . .

OPERATION PRAIRIE PACIFIC

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FALL & WINTER - 1954

IN THIS ISSUE

Biggest Operation of its Kind Ever Undertaken Anywhere - by Any Air Force

Operation PRAIRIE PACIFIC

***By* ARTHUR H. STEWART**

Interceptor, trainer and fighter of the RCAF are seen here in a special fly-past of a CF-100, (in the immediate foreground), a T-33 Silver Star and an F-86 Sabre during an air show of "Prairie-Pacific." The three jet types made up the Operation's aerobatic teams at the displays.

Cavalcade Photographer, AC1 Barry Herron, RCAF Trenton took every picture of Operation Prairie Pacific published here, in JET AGE . . . except this one . . . of himself.

NOBODY is quite sure how it all started. There are several versions to the story.

But, regardless, on August 13 last there were five CF-100s on the line at Winnipeg's airport, straining at their brakes with prairie dust clouding up behind them in the blasts from their Orendas. Twenty-five thousand people were watching the runup.

Down the line were five F-86 Sabres, thrusting their tailplanes in the air like bantam roosters waiting to take on all comers. And still farther down the line were five T-33 Silver Star trainers — jaunty, alert for the word to go.

Operation Prairie Pacific was on the line, set for the "cleared for takeoff" that would take them on an 80,000-mile operation.

For the next five weeks, those aircraft — representing the RCAF's jet interceptors, fighters and trainers — toured the West and Central Provinces, skimming between peaks and over valleys of the Rockies; dipping wings at towns, villages and hamlets dotted among the prairies' grain fields; staging aerobatics and flypasts for throngs at major cities in 50-minute displays.

One and a quarter million people saw the cavalcade of jets in aerobatics and on static display at the major cities on the route. Who can estimate the additional numbers of people in the towns, hamlets, crossroads villages, farming communities — who ran from barns, stores, garages, kitchens to see the jets w-h-o-o-s-h overhead in the flypasts over the rural areas?

Some estimate a total of at least two million Canadians saw Operation Prairie Pacific—saw long-range interceptors, short-range fighters and trainers of their RCAF in action—three distinct different types of jet aircraft but all bearing the label: Made in Canada. And one—the CF-100 interceptor—designed as well as built here in Canada and powered with Canadian-designed and built Orenda turbojets.

There was a three-fold purpose behind Operation Prairie Pacific: 1—to help Western Canada attain a fuller knowledge of the extensive use of jets in their modern RCAF; 2—to provide an exercise in mobility for the air force; 3—to stimulate interest in the RCAF among young Canadians.

These three objectives were reached.

But, beyond and apart from these objectives was an achievement that still has the air force talking; the tour proved to be self-sustaining with all aircraft kept serviceable by accompanying ground crew.

As one pilot exclaimed: "We put down at airfields that had no facilities at all for repair or maintenance; only facilities for sleeping."

That's an old story for Canada's fabled bush pilots, making repairs with an axe and slivers and chunks of wood from felled trees. But this is the Jet Age. And jet engines are complex.

"It seems," said Squadron Leader Roy Wood, of RCAF Station Trenton, who accompanied the tour as information officer, "that the RCAF has good airplanes, good engines—and mighty good ground crew, too. We ended that tour with the same aircraft we started out with and every one of the aircraft was on the line —ready—at every moment of the five-week schedule. Our air force can take it as well as dish it out."

That's particularly important in Canada where the shortest distance between two points can measure up to many hundreds of miles. Modern jet aircraft and jet engines need expert attention and care. Operation Prairie Pacific proved that RCAF jets can receive expert attention in emergencies far from home base.

On that 13th day of last August, Operation Prairie Pacific had still to prove itself and its findings. Five Avro CF-100s had flown in to Winnipeg from St. Hubert during the morning, followed by five Sabres from Bagotville and five T-33s from Trenton. They were joined by three C-119 heavy transports that pointed up their more familiar names of "flying boxcars" by disgorging 55 ground crew personnel.

On the following day, Operation Prairie Pacific was open for business:

Traffic officers in the cities visited by the cavalcade will testify to the size of the crowds. Newspaper headlines read like this: "Thousands See and Hear Daring Jet Aerial Show" . . . Star-Phoenix of Saskatoon; "Thousands Watch Jets Despite Traffic Tangle" . . . Calgary Herald; "Over 10,000 Witness Thrilling Air Show" . . . Lethbridge Herald; "Traffic Record Broken—Cars Jam Airport" . . . Vancouver Province; "100,000

See Sound Barrier Crashed" . . . Vancouver Sun; "Air Show Crowd Thought Record" . . . Port Arthur News-Chronicle.

Tabulations were kept regarding the size of crowds visiting the ground displays and watching the aerobatics at the bigger cities en route. Here are the figures:

25,000	at Winnipeg
30,000	at Saskatoon
25,000	at Regina
20,000	at Calgary
25,000	at Lethbridge
100,000	at Vancouver
20,000	at Victoria
35,000	at Lakehead
800,000	at Toronto

These were the larger centres of population visited by the cavalcade; but they don't begin to tell the story of the tour. From each metropolitan centre, word went ahead by Press and Radio to farmers, small town merchants and housewives, oilmen, miners and ranchers: Watch for the Jets. But look ahead of the sound if you want to see the aircraft. They're that fast.

That warning was obeyed. As one headline in one newspaper — the Sun of Swift Current, Sask. — recorded: "WHOOSH! THEY'RE GONE."

International Falls saw the 15 jets "whoosh" overhead in tight formation; then Fort Frances and Rainy River, Kenora, Lac du Bonnet and Beausejour.

Also, Neepawa, Minnedosa, Souris, Brandon, Clear Lake and Dauphin. So it went. Carman, Morden, Winkler, Morris, Steinbach, Emerson.

You name it if it's in Manitoba, Saskatchewan, Alberta, British Columbia or Ontario, the chances are reasonably good that the town saw 15 representatives of Canada's air force "whoosh" overhead during Operation Prairie Pacific.

At the bigger centres, ground "static" displays shared the aerobatics' interest with the crowds. At every major city, scheduled closing hour of the displays was far exceeded by the interested visitors who stayed on until darkness dropped the curtain.

At Saskatoon, for example—well, this is how the city's Star-Phoenix reported it: "The biggest crowd in Saskatoon's history turned out Sunday afternoon to watch a spectacular RCAF jet show and to witness a 22-year-old pilot from Peterborough, Ont., break the sound barrier. . . . Many spectators who were unable to get into the air station grounds watched the performance from adjoining farmyards, railway tracks, highways and sideroads. Thousands of cars lined roadways for miles in the biggest traffic tie-up ever seen here. Many would-be spectators had to return home when they found they could not drive their cars anywhere near the airport."

That story was repeated throughout the tour. As at Calgary, where, the Calgary Herald reported: "Thousands of Calgarians had their first good look at the modern jet aircraft which go to make the RCAF a formidable fighting machine . . . hundreds of automobiles packed solidly in one of the greatest traffic jams in the history of Calgary."

And at Vancouver, the Vancouver Province, under headlines of "Mighty Throng Jams Sea Island Airport" and "Traffic Record Broken" reported that "more than 100,000 people jammed Sea Island for the RCAF's jet air show."

This, then, is the indication of Western Canada's interest in Canada's jet air force, as revealed by Operation Prairie Pacific: "Mighty Throngs Turn Out . . . Biggest Crowds In City's History . . . Record Crowds . . ."

And that despite the fact that the tour ran smack into the worst weather experienced by the West in the last 35 summers.

Squadron Leader Wood of Trenton sums up the Operation this way:

(a) It was an eye-opener.

(b) Good crowds were expected at each major centre; but not even approaching the tremendous number who turned out.

(c) Canadians were given a chance to see their "Made in Canada" modern jet Air Force aircraft.

(d) Interest of crowds at the ground, static displays was mature and intelligent.

(e) The cavalcade offered a rare opportunity for an exercise in mobility.

(f) "And," he adds, "the tour underlined and underscored the dependability of our jet aircraft. We were far from home base and on our own. But we met every commitment."

It will be some time before the full value of the tour is assessed. And it is doubtful if the official report will refer to Operation Prairie Pacific as "the biggest single operation of its kind ever undertaken by any air force, anywhere in the world."

But that's exactly what many are saying in the top circles of the RCAF.

Individual air shows are not uncommon. And neither are cross-country or inter-continental jet flights.

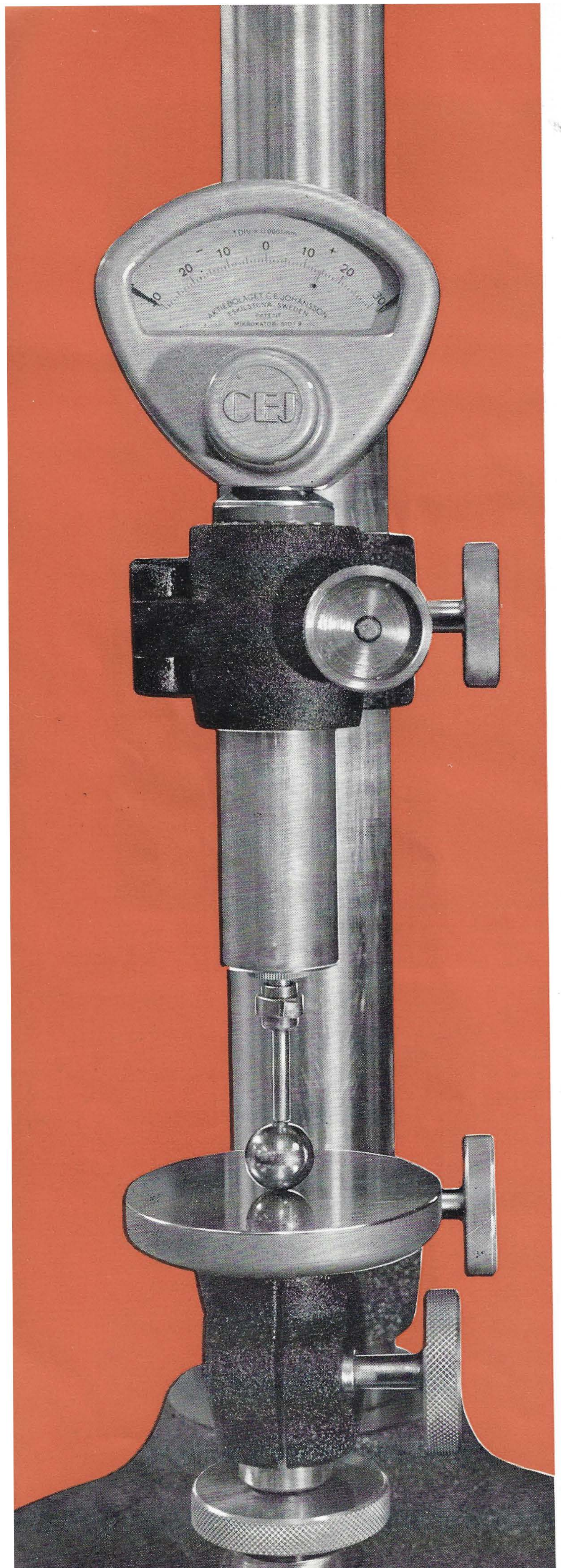
But never before has any air force attempted a cross-country, mobile air display of jet interceptors and fighters and trainers of the scale and scope of Operation Prairie Pacific.

It's another RCAF "first."

Picture story on pages 8 and 9

Born half a world apart, these flyers and RCAF CF-100 crew and two student navigators from the Dutch East Indies show a common, keen interest in Canada's long range, all-weather interceptor during the Operation Prairie Pacific tour. Photographed at Winnipeg, they are (L to R) F/O Ray Komar of North Battleford, Sask., CF-100 pilot; Cadet Fam Portier, H.D., Dam 41 Middleburg (Zld) The Netherlands; F/O Alex Martin, Saint John, N.B., navigator on the CF-100; and Cadet Fam F. Guel, Duineeg 1, the Hague, The Netherlands. The two Royal Dutch Air Force Cadets are attending the RCAF's No. 2 Air Navigation School.

Lull before another storm of applause, the aircraft of Prairie Pacific rest at Malton Airport before proceeding to thrill the hundreds of thousands attending the Canadian National Exhibition at nearby Toronto. This photograph was taken from inside one of the packets that accompanied the task force, looking out the rear door. To the immediate left can be seen a second of the three cavalcade C-119 heavy transports.



By CYRIL BASSETT

How do you measure in MILLIONTHS OF AN INCH ?

IF YOU were asked to nominate the most vital of defense industries — the one industry whose complete shut-down would quickly reduce the whole defense effort to futility — what would be your answer?

Steel? Power? No one industry, you say?

Only partly correct. You forget the bearing industry. Without bearings, no machines, no production. Deprive a country of its bearing factories and you deprive it of the power to defend itself or to make war. As the Germans learned in such dramatic fashion in 1944.

Which homily is to lead us into review of another major contribution to the Orenda engine program which come from outside the A. V. Roe Canada Ltd. organization — that of Canadian SKF Company.

Canadian SKF which, like so many other Orenda Engines Ltd. subcontractors, is a new Canadian manufacturing industry and was born largely out of the new demand and new opportunity generated by this jet age into which Canada is moving so swiftly and so successfully, is the producer of gear box and engine bearings for the Orenda engine.

To be precise:

Two cylindrical roller bearings for the engine itself;

For the gear box—7 cylindrical roller bearings; 5 single-row deep-groove ball bearings; 8 types of duplex-mounted angular contact ball bearings; one needle roller bearing and one double-row angular contact bearing.

In this work, Canadian SKF, again like many other subcontracting industries, has had to put a new and very fine shade of meaning on the word precision in its Orenda operations.

In the case of SKF, this precision is measured in millionths of an inch—where ten-thousandths was previously good enough.

All of which opens up vistas of fascinating speculation on the nature and scope of the SKF operation. Like: Just how is a ball made round and a band of hardest steel made into a perfect circle—and within such hard-to-visualize tolerances?

First a word about the company.

What do the initials SKF stand for? You could pardon a radio quiz contestant for replying: a European secret service agency. For there is truth in this, as the Allies gratefully found in World War II and as we will later relate.

SKF: Svenska Kullager Fabriken. Swedish Ball Bearing Manufacturers. Behind this unpretentious title (in its English translation, at least) lies 47 years of bearing manufacture and much pioneering in the field, also 300 years of high-grade steel manufacture which is the very stuff of a bearing.

Behind Canadian SKF is just three years of manufacturing (although the company, as a sales organization, has been in operation since 1917). This makes the Canadian company—wholly Canadian-financed by the way—a lusty infant, in terms of manufacturing, in a worldwide

This is the fifth in a series on major subcontractors serving Avro Aircraft Ltd. and Orenda Engines Ltd. to show the new industry that has been built up around the CF-100 and the Orenda.

SKF family which includes 21 manufacturing operations in 8 countries, plus 32 sales organizations spread through Europe, South and Central America, Africa, Asia and Australia.

But come with me down to the plant on Scarborough's Golden Mile, some eight miles from downtown Toronto. SKF sits comfortably in two stories on 40 acres and is notable for a landscaped frontage which at all seasons is a thing of beauty and presents that manicured look which comes only from careful and constant tending. This, by the way, is an outward expression of the painstaking, nothing-but-the-best attitude that President Gunnar Wester brings to all he essays whether at work or on the golf course.

Back of the 140,000 sq. ft. of office, storage space and manufacturing facilities you will always find five years' supply of the raw product of SKF bearings: steel tube forgings and bars. This it draws from Canadian and U. S. sources but mostly from the SKF Hofors Steel Works in Sweden.

This is the 300-year-old steel works which SKF acquired in 1916 and has since developed into the world's largest and most modern producer of high-grade and special ball-bearing steel with an annual ingot capacity of 180,000 tons—a move designed to assure that in no part of the operation would quality control be out of SKF hands.

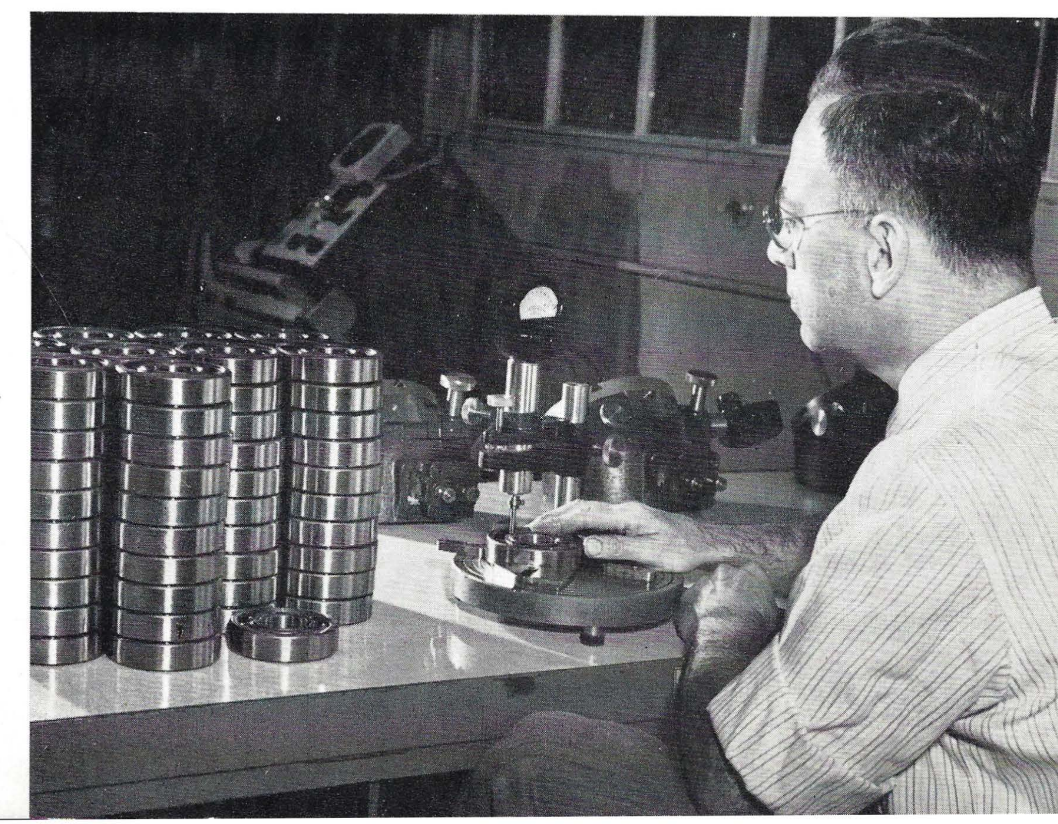
To convert this raw material into finished ball—or ring and raceway, as the case may be—of nearest possible perfection in roundness, smoothness and hardness—takes up to 40 separate operations or 10 departments. Yet it all adds up to something as fundamental as making butter balls between a pair of paddles or scooping a cantaloupe ring meticulously down to the rind.

Let's take a look at some of these operations as I did with Jack Pickett, Assistant to Executive Vice-President J. F. Murphy, who is also in charge of Orenda and other aircraft business.

Here the long tubes of steel are fed into the knife-edge maws of a turning machine. Out come bearing rings with ragged edges and an inner surface re-mindful of table silver long in need of cleaning. But this is the beginning of a ring with gleaming, hard, silky-smooth raceway more beautiful than any wedding band—and in itself the very guts of the machine into which it is destined to go.

It will get that way through numerous facings and chamferings, much turning, grinding and polishing, hardening and tempering, and at every stage of its intricate process of manufacture minute checking for dimension, finish and hardness.

Or, regard the gleaming ball of the



Here's the answer to our headline question. Width and parallelism of inner and outer rings is checked by gauge graduated in one-micron divisions (about 40-millionths of an inch). Gauge opposite has divisions of four-millionths.

bearing in its birth pangs—though this you will not see at the Canadian plant. But it is such a fascinating and integral part of the SKF operation that it is indeed worth the telling.

Here a giant shear slices off pieces of steel bar quicker than Granpaw could bite off a chaw of tobacco. There a furnace draws it into its fiery bosom. Here a pair of tongs snatches it back again to place it between the cupped dies of a press.

Out comes a sphere with nodules at its poles and a flange for equator—looking rather like the ball float in your toilet cistern.

Follow through with me if you will on how a ball is made round and in many essentials you will also learn how Canadian SKF makes the races into which they are to be enclosed, into perfect circles.

We have seen the balls emerge from the presses.

They come out this way at the rate of about 400 a minute—in the three-quarter inch size, which is what we'll use as an example from here on.

Then about 500 pounds of them at a time are fed into a hopper for two hours of rough-housing between two file cut discs. Off come the nodules, the flange (or flash) and other imperfections. The result, to the layman, looks like a pretty round ball. But they're way oversize in technical terms—generally about 35 hundredths of an inch. So, some more grinding.

At this stage the balls are fed into another grinding machine. This time, at the rate of 1,000 an hour, they're rolled in a circular slot between a lower grinding wheel rotating at 900 rpm and an upper driving ring moving in the opposite direction at 60 rpm.

In this and all grinding operations to come, the balls are always rolling and continually changing their axis of rotation. This way every high spot of each ball's surface gets indentically the same going-over.

By the time the ball leaves rough grinding it's really looking up. Now it's only two thousandths oversize. But in the multiple groove grinding machine which receives it next, in batches of 4,000 at a time, it is further refined down to within one ten-thousandth and should come out both spherically accurate and uniform as to size with its companions.

Now the ball gets a washing in abrasive grit and water in a tumbler five feet in diameter which, rotating at 30 rpm, puts 1,000 balls through at a time to free them of further minute imperfections and excess material.

From here, on to what looks like Hades and all-important heat treatment

Magnafluxing is important checking operation. Rings are magnetized in instrument at left, then immersed in bath containing fluid in which minute particles of magnetic compound are suspended. These particles cluster to any defect which is then revealed under magnifying lens to the operator at right.

by which the ball gets the hardness necessary for it to withstand the terrific pressures it's going to have to handle as part of a bearing.

In this process the balls go through a series of shaker hearths of progressively increasing heat up to a final 1,500 deg. F. Then a quenching in water and final treatment in a tempering furnace. For the ordinary hardware ball this is the end of the line—in manufacturing processes. But for the precision ball which goes into the Orenda bearing there is more grinding to come and the precision pace gets hotter.

In this next stage, the balls are brought down to within one-half of one ten-thousandth in 12 hours of rolling against the hardest-known kind of grinding wheel in a further battery of multiple-groove grinding machines.

One further refining operation and the ball is ready for a series of rigid inspection tests. In this operation—known as lapping—the balls are constantly bathed in a special compound and rolled between two metal plates containing many grooves. This not only puts an extremely fine finish on the balls but splits the previous tolerances by as much as one half—that is, to 25 millionths of an inch.

Now these balls—as also the races—have a brilliant, pristine appearance, and like so many gems, you'd like to pick them up to get closer to the brilliance they throw off. But don't. Even the smallest amount of perspiration from your fingers will render a ball useless because this will cause corrosion.

Watch the balls and the races through inspection and assembly into bearings. The girl who must put a gauge on them, or who must put them through visual inspection under bright lights, wears gloves. And the balls and races never remain long out of a fine oil bath which imparts to them a fine protective covering. Or in the bearing assembly operation you will find the girls doing the job with their hands constantly in and out of an oil bath for protection of the fine finish in this delicate operation where gloves would be an impossible handicap.

What happens in the inspection processes?

First a batch of balls is placed on a smooth surface under a bright light. Then the girl slips a sheet of white cardboard under them to turn them more easily. Another piece of white cardboard held above the balls makes surface defects instantly discernible.

That's the preliminary surface, or smoothness inspection.

Then the balls go to a line of machines each containing two slanting knife edges adjusted to within millionths of an inch. These sort the balls as to size. Gauges with hairline needles for indicators check the balls as to sphericity.

Just how sensitive these gauges are—and again just how important it is that the product be untouched by human hands

(lest in this case heat imparted from the body sets up expansion in the ball to give a wrong reading) is dramatically demonstrated to the visitor. This is done by inviting you to place your hand against a small steel column to which one of these sphericity gauges is linked. Immediately you see the needle do a dance, to tell you that indeed you have set up an expansion in the steel column you touched—even though of a very minute order.

In this experiment you will also have put your finger—quite literally—on the secret of success in this fascinating business: a precision which the lay mind cannot quite grasp or visualize because it is impossible to chart in static form.

And that, in highlight form, is the story of bearing manufacture at Canadian SKF. Not complete, of course, for it leaves many things untouched. But enough, it is hoped, to indicate the beginnings of yet another new industry for Canada which has come in the wake of the jet age.

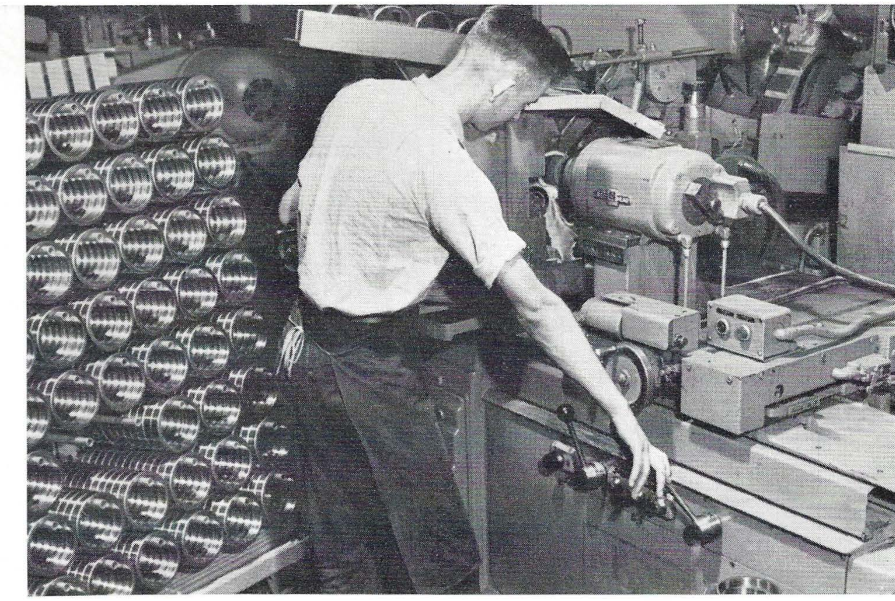
This new industry has distinguished forebears. SKF is a name long known and respected in bearing manufacture throughout the world.

Founded in 1907 by Sven Wingquist in Gothenburg, Sweden, SKF today claims to be the world's greatest exporter of roller bearings, selling to about 60 different countries through 155 offices in different parts of the world.

Its expansion has been rapid—from an initial employee roll of 16 in the one factory in Sweden to 30,000 or more in 21 factories in eight countries today.

SKF as a worldwide organization produces all types of bearings from the smallest to the largest—from 10 to 1,400 millimetres in outside diameter, from bearings that can be run at speeds of 60,000 rpm and others with a carrying capacity of 2,000 tons at low speeds. It has made a bearing weighing 5,100 pounds; at the other end of the scale has made them weighing no more than .053 ounce.

As hinted earlier, SKF made a significant contribution to the Allied war effort. The home plant in neutral Sweden, whose officers had ready access to the German high command, brought the Allies much in the way of invaluable intelligence and were directly instrumental in picking off German ball-bearing factories for the Allied bombers to destroy. At the same time, SKF maintained a regular air freight service of bearings and machinery to its English plant and in 1943 helped Britain to set up a giant ball-bearing plant in Northern Ireland, virtually all the machinery for which was flown secretly to



Raceway of roller bearing is ground in Heald Size Matic Internal Grinder. Workpiece is held by a set of rollers against a rotating backing plate thus assuring almost perfect concentricity between the outside die and the raceway.

Prototype aircraft roller bearing is being assembled here. Operator places rollers in silver-plated bronze cage before positioning inner and outer rollers.

the plant site from Gothenburg.

It is against this impressive backdrop that Canadian SKF now builds its manufacturing future.

The decision to go into manufacturing came in 1948 after a 30-year record of success in selling SKF products in Canada. The factory was ready in 1950 and first bearings were delivered in June, 1951 after many headaches, mainly concerned with securing and training the right type of personnel.

History since then has been one of steady progress and expansion. From a very limited scope in the original program the company has gradually spread into greater diversity of production. With the advent of a large-scale aircraft engine demand, the company went into sizeable plant expansion and additions of equipment to make the factory less dependent on outside suppliers for necessary tools.

Now Canadian SKF, matching its own experience of growth with the world experience of SKF in other countries, looks confidently ahead. And early announcement of another factory expansion will surprise no one close to the company.

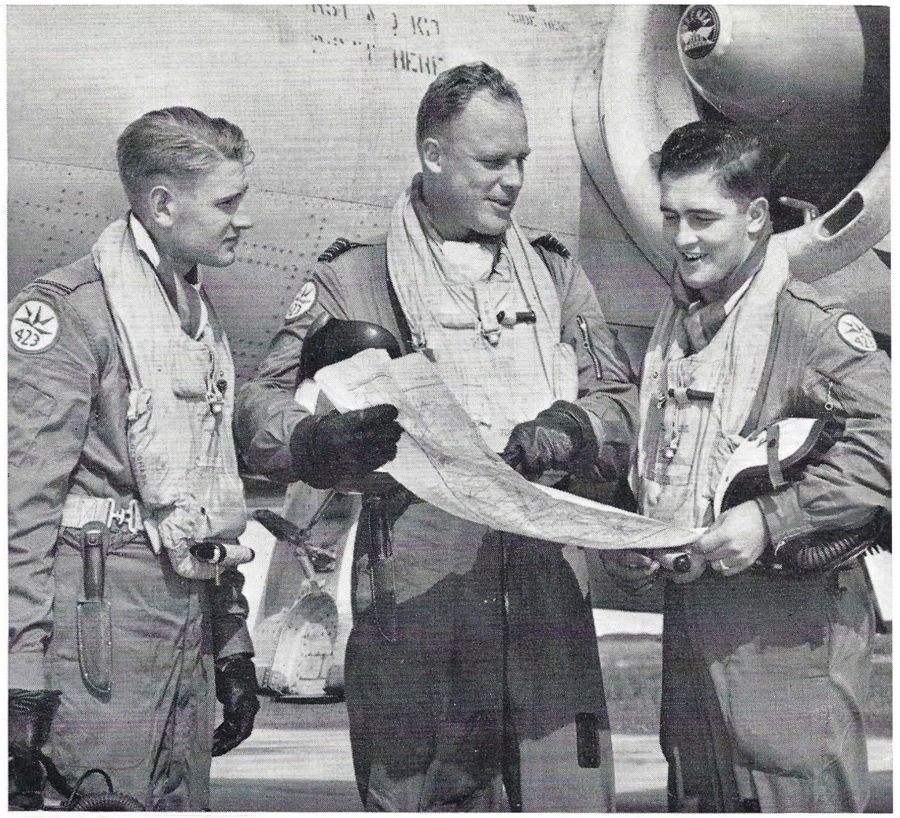
Two from the East coast bound for the West coast—Flying Officers E. MacFarlane and Alex Martin, both of New Brunswick, talk things over with three fellow-navigators from the RAF, students at No. 2 Air Navigation School, Winnipeg. F/O MacFarlane is third from left with F/O Martin on his left.

Where possible and practical, newsmen and radio commentators went up for their first jet ride when Operation Prairie Pacific called in on their home town. "What do you mean, newsMEN," says Helen Tesky, staff reporter of the Saskatoon Star Phoenix.

One of Vancouver's roving radio newsmen was taken up by S/L Lou Hill, leader of the Silver Star jet aerobatic team. Throughout the tour, the RCAF let Canada's newsmen and radio commentators do the talking—calling the shots as they saw them. Verdict? "Terrific."

OPERATION PRAIRIE PACIFIC

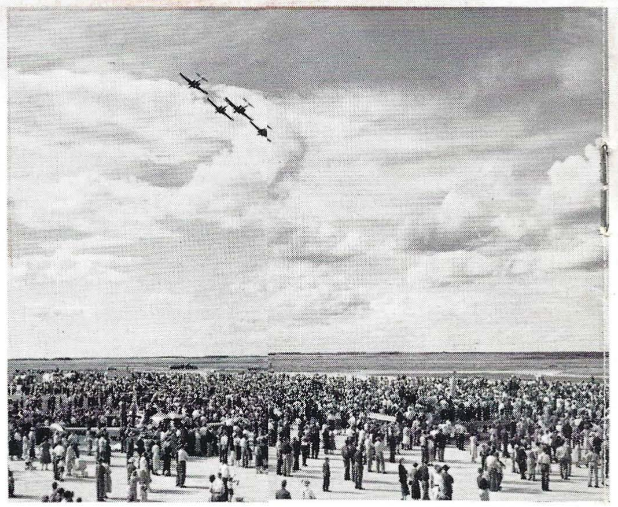
Continued from page 3



Looks good from any angle, agree F/O E. E. "Al" Hesjedahl of Bengough, Sask. (left), S/L Pat Bing, DSO, of Regina, Sask. (centre) and F/O Ray Komar of North Battleford, Sask., as they look over a map of their native province. They then took off on a 400-mile flight over Saskatchewan communities.

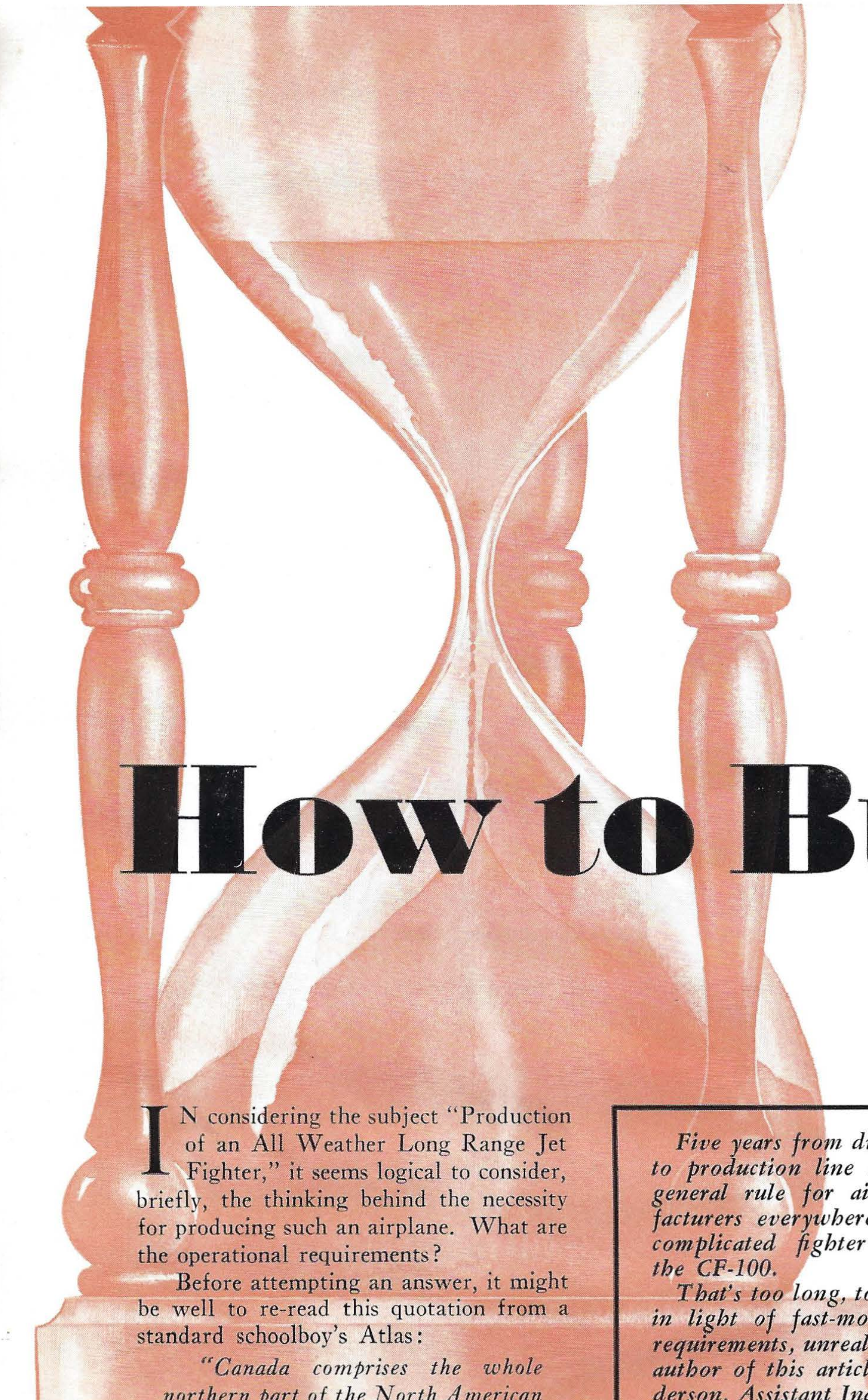
Never in the Lakehead's history had so many people ever gathered together at one time for a public demonstration of any kind, as they did here to see Operation Prairie Pacific's all-jet show. More than 30,000 people are pictured here, with thousands more outside the camera's range.

How big is a "crowd"? Here is a look at a portion of a crowd of 25,000 that gathered at the Lethbridge, Alta. airport to watch the Operation Prairie Pacific display. At this moment, four CF-100s are the centre of attention.



It was the same everywhere—crowds and more crowds—like this crowd of 30,000 at Saskatoon, jamming highways for miles in all directions, to reach the community airport and have a close-up look at the RCAF' jet power. Here, the CF-100 team banks over the crowd of spectators in tight formation.

The static displays, too, attracted keen interest. Here, the Winnipeg crowd is still converging on a CF-100, though the display officially ended an hour before.



What's the Toughest Problem in Aircraft Production Today? A Leading Industrial Engineer Gives it Searching Attention:

How to Buy Time

By ROBERT K. ANDERSON

IN considering the subject "Production of an All Weather Long Range Jet Fighter," it seems logical to consider, briefly, the thinking behind the necessity for producing such an airplane. What are the operational requirements?

Before attempting an answer, it might be well to re-read this quotation from a standard schoolboy's Atlas:

> *"Canada comprises the whole northern part of the North American continent, except Alaska, including the Arctic Archipelago lying between the 60th meridian on the east and the 141st meridian on the west and extending from the northern boundaries of the United States to the North Pole. The total area of the country is over 3¾ million square miles."*

These simple geographic statements when considered from a defence standpoint become facts that stagger the imagination. How can such a vast territory be defended? First of all it seems logical to assume that the potential threat to this country is by air. Again we ask, "How can Canada be effectively defended against air attack?"

It is fortunate, indeed, that we have people in our Government and in private industry who can see clearly into the future, not in the forecast of actual events but rather in the development of scientific equipment.

> ***Five years from drawing board to production line has been the general rule for aircraft manufacturers everywhere for today's complicated fighter planes like the CF-100.***
>
> ***That's too long, too costly, and in light of fast-moving defence requirements, unrealistic, says the author of this article, R. K. Anderson, Assistant Industrial Engineering Manager, Avro Aircraft Limited. It is based on a paper he delivered to an historic first joint meeting of the Canadian Aeronautical Institute and the U. S. Institute of Aeronautical Sciences in Montreal.***
>
> ***Two years can be cut off this five-year lapse, while costs in terms of man-hours per pound of aircraft can be cut as much as 50%, he maintains — and tells how.***

All of us have rather definite ideas of what to expect of aircraft in the near future. We know that our potential enemies can develop and are developing advanced bombers that are faster, that can attain higher maximum altitudes, and that will carry weapons that are more deadly and more accurate than anything that is in use today. Those things we must assume. Our air force planners have estimated the probable speed and ceiling of near future bombers.

In order to intercept and destroy such potential enemies after detection, we must have an airplane that can fly a long way, engage the enemy and return. This means that a terrific amount of fuel must be carried to feed the best available engines. This interceptor must have great speed to be able to make contact in a very short time and to be able to out-fly the enemy once contact is made. It must carry deadly weapons of the latest types and it must be equipped with the latest electronic devices for detecting and combating the enemy, under possible blind conditions.

These basic requirements plus many others are the facts that determine the size and approximate configuration of the required aircraft.

You can see that we are not talking about fighters and interceptors in the class of Spitfire, Hurricane or Mustang, nor are we any longer considering our present best fighters. We are talking about a 15 to 20 ton airplane that will fly in excess of the speed of sound and perhaps attain a ceiling of something over 10 miles. Airforce technicians and analysts who estimate future threats work closely with aircraft design teams in deciding in detail the specifications for the airframe and at the same time, develop such items as armament, radio, radar, pressurization, refrigeration, heating, etc.

At the close of World War II, defence planners accurately estimated the requirements that would be necessary in 1954 and as a result they are getting the Avro CF-100 long range jet interceptor which has the speed, maximum altitude, fuel capacity, radar facilities and fire power to intercept and destroy any known bomber in existence today. The time from conception through design, development and quantity production was five years. We can say accurately that it takes about five years for aircraft manufacturers in any country to produce aircraft in quantity from the beginning of design.

Past practice has been a development production cycle that began with the hand building of experimental prototypes, flight testing and then tooling for quantity production. The initial stage in this cycle, the hand building of prototypes, required that engineering design releases be only sufficient to enable first class aircraft workers to make parts strictly by hand methods, cutting and fitting on a trial and error basis. This results in an aircraft that may be a thing of beauty and may perform remarkably, but one that cannot be duplicated part for part. Further there will never be a desire to duplicate such an airplane part by part simply because parts were not developed with any thought as to ease of tooling and producing. This results in having to release a complete new set of detailed dimensioned drawings before processing, tool design and tool manufacture can be done. Then it becomes possible to manufacture detail parts in quantity and proceed with the business of making airplanes.

About five years after the original thinking started, usable production aircraft begin to be delivered. By this time the aircraft is obsolete, and so are those that have been planned for the next year and the next. It becomes evident that we must find a way to reduce that five years as much as possible.

After careful study of statistics on the development and manufacture of aircraft over the past 15 years, the following plan has been evolved. It is now thought possible because of our present engineering abilities and research equipment, to design an initial flight article that is extremely close to the specifications developed by wind tunnel work. This means that design engineering will now make a complete release the first time with all details fully dimensioned.

Robert K. (Bob) Anderson is Assistant Industrial Engineering Manager in Avro Aircraft Limited. Budget controls, man-hour costing, performance, company contracts, time study functions, program planning, methods and procedures, and general manufacturing administrative functions all get his attention.

He joined the Aircraft Division of A. V. Roe Canada Ltd. (now Avro Aircraft Ltd.) in December, 1953, from Douglas Aircraft Co. Inc. in Tulsa, Oklahoma, where he was Production Cost Co-Ordinator. He has also worked for Beech Aircraft Corp. in the United States.

The time lapse for so doing is little greater than would eventually have been necessary for a full production release but saves the time needed for a prototype release. What has been accomplished? All parts and assemblies can be planned for production. Tool designs for production can be started immediately. These are production tools which would have to be made later anyway but can now be ready to be used in making the first parts for the prototype.

In the past, convenience tools were made by the skilled workers and generally afterwards scrapped. Assembly jigs can be designed and built that will take no longer than would have been necessary for a prototype but, again, these are production jigs that will not have to be scrapped or rebuilt. Interchangeability media can be incorporated from the beginning. Of course, only one set of tools will be built at this stage. Further, only those tools that are economically feasible for making a few parts will be built. But those parts that are machined by non-production methods will still be made accurately to detailed dimensions.

Sub-assemblies that later will be tooled are now incorporated in main jigs. It is now possible to make several prototypes that are alike and that are the same as future production models except for those changes that are incorporated as a result of thorough testing.

In other words, revisions that are a result of research and testing are the only changes necessary and those would have to be made under any system, but those changes that would have occurred due to the difference of method of manufacture are eliminated.

All changes must be carefully recorded in the form of concurrent detail drawings. Tool drawings must be kept abreast of the changes and tools reworked or rebuilt as necessary. The elapsed time will be no longer or very little longer than with the old method, but since all engineering details, all production planning and processing papers, all tool designs and some actual tools have been kept current, production in quantity can start immediately and can accelerate rapidly as the remainder of the tools plus duplicate tooling and convenience tooling are completed. Approximately two years of elapsed time have been saved.

Now, let us consider the cost of such a program. Much to the surprise of most proponents of this theory the saving in cost can be enormous. It should not cost more. It has been determined that except in very unusual cases no greater than 25% scrap loss has occurred in past programs. Twenty-five per cent sounds like a lot but the loss is at a point in production where it is the cheapest.

Sheet metal tools and sheet metal parts are the greatest affected. The cost of these items more than the cost of the same items under the old system is negligible, and the wrong or spoiled parts because of hand methods, are practically eliminated. Further, expensive castings and forgings are not involved since nearly all parts of this nature must necessarily be hogged from raw stock in the beginning. The real saving in cost is in the lower labor cost of producing the first several production models.

The cost of the first production aircraft will be reduced to the point where the cost will now be in the general area of 15 to 20 man hours per pound where 25 to 40 is more normal under previous methods. Take this difference over 20 tons of airframe and a considerable saving has resulted.

The reason for this saving can best be explained by reference to the now common tool of aircraft industrial engineers, the learning or reduction curve. The use of learning curves is a major subject in itself and I shall not go into detail at this time concerning it. It is sufficient to say that learning as applied by the aircraft industry means plant wide learning rather than the learning of the individual worker on the machine or bench. By that I mean the flow of paper, materials, purchased parts, tools, both production and general, and learning of all the service functions that aid direct labor as well as the direct laborers' learning, all go together to make up a reduction of direct labor cost from one unit of work to succeeding units.

The fact that such reduction occurs is common knowledge, and it is also well known that the high cost of direct labor on the first units produced is caused by the fact that all of these supplementary functions must be perfected as the first units are being produced.

Under this plan most of these functions will have been perfected during the prototype manufacturing and since tools will have been proven and direct labor methods basically unchanged from prototype manufacture to quantity production, the consequent lowering of direct labor cost on the first production units is the inevitable result.

Now let us consider the effect and responsibility on the indirect or service functions of an aircraft plant.

Production Engineering

During the design period Production Engineering people will be working very closely with Engineering in order that, where possible, detail parts are designed for ease of production, and Production Engineering can obtain as much advance information as possible. In this manner interchangeability components can be selected and plans made for insuring interchangeability from the first article where possible. Metal and plaster die models can be constructed in advance of manufacture of form dies. These will aid in avoiding countless changes to parts and tooling that are largely trial and error otherwise. In addition, aircraft designers can view their efforts in full scale, three dimensional models so that lines may be altered where it seems advisable.

As fast as detail drawings are released the process planning will be done so that operation sheets can be prepared, tool design orders written, tools designed and tool manufacturing orders prepared. Tool manufacturing orders for those tools deemed necessary for prototype work will be scheduled and released.

Production Engineers, who, of course, are responsible for determining how each part shall be made, can order sooner any expensive machine equipment such as special extra capacity, mills or sheet stretching machines that require many months to obtain.

In short all tooling activities will be completed before and during the building of the prototype aircraft except for the actual fabrication of those tools not needed for the prototype. As changes occur due to the building and testing of the prototype, all processing papers, tool designs and, of course, those tools in use, will be kept up to date.

Industrial Engineering

As operation sheets are completed by planning, estimators can establish standards. Operations other than machining can be studied as they occur, because now these operations will not change appreciably from the prototype manufacture. Standards having been established, highly accurate manpower figures can be forecast and detailed production schedules can be prepared. The cost of the impending production program can be estimated accurately, much more accurately than without this information. Later when the production program starts, performance reports can start immediately on a realistic basis. Management reports will be accurate rather than the "seat of the pants" method necessary until later in the program.

Production Control

There are many facets of production control that will benefit from the advance information. The fact that all parts will have been processed by planning and standards applied by Industrial Engineering allows Production Control to determine the load for each type of machine in the machine shop as well as in sheet metal fabrication. Any possible need for future sub-contracting of parts will be apparent. Since the size and shape of all parts will be known it is now possible to determine the type and size of storage facilities as well as the necessary floor area required for such storage. As I mentioned earlier, the perfection of Production Control systems plays a vital part in reducing the hours of direct labor and reduces immeasurably the lost or idle time of direct workers who are waiting for tools, materials or parts.

Procurement

Since this method calls for detailed drawings, proper material lists can be established much earlier than before. As a consequence materials can be ordered with a much greater degree of accuracy than the bulk type orders necessary in the past. A consequent saving of the material dollar is obvious and the right material is on hand considerably sooner.

Sales and Service

Contract pricing of spares as well as of the complete program is done with a much greater degree of accuracy at the time when that accuracy is needed. Usually pricing of these contracts depends entirely on statistics of past programs with very little knowledge of the current one. Since standards are established before the production program, better pricing results. Sales and Service manuals and brochures will be forthcoming sooner, due to the advanced information.

Proper administration of this can and will result in a substantial saving in cost, but perhaps more important, it produces aircraft in quantity approximately two years ahead of other known methods and thus makes available more nearly up to date equipment in order that we may always stay ahead in the armament race. Variations of this theory are now in use in the United States. An article in Aviation Week of April 12, 1954, outlines briefly the current thinking of USAF along these lines. The article states that the Boeing B-52, the North American F-100, the Convair F-102, McDonnel F-101, Douglas C-133 and Lockheed C-130 are all being produced under modifications of this program.

The content of the foregoing is a summary of the thinking that has been taking place at Avro Aircraft Ltd. Our reasons for concern in this matter are patriotic as well as selfish. We feel that we have an obligation to Canada and to all free countries, to keep abreast of anything that is possible in other countries, friendly as well as unfriendly, and we are definitely obligated to our Company and to ourselves to produce as economically as possible.

It is indeed unfortunate that so much of our thoughts and efforts must be directed toward protecting ourselves against aggression. It is our fervent prayer that this will be changed as soon as possible, and that we can then concentrate on the peacetime development of our country.

AVRO AIRCRAFT

ORENDA

CSI

NOW *it's the* A.V. Roe Canada Group

Aircraft, Engine Divisions Become Separate Companies, A.V. Roe Canada Buys Canadian Steel Improvement

FROM a world-famous Group came A. V. Roe Canada Limited just nine years ago—a Group itself it now becomes.

That, in a sentence, is the substance of a program of expansion and diversification of A. V. Roe Canada interests announced for the New Year by Crawford Gordon Jr., President and General Manager.

Two new companies are formed and a third is acquired in this program as follows:

Avro Aircraft Limited is formed out of A. V. Roe Canada's Aircraft Division (currently employing about 10,000).

Orenda Engines Limited is formed out of the Gas Turbine Division (currently employing about 6,000).

Canadian Steel Improvement Limited, producers of precision forgings in a wide range of materials, employing about 400, is bought outright by A. V. Roe Canada Limited. A plant expansion program is underway for this company which will include a light alloy foundry.

All three companies are wholly-owned subsidiaries of A. V. Roe Canada Limited which, in turn, is a member of the Hawker Siddeley Group.

The two new companies—Avro Aircraft Limited and Orenda Engines Limited—were created by letters patent on July 29, 1954, under the Dominion Companies Act. Both are private companies having authorized capital of one million npv shares.

Each company has purchased the related assets of the A. V. Roe Canada Limited business (and assumes the applicable liabilities) in exchange for fully-paid and non-assessible shares in the capital stock of each company, plus certain other considerations. In the case of Avro Aircraft Limited it was 350,000 shares; in Orenda Engines Limited, 400,000 shares.

The purchase was effective August 1, 1954, the change in constitution effective January 1, 1955.

Canadian Steel Improvement Limited capital stock is purchased for cash from the Hawker Siddeley Group, who bought the plant from the Crown in April, 1954.

Operating heads of the three companies are: Avro Aircraft Limited—Fred T. Smye; Orenda Engines Limited—Walter R. McLachlan; Canadian Steel Improvement Limited—Cyril J. Luby.

Mr. Gordon, in announcing these details, stressed that from now on each unit in the new group will be completely independent of the others. He said the move was a natural step in the growth of A. V. Roe Canada Limited, a logical conclusion to a de-centralizing program which had been proceeding for some time now.

Noting that Canada has emerged in a very short time as one of the world's four leading nations in air power, Mr. Gordon forecast an ever enlarging future for Canada's aircraft industry and for A. V. Roe Canada Limited as its largest enterprise.

Tracing the steady and often-spectacular growth of A. V. Roe Canada Limited from its beginnings in 1945 (when the Hawker Siddeley Group through Sir Roy Dobson made its initial investment by purchasing the Crown-owned assets of Victory Aircraft) he said the parent group had since made a total permanent investment in Canada of more than $16 millions.

Not one cent of profit had been taken out, he emphasized. All earnings, with cash recoveries from depreciation, had been re-invested from the start with the result, that today the A. V. Roe Canada Limited group represents the largest single British industries investment in Canada.

"In addition," he said, "we have those very substantial but intangible assets of engineering, technical and production personnel knowhow, and experience—and the various advanced projects now under-way."

It was nine years ago today that A. V. Roe Canada began operating Mr. Gordon noted. Then it had 300 employees. Today the three companies in the new group employ a total of 16,000.

Total manufacturing and engineering area in 1945 was one million sq. ft., now the total for the three companies is approaching three million sq. ft., 2.5 million of this concentrated in the 550 acres at Malton.

Growth of the company can be marked

All This in Less Than 10 Years!

By Sir ROY DOBSON,
Chairman of The Board, A. V. Roe Canada Limited

These are very important days for the A. V. Roe Canada family. We have taken over a leadership and assumed big responsibilities. We have changed the corporate structure of A. V. Roe Canada Limited to permit the formation of a three-company organization, each engaged in separate operations.

It's a big step forward and a good, sound, logical move. We have established a record of achievement that made the move possible. With a continuation of that effort, we can look to the future with every confidence.

I feel we have every justification in recalling our achievements with pride and satisfaction. In less than 10 years we have given Canada its first jet transport, its first jet interceptor, its first jet engine and its first private aeronautical facility for original research. And our original research and development is assuring us a continuation of our leadership on into the future.

Who can come even close to matching that record? So we look to the future with confidence.

The formation of the A. V. Roe Canada Limited family group is a direct, positive and tangible re-affirmation of the confidence of all of us in the Hawker Siddeley Group that A. V. Roe Canada Limited is a winner.

by several major investments:

—Purchase of the Government-owned gas turbine plant, now Plant 2 of Orenda Engines Limited.

—Purchase, modernizing and equipping of a former army warehouse as a Design office and Experimental shop for Orenda Engines Ltd.

—Modernization and re-equipment of aircraft manufacturing facilities and purchase of research and development equipment.

—New machine tools and other installations for new projects.

—A new engine laboratory, now being built.

—Purchase and modernization of a building owned by Sheaffer Pen Co.

—Purchase of two 100,000 sq. ft. hangars and warehouse built by the Crown.

—Acquisition of plant and equipment of Canadian Steel Improvement Limited.

In reviewing the production achievements of A. V. Roe Canada Limited, Mr. Gordon recalled that the initial production contract for 70 CF-100s had been completed ahead of schedule. A second contract, for the Mk. 4, is well on its way to completion and preliminary manufacturing has been started on a third contract.

He said Orenda Engines Limited too had a solid record of engineering and production achievement. Over 1,500 Orendas have already been turned out in a plant that only officially opened a little over two years ago.

Production costs and overhead were as low, if not lower, than for comparable Canadian and U. S. operations. Increased production efficiency had made it possible to move out of a cost-plus type of contract and for some time now, A. V. Roe Canada Limited had been delivering aircraft and engines on the basis of negotiated price contract.

As for the future, both Avro Aircraft Limited, and Orenda Engines Limited, have new projects underway.

Avro Aircraft had a development contract for the C-105 which is one of the most advanced aircraft being designed today.

On the engine side, the company had already spent $4 millions on a new jet engine project which will be unique in its utilization of titanium and which is expected to open up new fields of jet power.

Referring to Canadian Steel Improvement Limited, Mr. Gordon said the company was set up in late 1951 to supply blades and other forged components for jet engines. "It has supplied millions of blades for our Orenda engines and has been producing forgings for other buyers. Now it is increasing the range of forging equipment to undertake the largest forgings in the aircraft industry. It is also expanding into commercial business in other fields for which a sizeable plant expansion program is underway, including magnesium and aluminum foundries, thereby bringing closer its goal of a complete forging and casting service."

Mr. Gordon said the new three-company set-up had developed out of the rate of growth and increasing complexity of the aircraft industry. It had been clearly demonstrated, for example, that airframes and engines, as different products, should be dealt with independently of each other.

The Board of Directors had therefore felt that sound growth could be best achieved by encouraging individual and collective effort and giving each operating unit a bill of rights to develop its own future, and ensure continued advancement of each individual company.

From now on, therefore, each company would be free to develop its own products and customers regardless of the other's problems. At the same time each would enjoy the benefits of group association; notably financial and management strength of the group as a whole.

"These changes," said Mr. Gordon, "may be likened to the coming-of-age of members of a family wherein each has attained his majority and is capable of carrying out his own destiny, without in any way ceasing to be part of the family."

Each of the two new companies will have their own Board of Directors and under the new set-up, the functions of Finance, Legal, Industrial Relations, and Public Relations Divisions as at present constituted, pass from the parent company to the subsidiaries—except as to over-all policy and co-ordination.

Several new Vice-Presidents are created in the change of constitution.

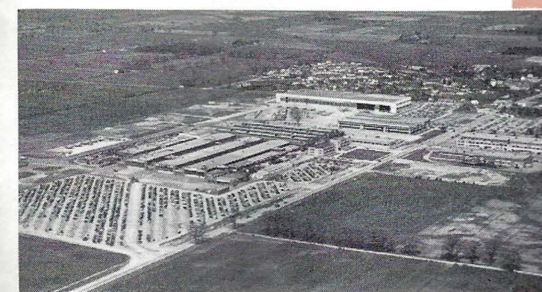
New Vice-Presidents in the holding company are: A. A. Bailie, Vice-President, Finance and W. H. Dickie, Vice-President, Industrial Relations.

In Avro Aircraft, J. C. Floyd becomes Vice-President, Engineering; H. R. Smith, Vice-President, Manufacturing; J. A. Morley, Vice-President, Sales and Service. In addition, Joseph Turner is appointed Secretary and Treasurer.

In Orenda Engines, C. A. Grinyer becomes Vice-President, Engineering; E. K. Brownridge, Vice-President, Manufacturing; F. L. Trethewey, Vice-President, Sales and Service. In addition, K. R. Church is appointed Secretary and Treasurer.

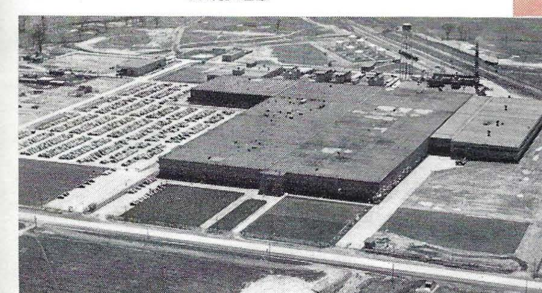
In Canadian Steel Improvement, J. A. Wellings becomes Vice-President, Operations.

AVRO AIRCRAFT LIMITED



Avro Aircraft plant at Malton, Ont., ranks among the largest manufacturing plants in Canada. Covering 1,600,000 square feet of engineering, manufacturing and hangar space, it provides employment for 10,000 persons.

ORENDA ENGINES LIMITED



Main production plant of Orenda Engines Limited, covering 750,000 square feet at Malton, Ont., was officially opened in September, 1952. It is considered one of the finest facilities of its kind. Company has 6,000 employees.

CANADIAN STEEL IMPROVEMENT LIMITED

Canadian Steel Improvement plant at New Toronto, Ont., opened in February, 1952, covers 60,000 square feet, is being substantially enlarged with addition of new forging facilities and light alloy foundry. Now employs 400.

THE THREE COMPANIES

AVRO AIRCRAFT LIMITED in size ranks among the largest manufacturing plants in Canada. It employs about 10,000 persons and covers 1,600,000 square feet of engineering, manufacturing and hangar space.

Current production effort is concentrated on the Mark 4 rocket-firing version of the CF-100, the long-range, all-weather interceptor designed for the defence of Canada. Squadrons of the Mark 4 and the earlier gun-firing Mark 3 version are in operational service with the RCAF. Trainer versions of the aircraft are in service at RCAF Operational Training Units.

Avro Aircraft's Engineering department is pre-eminent in Canada, and through its past and current achievements, plus its advanced thinking, is highly rated throughout the world. A large staff of specialists in every phase of engineering work together on a wide diversity of projects, including the most advanced fields of electronic and weapons development.

Production facilities, constantly improved with the addition of modern up-to-date equipment, are capable of swift adjustment to a higher rate of production, if necessary. Tight budget control along with constantly improved production methods and techniques have earned industry recognition for the company as a most efficient aircraft manufacturer.

Unique in the Canadian aircraft industry are the Experimental Flight Test facilities, which are closely co-ordinated with the design and development sections. A number of CF-100s is maintained for development testing of new weapons, equipment and ideas.

ORENDA ENGINES LIMITED is the sole designer and builder of jet engines in Canada, employing about 6,000 persons. Currently in production are Orenda Series 11 and 14 for the RCAF's CF-100 and Canadair Sabre V and VI.

From its engineering department came the first two all-Canadian aero-engines, the Chinook, a development project, and the Orenda turbojet. Through constant development, the Orenda has passed through a number of marks or types, each increasing power, efficiency and reliability. In addition to present design offices and laboratories at Malton, and a full-scale test plant at Nobel, Ont., expanded research facilities are now under construction to deal with the increasingly complex requirements of the future.

The manufacturing plant, occupying nearly 750,000 square feet, was planned to provide a degree of flexibility which allows for the rapid change from one engine model to another, or the manufacture of two or more models concurrently. The plant has earned a reputation as an efficient producer, and since September, 1952, when it was officially opened, has turned out about 1,500 Orendas.

Flight Test facilities, using three different types of aircraft, make exhaustive tests of engine developments and new engines. All flight test work is closely co-ordinated with the design and development section to prove the air worthiness of the product.

A staff of specialists — thoroughly experienced service representatives — is maintained in the field, both in Canada and in Europe, while a complete overhaul service enables speedy and economical reconditioning of major assemblies and time-expired engines.

CANADIAN STEEL IMPROVEMENT LIMITED occupies a unique place in Canadian industry as the only complete Canadian producer of the most exacting forged component used in Canadian industry today — blades for the Orenda jet engine, of which hundreds are used in each engine.

Formed in 1951 to provide a continuing Canadian source of supply of these blades, the company has produced several millions of them and has since expanded into other fields calling for precision forgings in steel, high temperature alloys, aluminum, titanium and other non-ferrous alloys.

The Company has some 400 employees and at present has 60,000 sq. ft. of engineering and manufacturing space.

A large expansion program is under way to provide a more comprehensive service to industry.

Extensions to office block, die shop and laboratory are scheduled for completion in February, 1955.

An addition to the forge plant is planned for completion in April. Range of forging equipment will be increased to include a 10-ton gravity drop hammer. There will be additional presses and hand forging facilities.

With these additions, Canadian Steel Improvement will be in a position to undertake large forgings in high-strength aluminum alloys and titanium for the aircraft industry.

A modern, well-equipped foundry is also being planned for completion in August, 1955.

This foundry, of 73,000 sq. ft. will have facilities for producing sand castings, pressure die castings and permanent mould castings in aluminum, and sand castings in magnesium.

DIRECTORS, OFFICERS OF THE NEW GROUP

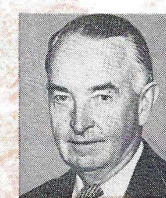
Here Are the Directors of A. V. Roe Canada Limited

(in addition to F. T. Smye and W. R. McLachlan, below)

Sir Roy Dobson
Chairman of the Board

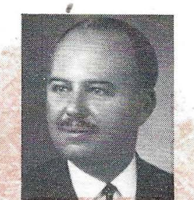
Crawford Gordon, Jr.
President and General Manager

A/M W. A. Curtis
Vice-Chairman



Sir Thomas Sopwith
Chairman, Hawker Siddeley Group

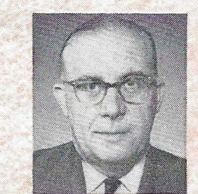
Sir Frank Spriggs
Managing Director Hawker Siddeley Group



J. S. D. Tory
Director, A. V. Roe Canada Limited

Operating Heads of Three Companies

F. T. Smye
Vice-President and General Manager, Avro Aircraft Limited also a Director, A. V. Roe Canada Limited



W. R. McLachlan
Vice-President and General Manager, Orenda Engines Limited also a Director, A. V. Roe Canada Limited

C. J. Luby
President, Canadian Steel Improvement Limited

New Vice-Presidents

(A. V. Roe Canada Ltd.)

A. A. Baillie
Appointed Vice-President, Finance and Treasurer, A. V. Roe Canada Limited

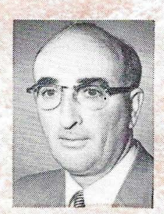
W. H. Dickie
Appointed Vice-President, Industrial Relations, A. V. Roe Canada Limited

Appointed Vice-President in the Three Companies

Avro Aircraft Limited

J. C. Floyd
Vice-President, Engineering

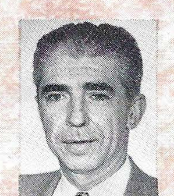
H. R. Smith
Vice-President, Manufacturing



J. A. Morley
Vice-President, Sales and Service

Orenda Engines Limited

C. A. Grinyer
Vice-President, Engineering



E. K. Brownridge
Vice-President, Manufacturing

F. L. Trethewey
Vice-President, Sales & Service

C.S.I.

J. A. Wellings
Vice-President and a Director

Secretary-Treasurers

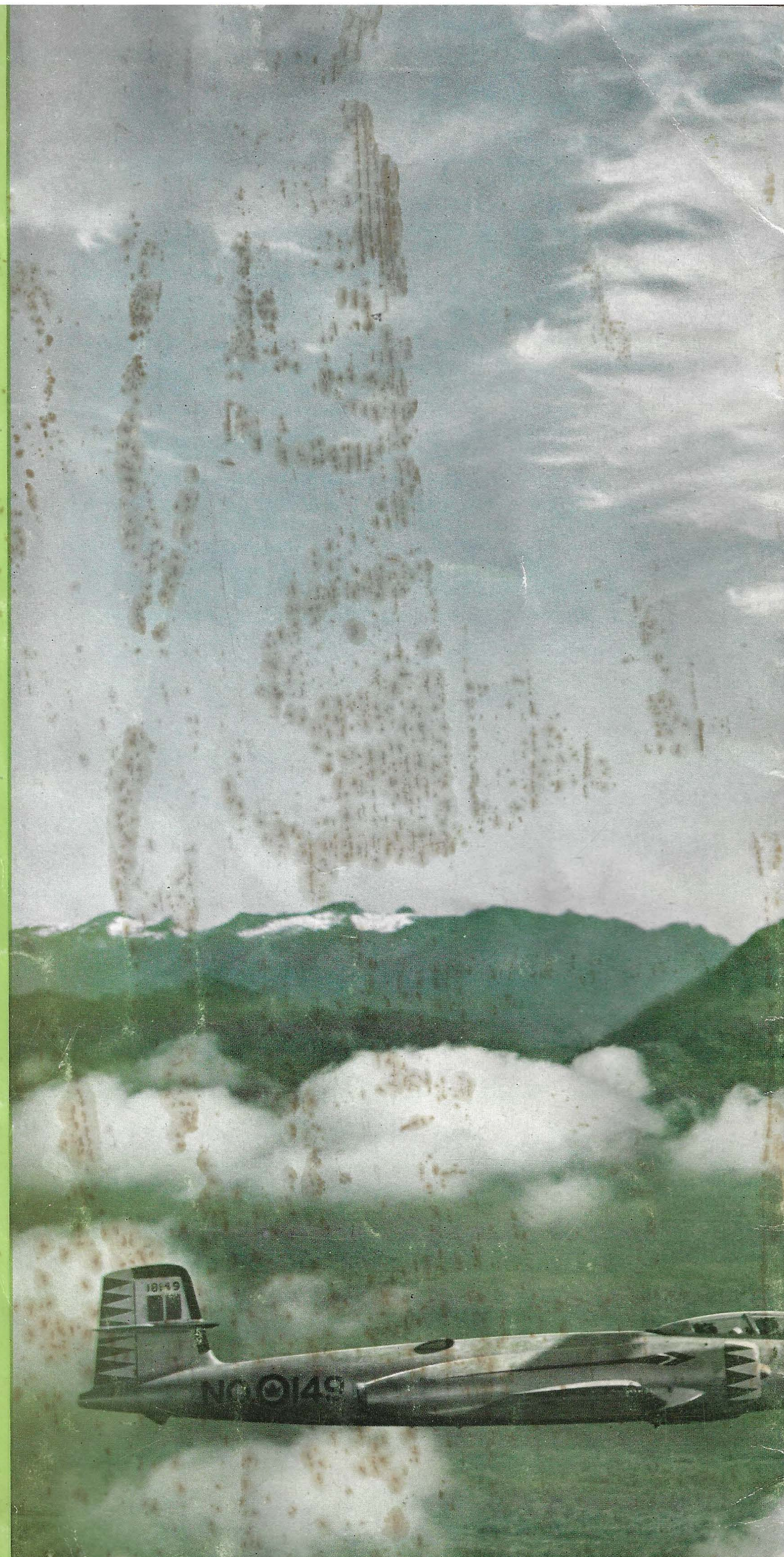
J. Turner
Appointed Secretary and Treasurer Avro Aircraft Limited

K. R. Church
Appointed Secretary and Treasurer, Orenda Engines Limited

F. McAlpine
Secretary-Treasurer, Canadian Steel Improvement Limited

Literally leaping into the air from its jet assisted takeoff, this production line Mark 4 CF-100 interceptor appears to be sitting on top of its JATO smoke-pillows. The "bottles," or miniature rockets, attached to the interceptor's belly had just about finished their thrust when Avro Aircraft Photographer Verne Morse decided the picture was "right" . . . and got it.

High over the mighty Rockies fly these CF-100s in the first formation flight of Canadian jet aircraft over the West Coast mountain chain . . . part of Operation Prairie Pacific . . . the biggest operation of its kind ever undertaken anywhere by any air force.
(See Inside Front Cover.)



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