THE AIRCRAFT INDUSTRY

11 February 1954

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

Mr. William B. Bergen, Vice President of Operations of the Glenn L. Martin Company, was born at Floral Park, Long Island, New York, 29 March 1915. He is a graduate of the Massachusetts Institute of Technology and began his business career in 1937 when he joined the Glenn L. Martin Company. In 1939 he was appointed as chief, Vibrations Engineer and later assumed the duties of chief, Flight Test Engineer. In 1945 he was appointed chief, Pilotless Aircraft to initiate and direct the Martin guided missile program. Under his direction, this section was enlarged to a Special Weapons Department charged with development and design of guided missiles, fire control, electronic and electro-mechanical systems. He became chief engineer in 1949 and was elected vice president in 1951. Mr. Bergen is the author of numerous technical papers and winner of the Lawrence Sperry Award in 1943 for "Theoretical and Experimental Investigations of the Dynamic Leads on Airplanes." In April 1953 Mr. Bergen was appointed Vice President of Operations coordinating all company functional activities for the various projects.

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CAPTAIN HALE: Good morning, gentlemen: Today is Glenn L. Martin day at the Industrial College. Our subject today is the production problems in "The Aircraft Industry." To set forth the problems that affect the feast and famine industry, such as the aircraft industrial complex, we have invited Mr. Bergen, Vice President for Operations at the Glenn L. Martin Company, to speak to us this morning and also his team of seminarists to continue the discussions this afternoon.

Mr. Bergen has on his production horizon the B-57, which is the American model of the British Canberra; he has two Navy patrol planes and two guided missiles, the Matador and the Orion. I would say that with such an array of service articles which require unique and special tooling and special processes, I am certain that Mr. Bergen will have a field day today.

Mr. Bergen, it is a great pleasure to welcome you back to the college and to present you to this year's class.

MR. BERGEN: General Greeley, Captain Hale, gentlemen: You can talk a long time about this business of airplanes, so I have divided the subject into what I think are several important phases of it.

The first one--I put it first because I think it is more important than anything else--is organization. We hear a lot about mobilization and plants, rapid writeoffs, and all that kind of thing--but so far as I am concerned, if you have to, you can build airplanes in tents. But you don't build an organization overnight. So I think the most significant part of the production setup is the organization team you have to do the job.

Second, of course, are the facilities. Here, again, I have a very low regard for brick and mortar. The more important elements are the machine tools and the things that go into the facilities.

The third is the planning that has to be done--and this, too, is extremely important. As I can point out to you, this is where we may be in trouble today because of decisions we made ourselves, or which were made for us, two or three years ago. When we are talking about things which take a long time to bring into being, plans are most important.

I am going to tell you a little bit about the B-57, in the light of how American practices differ from those of our British cousins. Finally, I think there is a very, very important development taking place in the aircraft industry in the method of fabrication. We are getting away from the old technique--riveting, bolting, and screwing--and into a new process, essentially using glue. Before we get into that however let us talk about the organization a little bit.

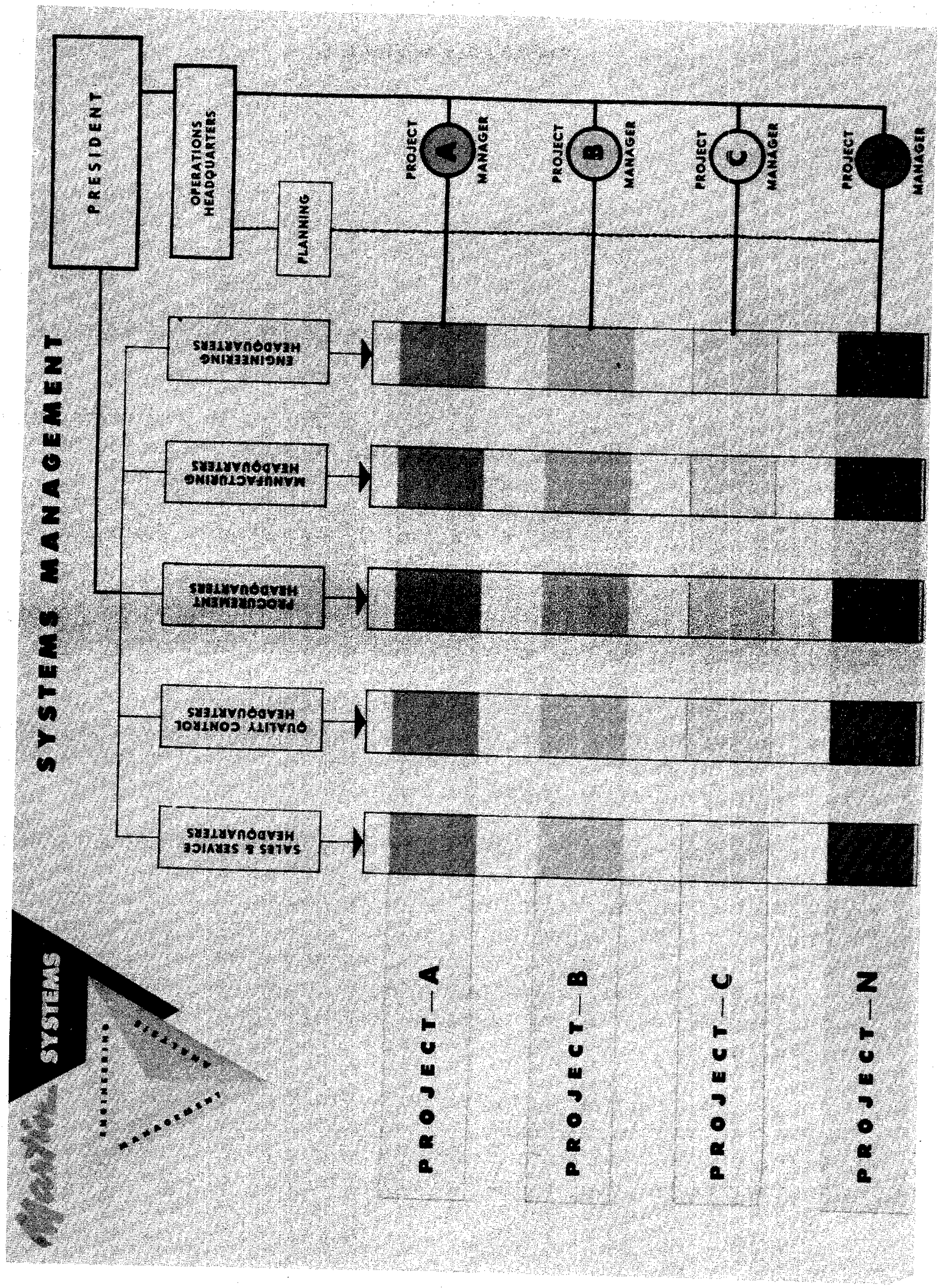
Chart 1, page 3.--I would like to point out that this is by no means the last word in organization. I do not pretend to suggest that if all factories were organized this way, everything would be fine. This is an organization we are experimenting with. It fits our needs very well. It may or may not be good for somebody else.

We are building a very complex article. We don't build many of its kind. We really never know from one month to the next how many we are going to build. At the same time we have to maintain an organization of a great many diverse skills; we can't afford to send them out into the woods to go duck shooting when we don't need them and bring them back when we need their particular skills.

This business of stability becomes more and more important when the economy plateau is reached. So, to control these many projects, some of which are going into production, some of which are not, we decided to organize our company on the basis of the skills that are required. Skills are more important than any individual product. The skills utilized by an aircraft company then, include such things as engineering, procurement, production--or manufacturing techniques, if you will--inspection, and even sales. I don't know how they do it, but I know there is a considerable skill involved in selling an airplane--and we know that is a mighty essential part of the airplane business.

So I would like to show you how we are organized. Up at the top of the chart, we have the president, and ranged just below him are all the vice presidents who represent the skills I was talking about--sales, quality control, manufacturing, engineering, and so on. All of the people then, who are employed at the Martin Company, work down along the vertical lines. They wear badges which say "Manufacturing Expert," "Engineering Expert," and so forth. We do have

CHART 1


SYSTEMS MANAGEMENT
PRESIDENT
OPERATIONS HEADQUARTERS
PLANNING
PROJECT A MANAGER
PROJECT B MANAGER
PROJECT C MANAGER
PROJECT MANAGER
ENGINEERING HEADQUARTERS
MANUFACTURING HEADQUARTERS
PROCUREMENT HEADQUARTERS
QUALITY CONTROL HEADQUARTERS
SALES & SERVICE HEADQUARTERS
PROJECT—A
PROJECT—B
PROJECT—C
PROJECT—N
SYSTEMS

a Finance Department, of course, which is very important. There is a cafeteria, to see that the company's people are fed, as well as a Fire and a Protection Department. But we haven't shown them, because I want to emphasize the operations aspects.

If we had only one project in the house, say this B-57 Night Intruder Bomber, everything would be fine--because, in effect, the president would be the project manager on the B-57 and the vice presidents would be the boys responsible for putting it together. When they got to fighting with one another about whether the product should be made more cheaply or be made engineering-perfect at any cost, he would be the one to reconcile them.

But we haven't. We have a lot of projects. Only four projects are shown on the chart, but in a company such as ours, we may have to handle as many as a dozen large contracts at one time. Of these, perhaps, three or four may be in production at one time--yet one of the others, while still under development, may require more skills than any of the production jobs.

So we have set up an Operations Division. The Operations Division simply means that we have appointed for each project a so-called project manager. He is completely responsible for the conduct of the project. In following along any of the horizontal lines on the chart, you will cross with the divisional breakdown of skills assigned to each project. In other words the project manager's function represents a form of product control--in terms of an orientation of the skills.

This is interesting because it is a thing that no one thought could be done. It works out, in effect, that many of our supervisors have two bosses. One may be his procurement manager, if he happens to be in the Purchasing Department, and the other would be the project manager. The explanation is simple. We admit that we are in a complex business; we have a complex problem; therefore, we must accept a complex solution. We recognize this and so try not to oversimplify the solution.

It is made clear to the individual to which boss he is responsible and for what. He is responsible to the project boss for such matters as cost and schedule adherence but to the procurement boss for the procurement know-how, the procurement techniques--for exercising the skills that are associated with the job of procurement. He is responsible to the project chief for what he does of a procurement nature, affecting the particular project to which he is assigned. So far, it is working pretty well.

Chart 2, page 6.--This is all right on an overall basis, but it works in detail only if it is carried throughout the organization. We have done that. If we look at the Engineering Division, we find the vice president of engineering sitting in the exact spot occupied by the company's president in the overall setup. The skills required to run the engineering outfit are again represented by the vertical lines--aerodynamic skills, structural skills, electronic skills, and so on.

Here again, in engineering, we appoint a project engineer and he is responsible for controlling the direction of the efforts of all the engineers identified with that particular project. In other words if there is a conflict between a stress man and an aerodynamics man--which seldom happens, but once in a while it does--the project engineer is the fellow who straightens it out. You will recognize that there is a system of checks and balances here. So this is the setup in engineering, and we have exactly the same pattern within each of the divisional domains.

Chart 3, page 7.--This is manufacturing. We said, first, what are the main manufacturing skills? This is always the basic question--what are the skills? These are the chief categories--production control, tool engineering, detail fabrication, subassembly, final assembly, and ground test. Here again, the pattern is the same. These are the skills and a manufacturing manager is assigned to each project.

Now this is of value from the customer's point of view because, although he may be mildly interested in the Martin Company in general, his vital interest is in the product he is buying--for example, the B-57. Who do you go to? Who is your team? So under this system, if we desire a detailed look at a project as it is actually organized in the company, we can show something graphic, like this representation of the functional control of all operations under project "A."

Chart 4, page 8.--Here we find the operations manager and the representatives for each of the skills utilized within the Operations Division--all reporting to him for control and direction on this project "A." To make this completely self-contained, we have given the operations manager a staff to work out all details of the assignment of the various skills to the job and to see that the assignments are carried out.

CHART 2

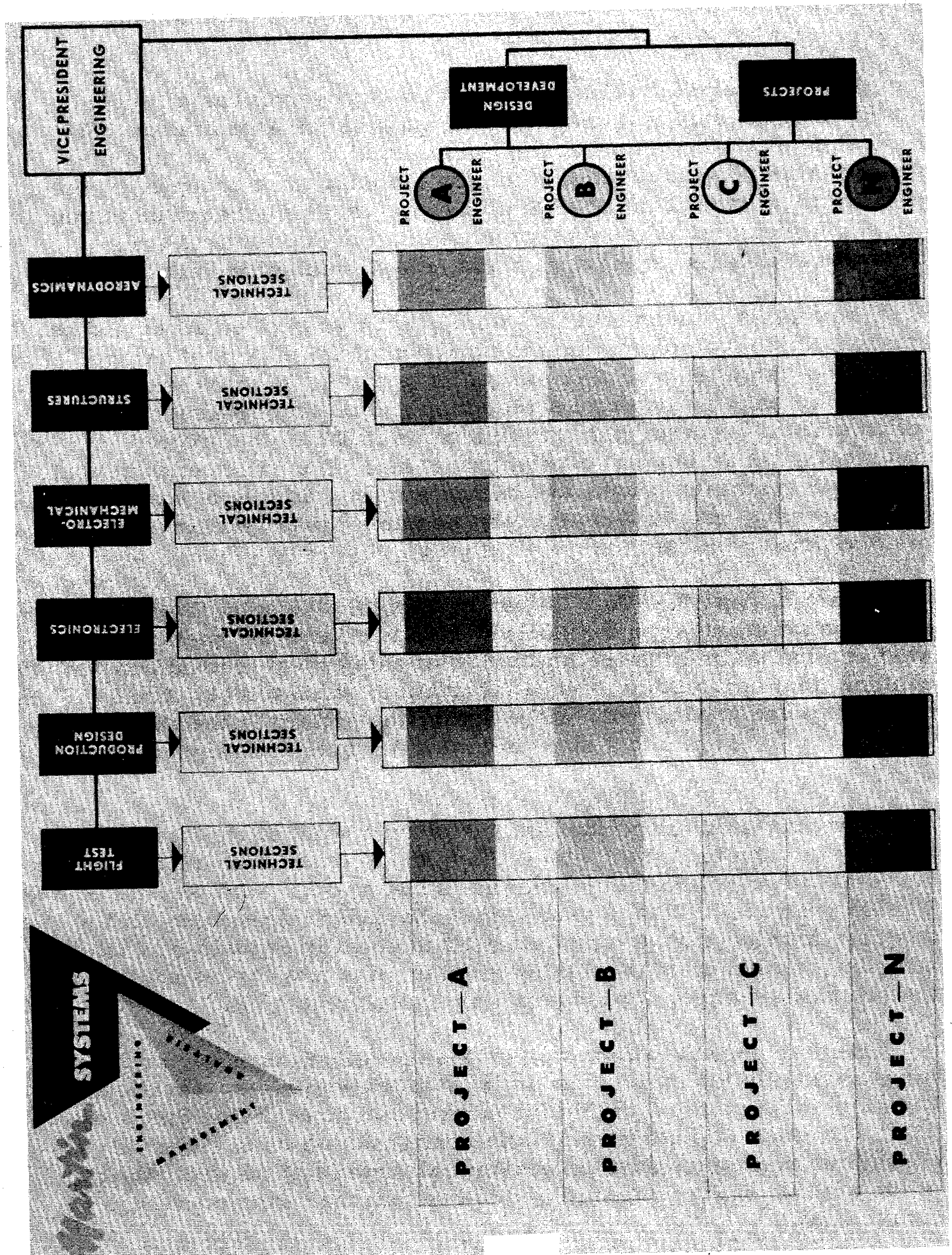

VICE PRESIDENT ENGINEERING
DESIGN DEVELOPMENT
PROJECTS
PROJECT A ENGINEER
PROJECT B ENGINEER
PROJECT C ENGINEER
PROJECT N ENGINEER
AERODYNAMICS
STRUCTURES
ELECTRO-MECHANICAL
ELECTRONICS
PRODUCTION DESIGN
FLIGHT TEST
TECHNICAL SECTIONS
SYSTEMS
ENGINEERING
MANAGEMENT
PROJECT—A
PROJECT—B
PROJECT—C
PROJECT—N

CHART 3

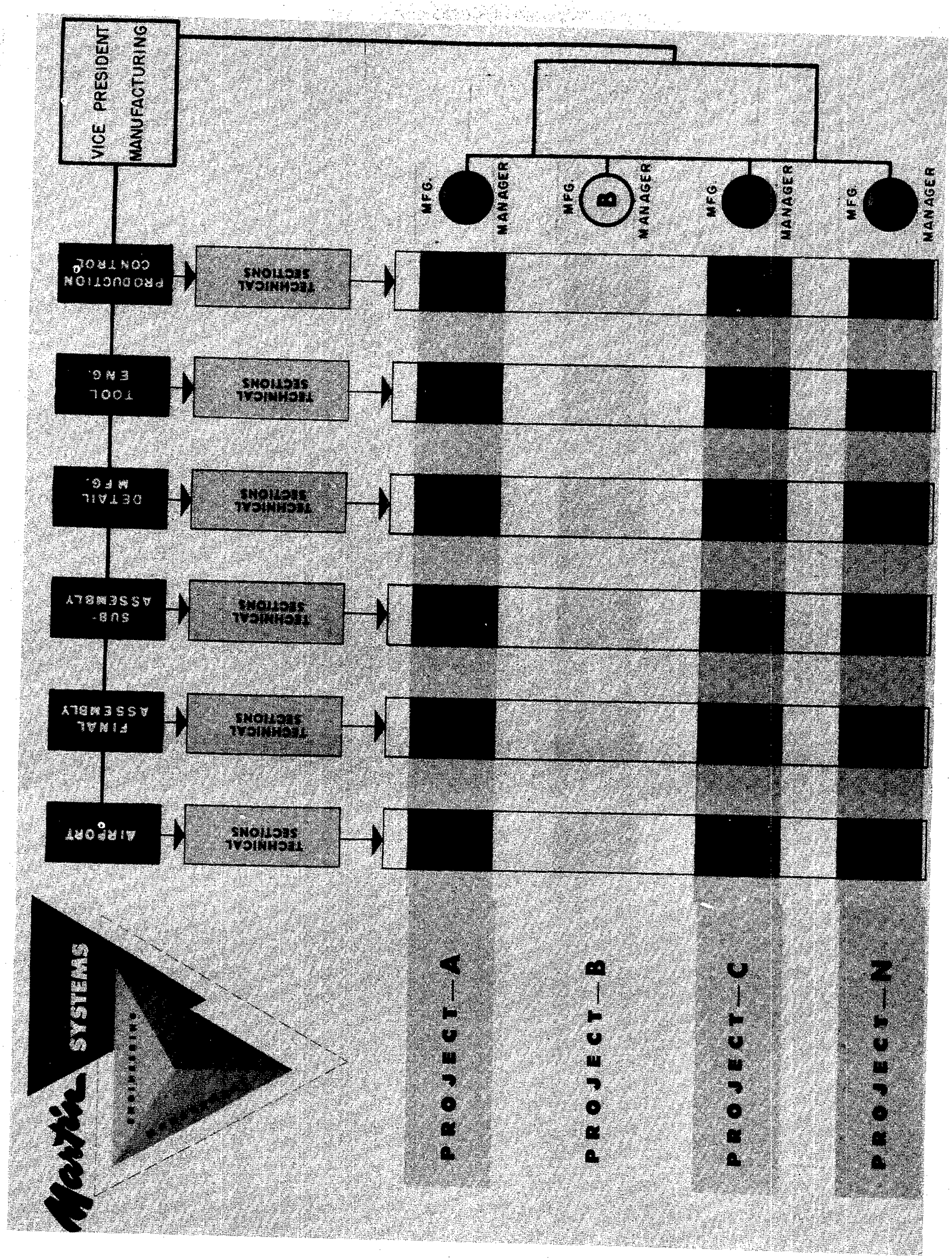
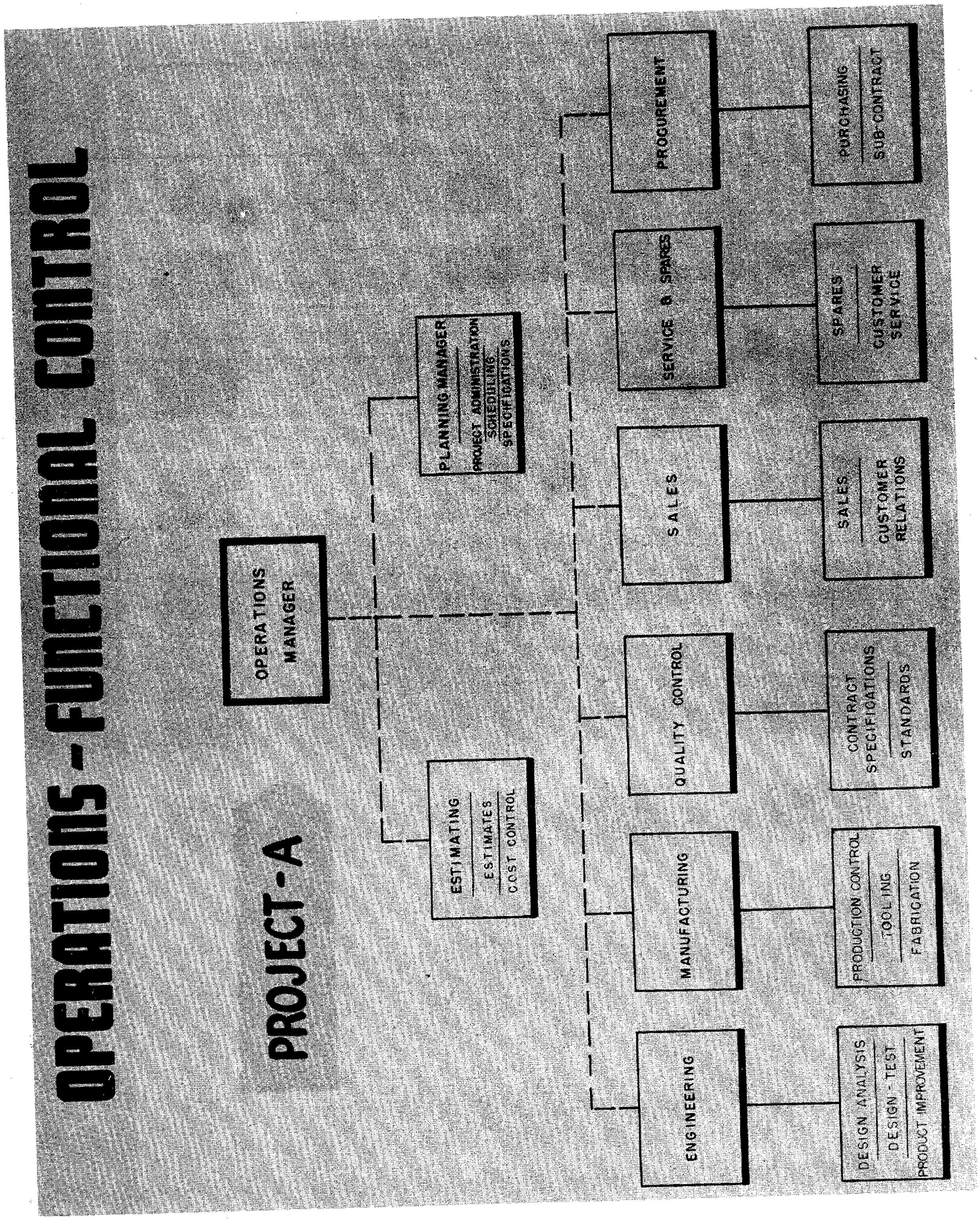

VICE PRESIDENT MANUFACTURING
PRODUCTION CONTROL
TOOL ENG.
DETAIL MFG.
SUB-ASSEMBLY
FINAL ASSEMBLY
AIRPORT
TECHNICAL SECTIONS
MFG. MANAGER
B
PROJECT—A
PROJECT—B
PROJECT—C
PROJECT—N
Martin
SYSTEMS

CHART 4


OPERATIONS - FUNCTIONAL CONTROL
PROJECT - A
OPERATIONS MANAGER
ESTIMATING
ESTIMATES
COST CONTROL
PLANNING MANAGER
PROJECT ADMINISTRATION
SCHEDULING
SPECIFICATIONS
ENGINEERING
MANUFACTURING
QUALITY CONTROL
SALES
SERVICE & SPARES
PROCUREMENT
DESIGN ANALYSIS
DESIGN - TEST
PRODUCT IMPROVEMENT
PRODUCTION CONTROL
TOOLING
FABRICATION
CONTRACT SPECIFICATIONS
STANDARDS
SALES
CUSTOMER RELATIONS
SPARES
CUSTOMER SERVICE
PURCHASING
SUB-CONTRACT

For example, he has a force of estimators attached to his project. The estimator is the fellow, among other things, who provides the means for cost control--and that is very important. Overruns are very unpopular. Cost-plus contracts are becoming increasingly less attractive to the Government.

In addition, the operations manager is assisted by a planning group. The planning manager is essentially a businessman. He does general administrative work and sets the scheduling. He is also in charge of specifications. We found, in putting specifications near the top of the heap, that we can hold a good club over the heads of all operating personnel. Specifications used to be located in engineering, but whenever the engineer finds something requiring a change in design, he changes the specifications; it is easier to change the specifications than to change the design. So we took the function away from engineering and put it here in operations planning.

Chart 5, page 10.--Let us take this business of cost control. We start out with an estimate, broken down, of how much it is going to cost to do the job. Then the estimator, acting like a banker, gives out so many dollars to the department managers--manufacturing, procurement, and so on. These dollars are distributed among the department's functional representatives and the project managers. Essentially, the departments can do only so much work. There is considerable subcontracting. Once a month the managers account back to the estimator, as to what they have bought and what work they have accomplished. We are rapidly getting to the point--budgetwise--where we can tell you exactly where we are and where we will be in the next six months or even next year.

You have to be careful that you don't let it become the tail that wags the dog; but, once you exercise control, you get better designs and better manufacturing in less time for less money. Such controls indicate where people are not pulling their weight and it is easy to weed them out. This organization setup is rather unique; so far, we like it.

The next thing I want to talk about is facilities. In case you are not too familiar with aircraft manufacture, it is basically a machine-shop operation. More and more aircraft work is being done in the machine shop rather than in the metal shop. Machine tools are doing more and more of the work on electronic assemblies.

CHART 5

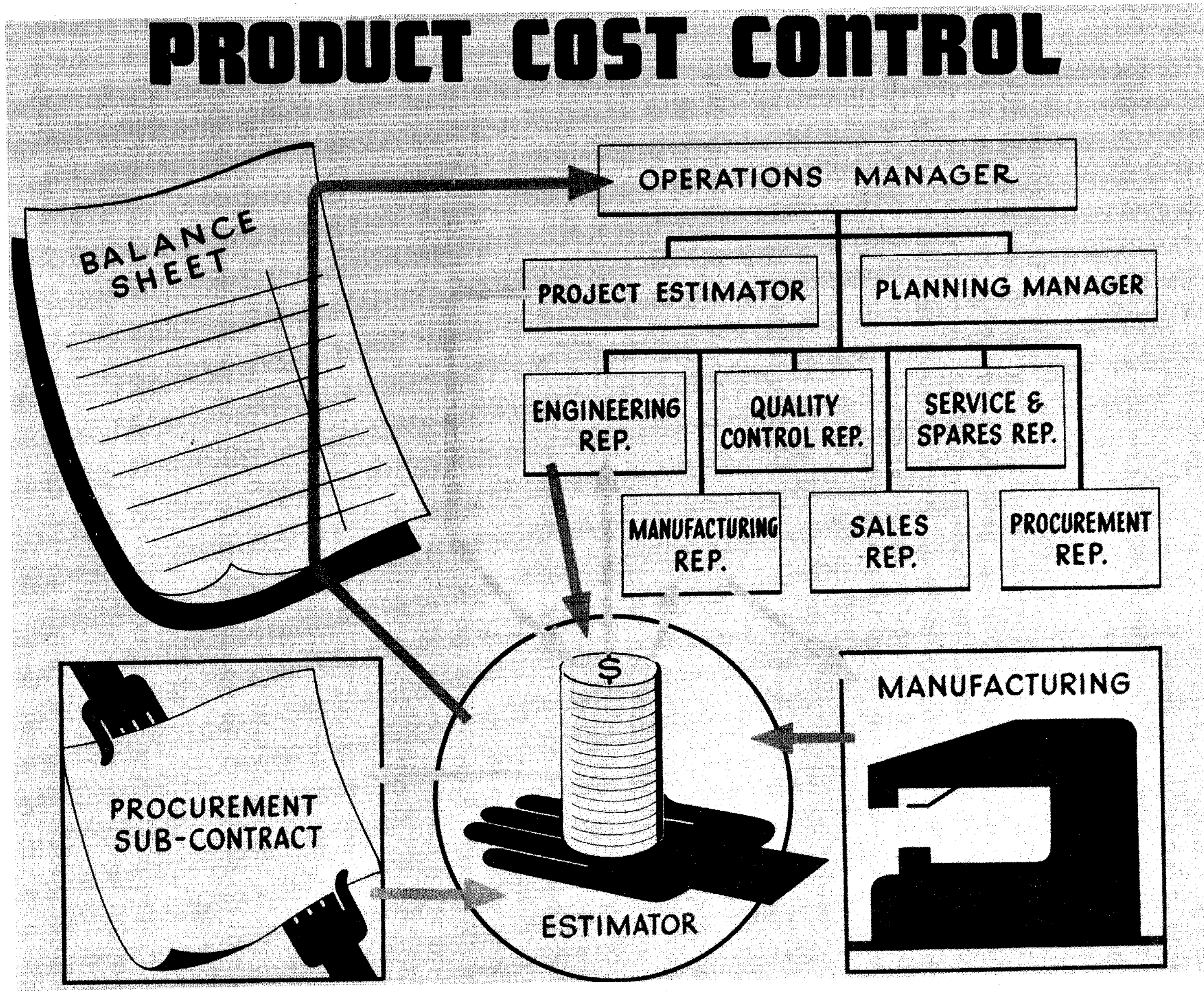

PRODUCT COST CONTROL
BALANCE SHEET
OPERATIONS MANAGER
PROJECT ESTIMATOR
PLANNING MANAGER
ENGINEERING REP.
QUALITY CONTROL REP.
SERVICE & SPARES REP.
MANUFACTURING REP.
SALES REP.
PROCUREMENT REP.
$
ESTIMATOR
PROCUREMENT SUB-CONTRACT
MANUFACTURING

Chart 6, page 12.--This photograph shows the type of machine we have. Machine tools are hard to get. These are German machines made after World War II.

Chart 7, page 13.--As for sheet metal work, here is a stretch press which draws aluminum sheet over a form.

Chart 8, page 14.--Somewhat less popular in aircraft work, because good quality control is difficult, are such processes as spot welding. However, a lot of spot welding equipment is still being used.

Chart 9, page 15.--In the modern aircraft factory, electronic assembly work is carried on much as you would find it in the radio and television industry--except these do not come off the line quite so fast.

I want to call your attention, at this point, to some of the more essential aspects of production planning. This is a broad subject; I can only hit a few of the high spots.

Chart 10, page 16.--Assuming that we are going to build a quantity of B-57's, the first thing we do is to come out with a planning schedule. This shows that you don't really do anything much at all until you have your mockup, which may take seven months for a major job. That is doing pretty well.

Then comes the engineering span, which may run 11 or 12 months. This is extended beyond the basic span--because even after the engineering design is out, you will still be making some changes. An engineer has designed something that he thinks he can do better, or some fellow in the shop finds it just doesn't go together, so you have to make a change. The same thing happens with tool design and tool manufacturing, which, incidentally we group together.

The next item is raw materials. This, too, can be spaced simultaneously with tooling--and close on the heels of engineering.

Now that all the teams have been picked, the procurement manager, the engineers, the tooling and production people actually sit down together and work out the procurement items. So even if a man isn't going to have any metal to cut for a year, he knows what metal is to be cut and he will not be caught napping by late procurement.

CHART 6

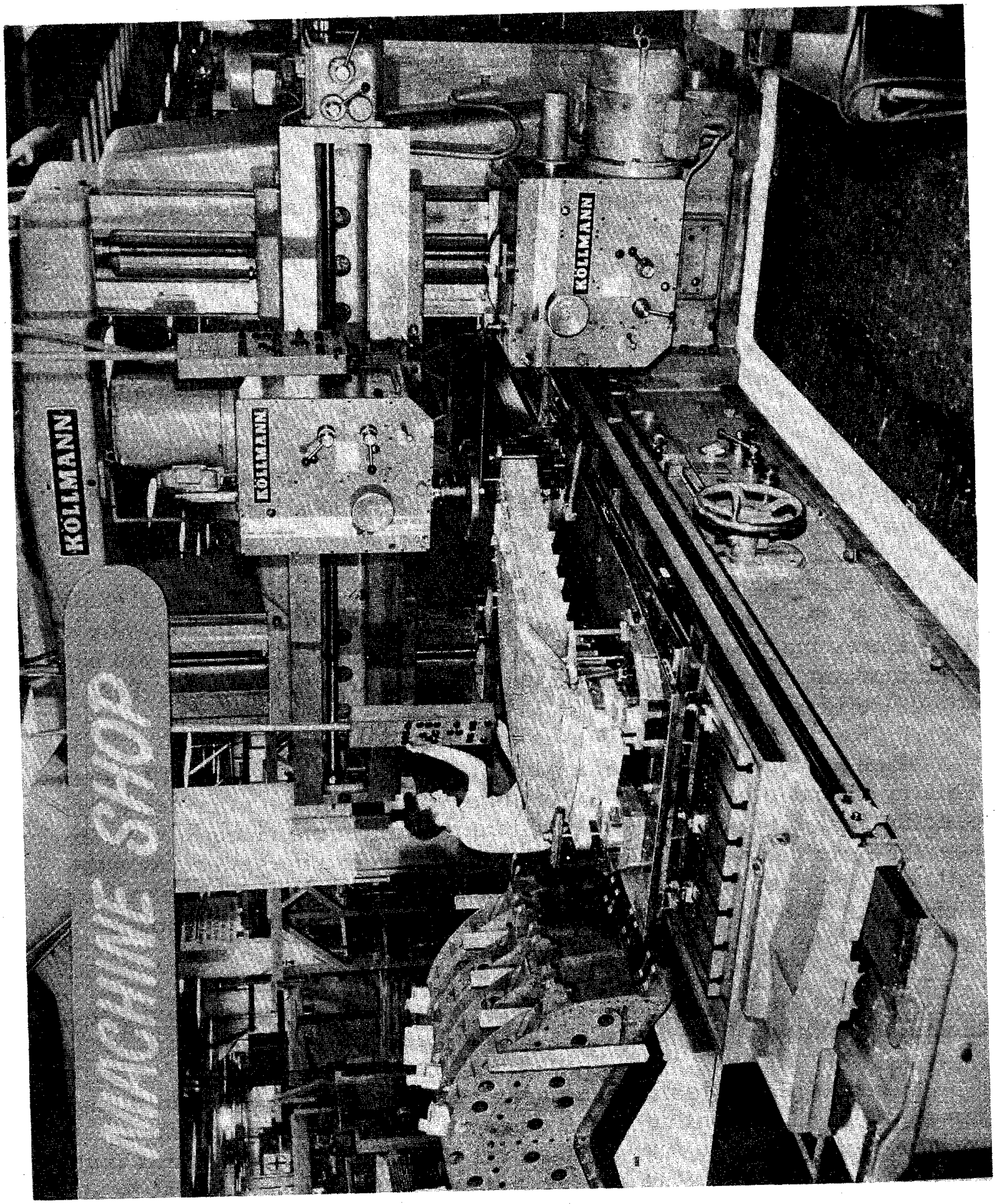
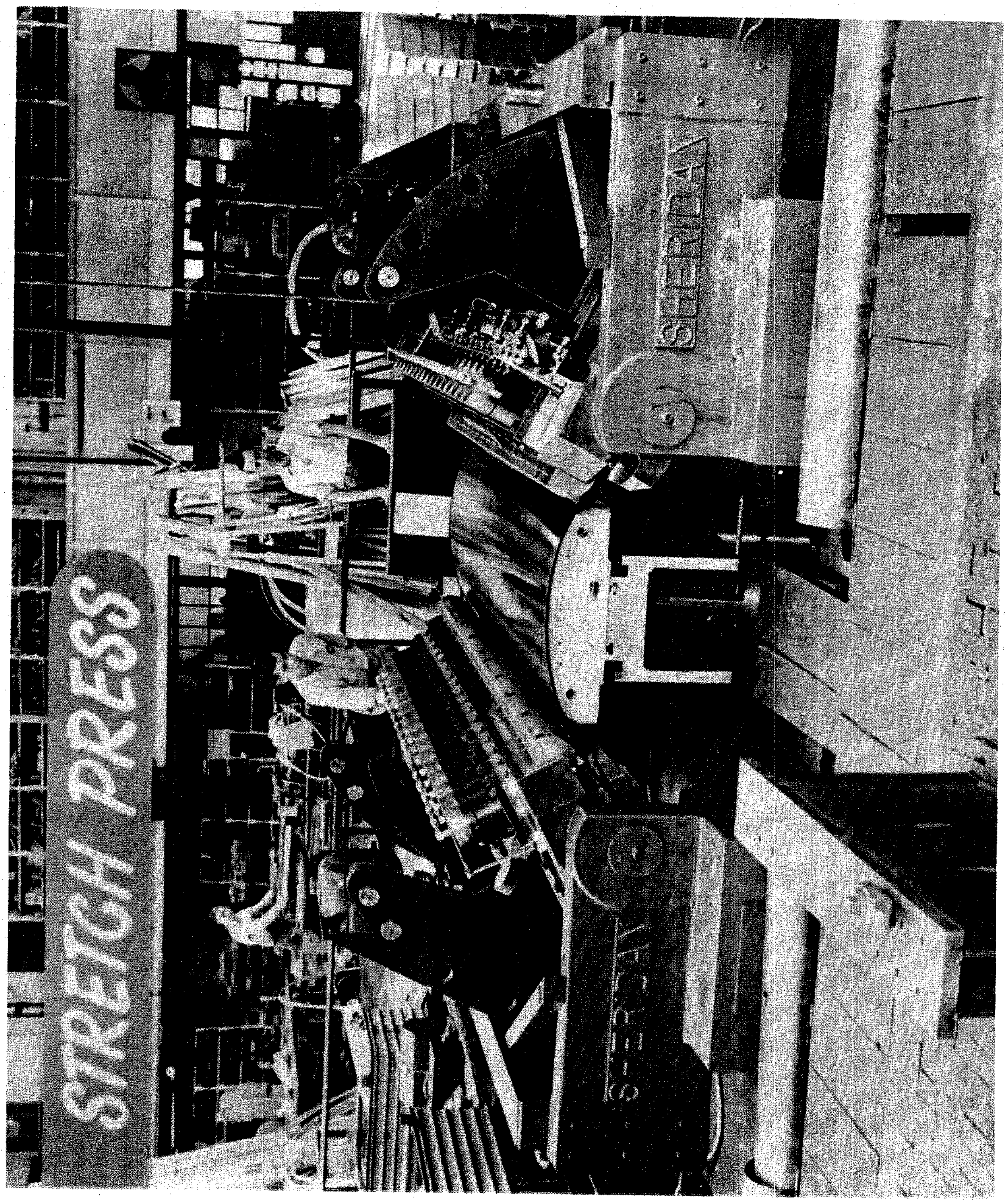


CHART 7



1334

CHART 8

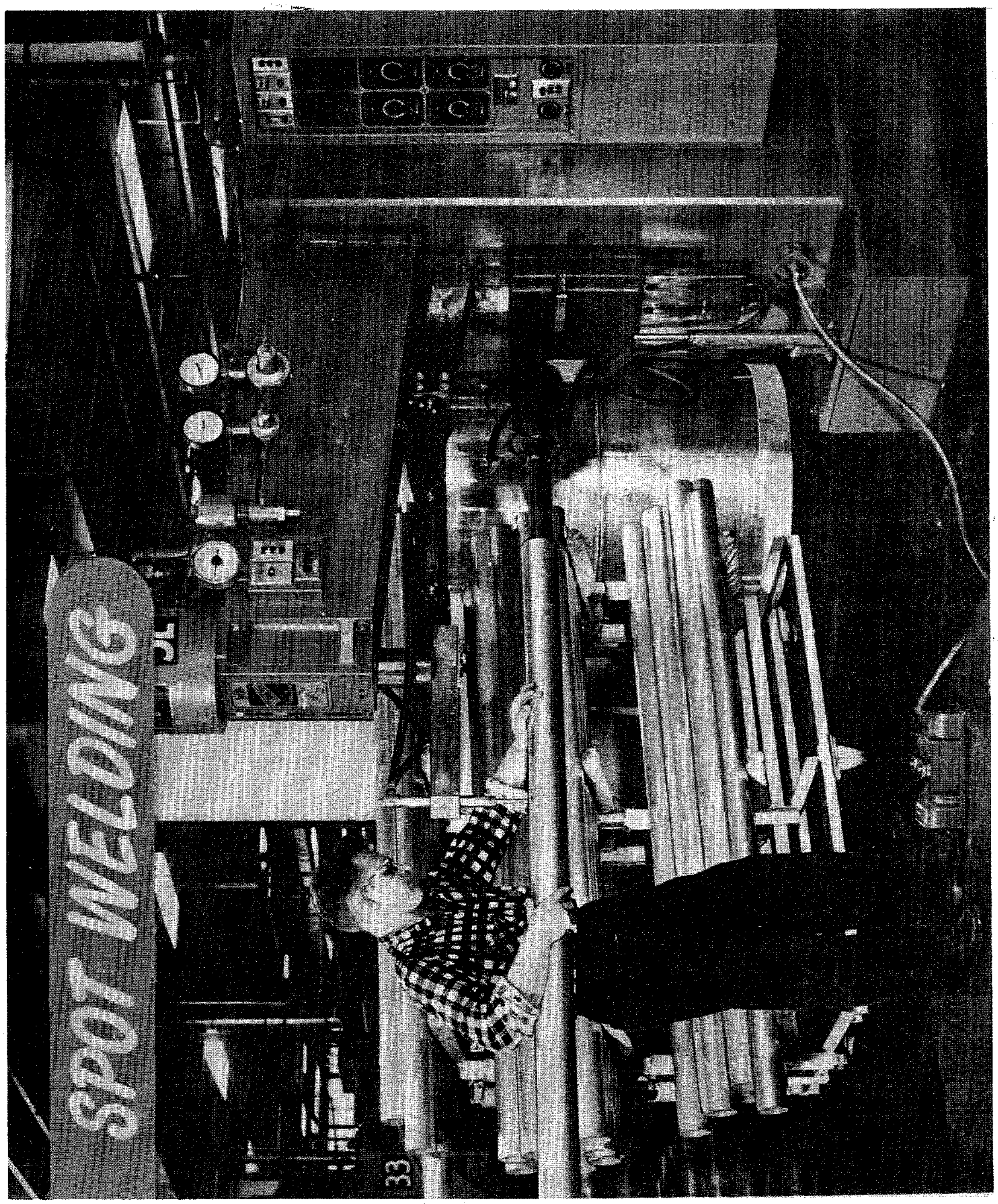
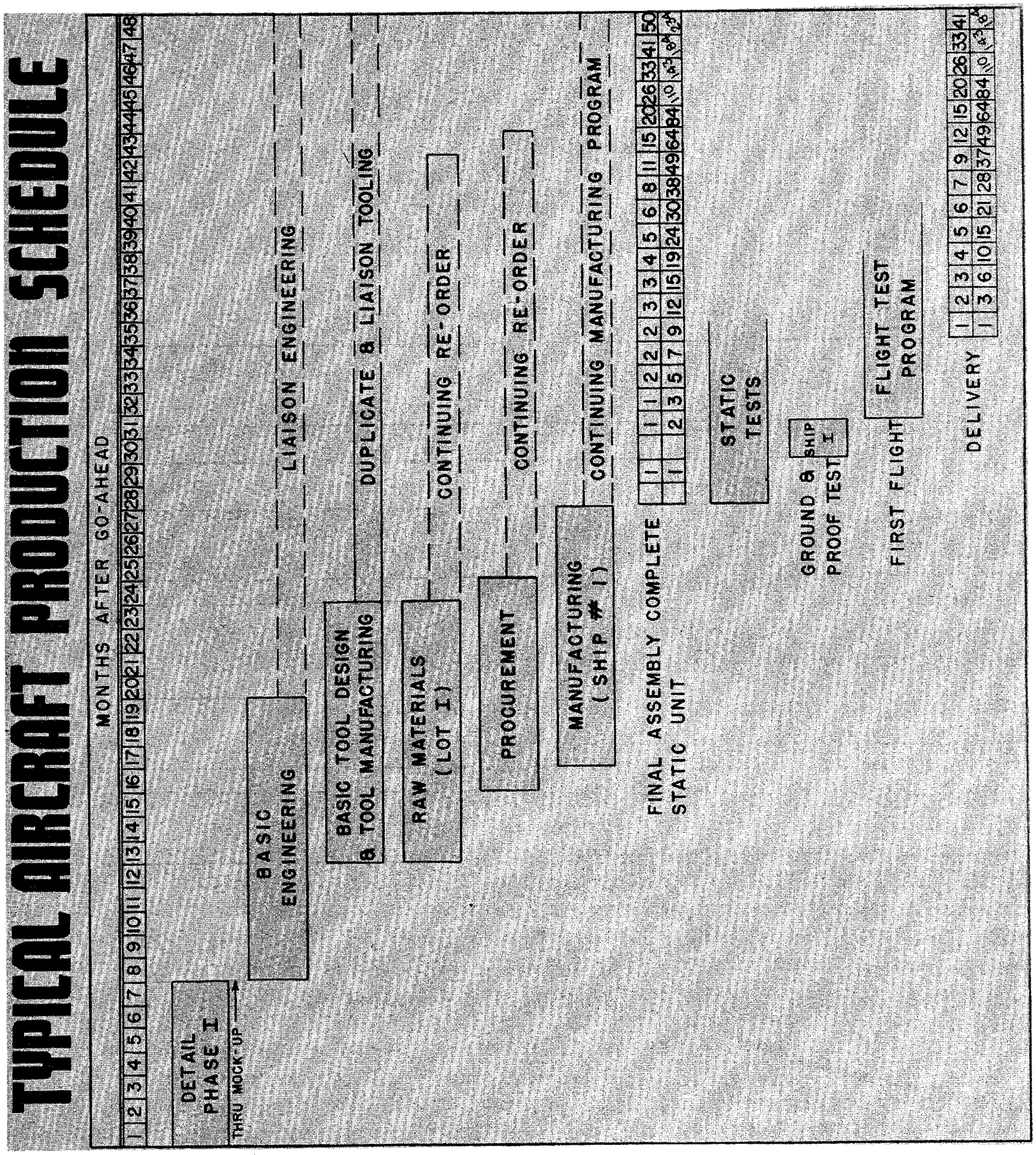


CHART 9

CHART 10


TYPICAL AIRCRAFT PRODUCTION SCHEDULE
MONTHS AFTER GO-AHEAD
DETAIL PHASE I
THRU MOCK-UP
BASIC ENGINEERING
LIAISON ENGINEERING
BASIC TOOL DESIGN & TOOL MANUFACTURING
DUPLICATE & LIAISON TOOLING
RAW MATERIALS (LOT I)
CONTINUING RE-ORDER
PROCUREMENT
CONTINUING RE-ORDER
MANUFACTURING (SHIP # I)
CONTINUING MANUFACTURING PROGRAM
FINAL ASSEMBLY COMPLETE
STATIC UNIT
STATIC TESTS
GROUND & PROOF TEST
SHIP I
FIRST FLIGHT
FLIGHT TEST PROGRAM
DELIVERY

Finally, under manufacturing, you have to figure out what rate you are going to maintain. This opens up a whole new subject--whether, in designing an airplane, you should build one or two experimental ones first or build experimental tooling and then redo the whole thing, based on changes fed in from the flight test program. All I can say is that we are doing it several ways.

Chart 11, page 18.--This lead time chart shows the delivery schedule over a 48-month period, which is a pretty long time. Once you have this chart set up, you can work backward. Suppose you assume a production rate level of 15 a month, represented by the curve. Now if you want to be scientific, you can figure to produce 50 airplanes in something less than three years and to build 250 airplanes before the end of the fourth year. This confirms that from the time you start on the mockup until the plane is fully operational, you have a six- or seven-year period. But you cannot generalize. Every program is an individual case.

Chart 12, page 19.--This chart shows how to build up for planning purposes. On the tail section of the B-57, we use what we call system control points. We give them each a number. This whole assembly is control 803. This control, in turn, is broken up into a whole series of subcontrol points--keyed into the manufacturing sequence plot, at right, by the numbers. This time span, in weeks--working backward--tells you that it takes seven weeks to assemble the aft-fuselage, once production release has been issued. The airplane as a whole is broken up into a dozen or more major control points which form the backbone of the schedule.

Incidentally, we make our operations manager responsible for these rate schedules--in other words, for the basic control points. From there on in, we let the Manufacturing Division and the Production Department work out the details. How and in what sequence they build the lesser components is mostly their own business. All we are interested in is that the aircraft come together at the right time. The operations managers are not trying to do everyone's job for them. Their assignment is to see that the other fellow does the job he is supposed to do.

Chart 13, page 20.--Another factor in this business is completeness of plant layout. I have seen cases in which judicious layout produced twice as many airplanes in one-half the space formerly used.

CHART 11

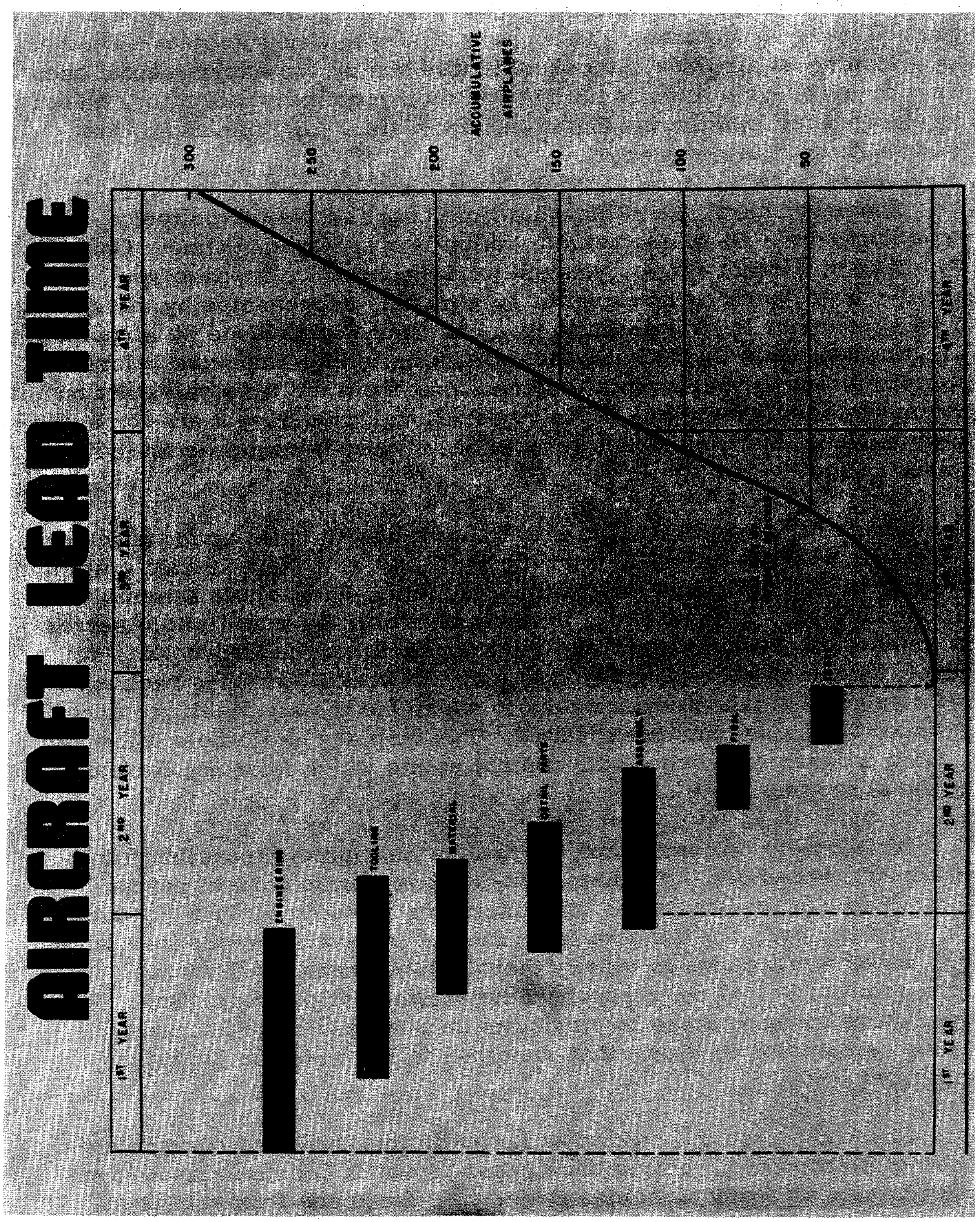

AIRCRAFT LEAD TIME
1ST YEAR
2ND YEAR
3RD YEAR
4TH YEAR
ENGINEERING
TOOLING
MATERIAL
DETAIL PARTS
ASSEMBLY
300
250
200
150
100
50
ACCUMULATIVE
AIRPLANES

CHART 12

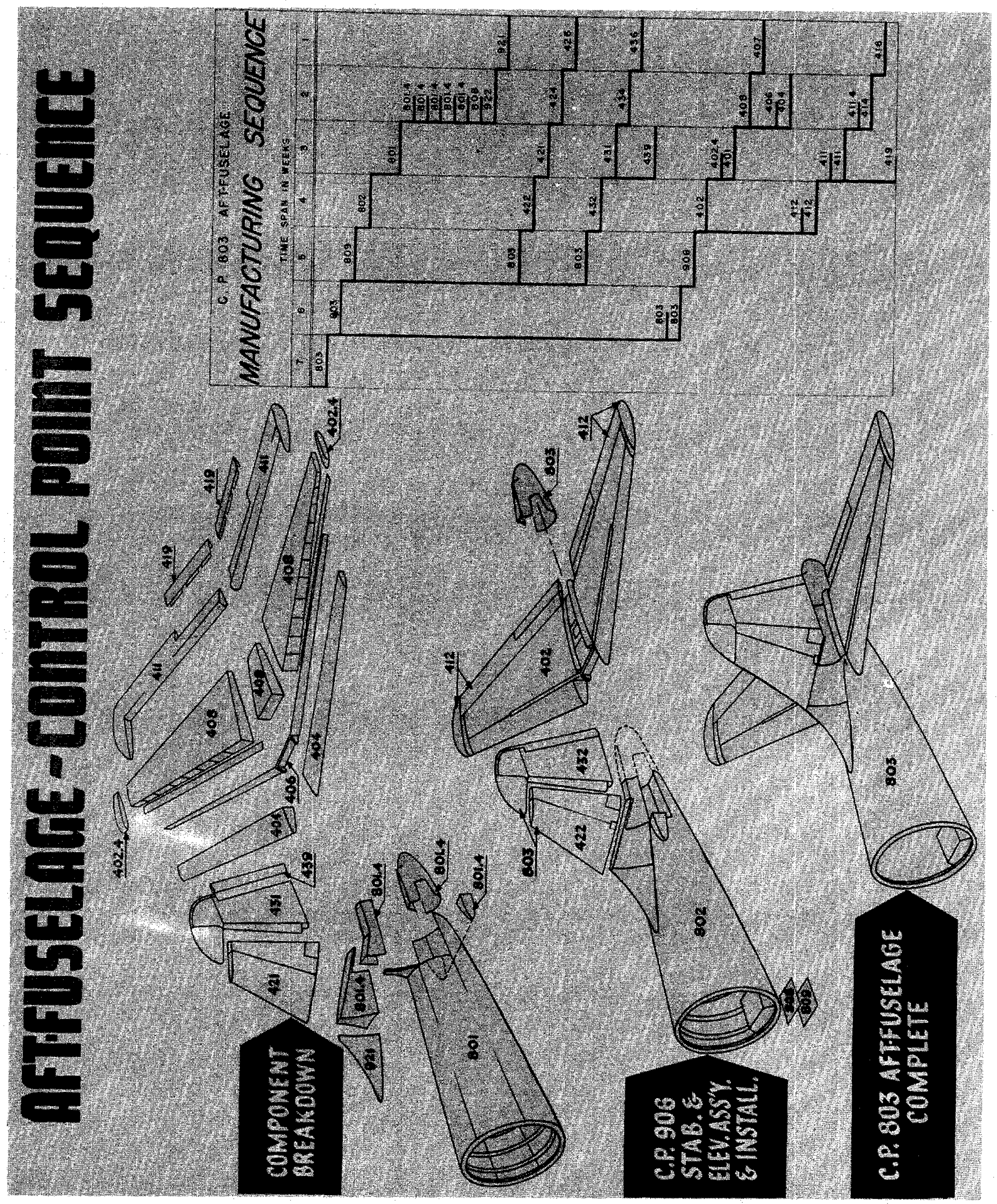
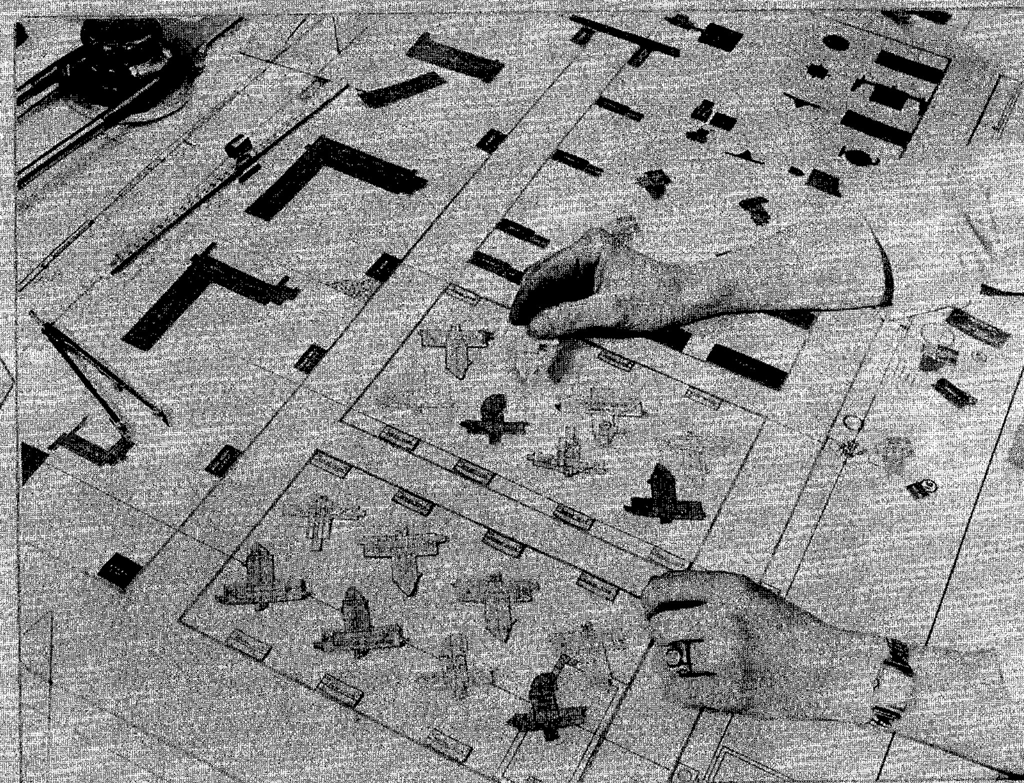

AFTFUSELAGE-CONTROL POINT SEQUENCE
COMPONENT BREAKDOWN
C.P. 906 STAB. & ELEV. ASS'Y. & INSTALL.
C.P. 803 AFT-FUSELAGE COMPLETE
C. P. 803 AFT-FUSELAGE
MANUFACTURING SEQUENCE
TIME SPAN IN WEEKS

CHART 13

PLANT LAYOUT

PLANNING
MACHINE SHOP
LAYOUT



Whether or not you plan the layout with paper tools, it is well worth while to plan it. If you have a good layout, you won't find all sorts of people milling around the aisles. We can go into such things as open bin stocks, and all sorts of techniques, some of which may seem incidental--but cumulatively, such items are very important.

Chart 14, page 22.--When you have the finished production plans on paper, you have an important guide to how things all fit together. The subassemblies are each placed in a specific area, according to the optimum flow pattern and convenient to the major assembly section. The overall arrangement is shown on the chart. We have cut the B-57 line down to 12 final assembly positions--compact and functionally placed. Once you are set up, if you discover you have made a mistake, it may cost many thousands of dollars to change it. So it pays to make sure you are right the first time.

To return to the question then, of how to build an airplane you must consider what kind of tooling you are going to have. The next illustration shows wood and masonite tooling of the experimental type--for the construction of fewer than 10 airplanes.

Chart 15, page 23.--A tool man will tell you that if you spend several million dollars for tools, you can cut many manufacturing man-hours. On the other hand artisans say that the only way to make a plane is to make it their way--that you don't really need these tools. We do know however that the more production you have, the better the job you can do with a full program of tooling.

Chart 16, page 24.--This photo shows low-production tooling--the type you see most of in an aircraft factory. Made of steel and masonite, it is indicated for the construction of quantities of from 10 to 200 aircraft.

Chart 17, page 25.--Finally, if you have the production order to justify it, you can really tool up for volume production. This happens to be an all-steel tool used on the Matador B-61. With this sort of equipment, you can accomplish a number of operations in a matter of seconds. Interchangeable and highly accurate--this tooling makes possible such precision in manufacturing, that we never have to assemble the finished sections in the plant. They go out disassembled. We know they will come together in the fields. Such tooling is called for in the quantity bracket between 200 and 10,000 aircraft units.

CHART 14

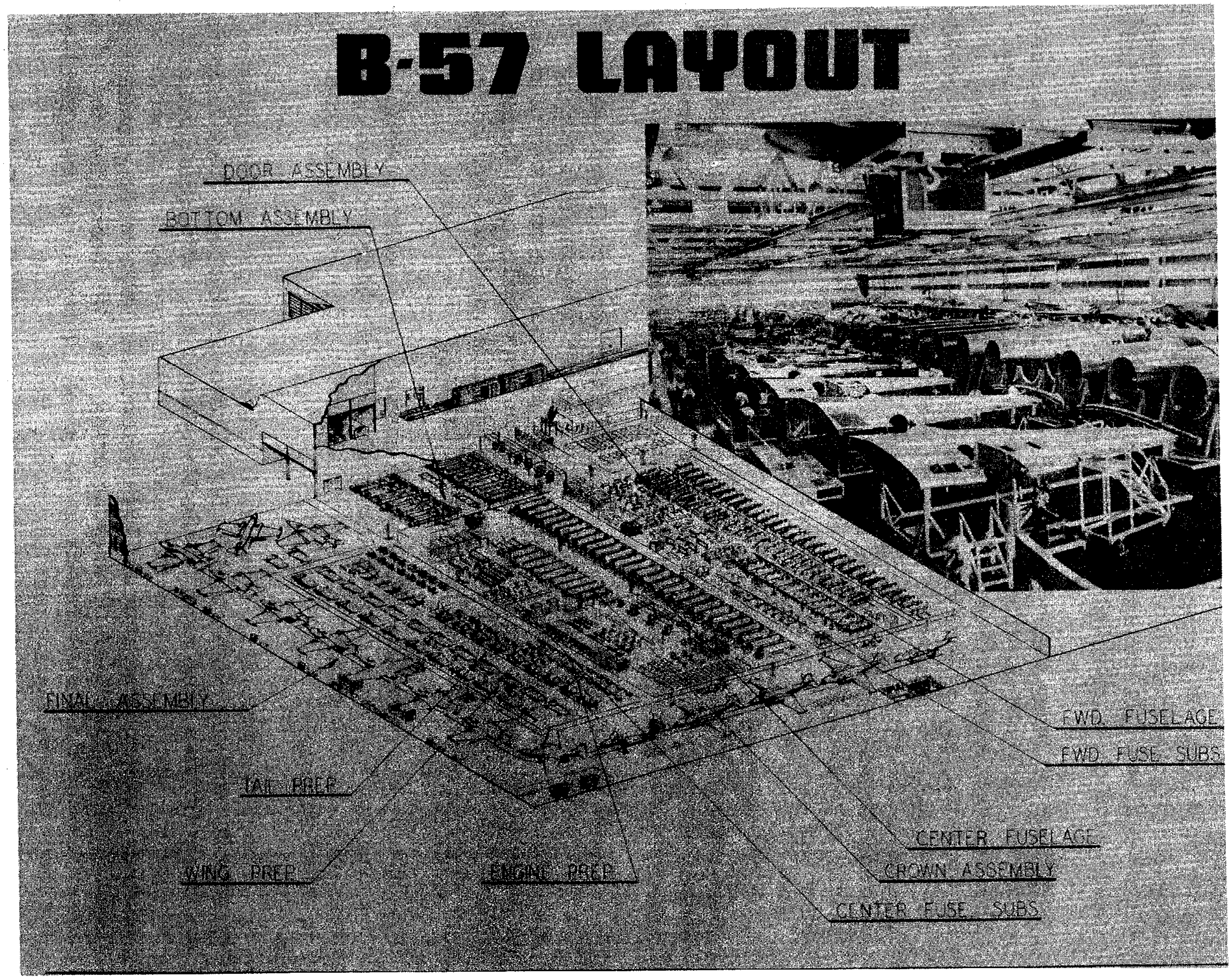

B-57 LAYOUT
DOOR ASSEMBLY
BOTTOM ASSEMBLY
FINAL ASSEMBLY
TAIL PREP
WING PREP
ENGINE PREP
CENTER FUSE SUBS
CROWN ASSEMBLY
CENTER FUSELAGE
FWD FUSE SUBS
FWD FUSELAGE

CHART 15

TYPICAL EXPERIMENTAL TOOLING

WOOD & MASONITE
CONSTRUCTION
I TO IO AIRPLANES

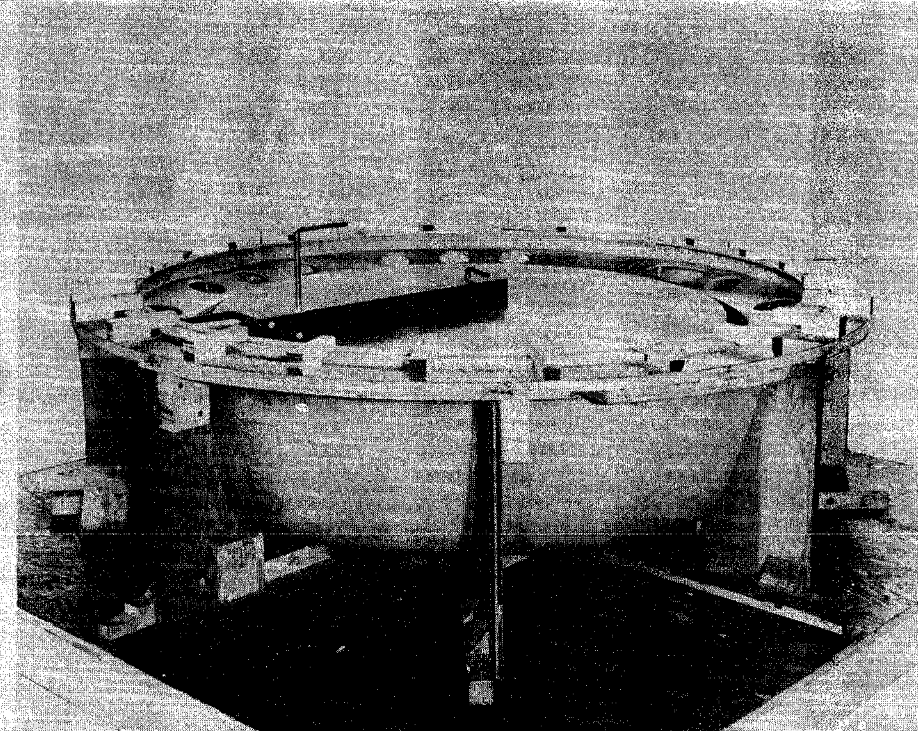
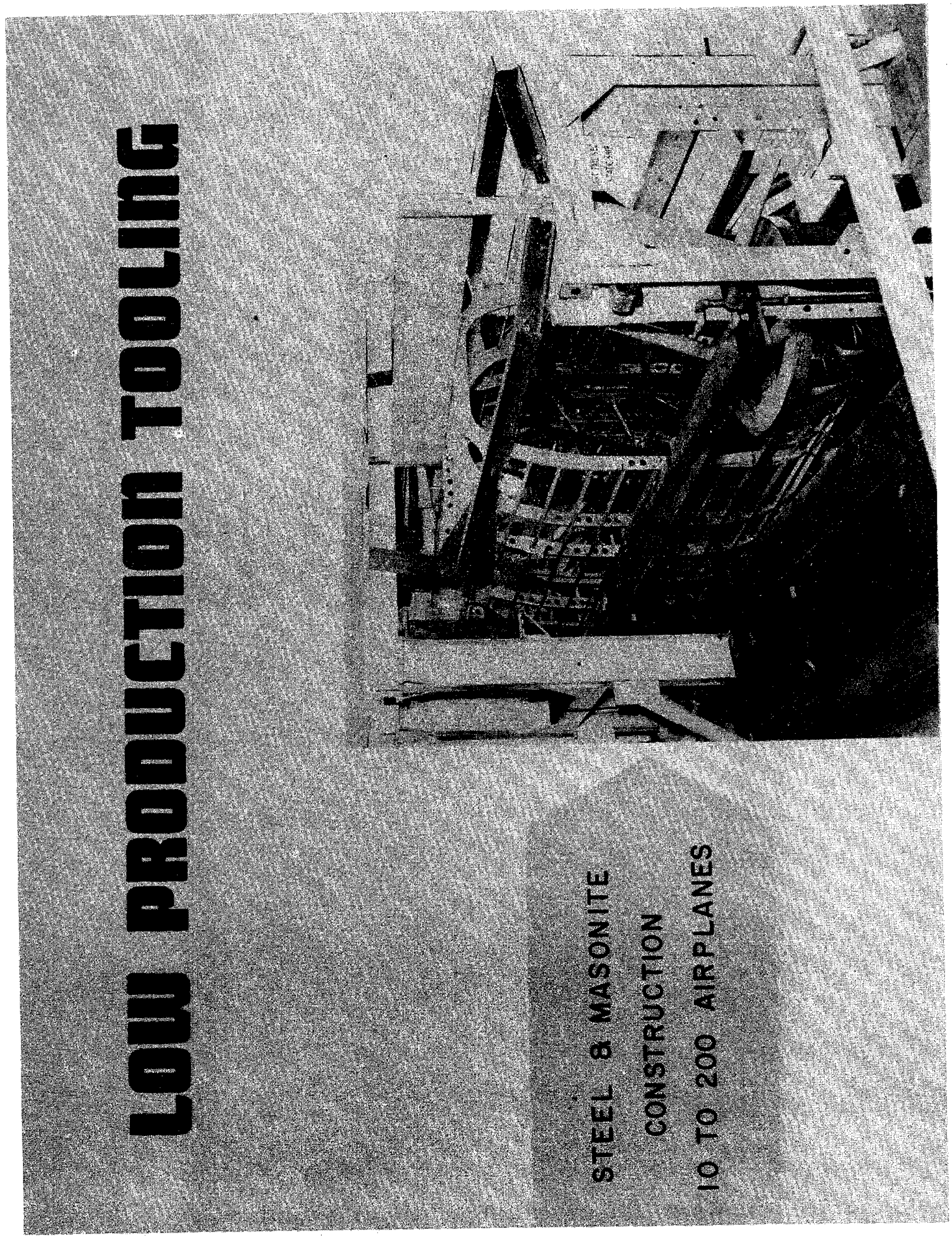


CHART 16

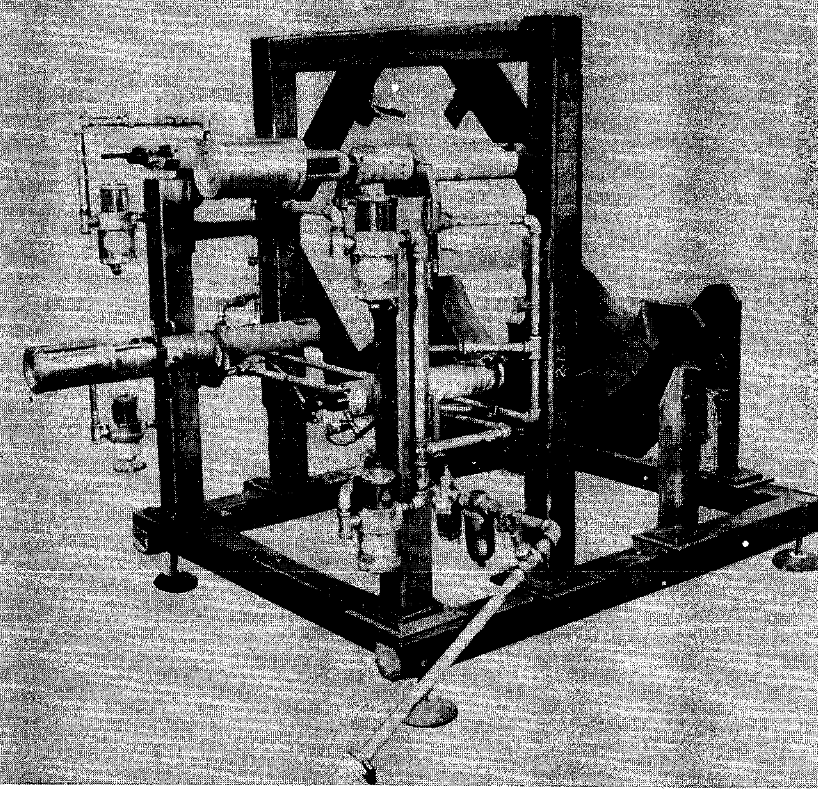

LOW PRODUCTION TOOLING
STEEL & MASONITE
CONSTRUCTION
10 TO 200 AIRPLANES

HIGH PRODUCTION TOOLING

STEEL CONSTRUCTION

CONTROLLED AUTOMATIC OPERATIONS

200 TO 10,000 AIRPLANES



Now, I should like to discuss the B-57 which was born in England and is being manufactured by the Martin Company. Some of the things I say may appear to be critical of the British. I don't mean it that way at all. It is like comparing oranges and apples. Our industry situation is different; our economy is different in this country. This happens to be a good comparison and in all fairness, as far as the airplane is concerned, we believe the British design to be excellent. We have learned a lot from the British design philosophy. With respect to simplicity, it is very good--and on the other side, I will show you some things I think we do better than the British.

Chart 18, page 27.--This picture shows the airplane we are talking about. This airplane was born in the middle of the Korean situation, while the Air Force was still using the B-26 to do the job--and it was supposed to be a rush-rush development. We were told at first to build Chinese copies of the British airplane. This meant flying the British templates over here. We then realized that they used the opposite projection to our own. We were afraid our mechanics would have to stand on their heads to do their jobs, so that plan didn't materialize.

We made some changes--very simple ones--and we were going to change the engines. Then it became necessary to put some American equipment in the cockpit. The British bomb bay--like some of our American bomb bays--is good except when it is open at high speeds. It was silly to have to reduce the bomb-dropping speed to 300 mph--when the airplane itself is capable of going 600 mph, so we installed a new type, rotating bomb bay. It was a high altitude bomber and had no guns--so we put some guns in the wings, which is very easy. Finally, we needed more range--as we always do--so we had to put fuel in the wings. Outside of these items, the airplanes are the same!

I should like to comment on what happened in this case of the B-57. It is a very significant thing. If we intend to maintain our standard of living--and the average American is getting very close now to the two cars in every garage and those two chickens in every pot--we are never going to be able to build airplanes like they do abroad.

Chart 19, page 28.--The British paid 59 cents an hour for labor; we were paying $1.50 an hour. If we are going to build an airplane in competition with the British, we will have to build it with fewer man-hours than they do.

CHART 18

CHART 19

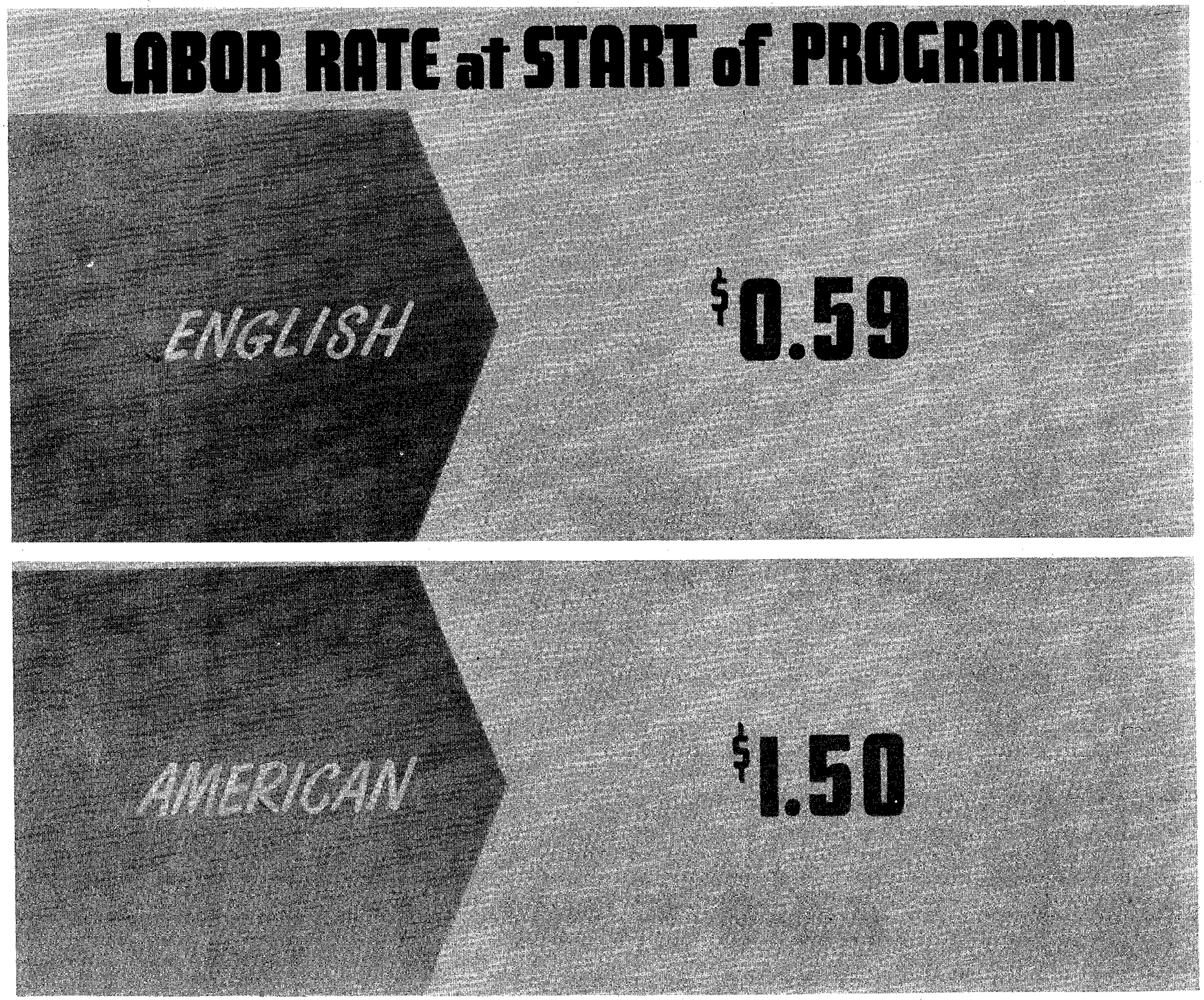


Chart 20, page 30.--This photo shows the British cockpit with all of the equipment in it. I imagine the technicians carefully wound the wires around and then just tied them together--that is the British cockpit.

Chart 21, page 31.--This is what it looked like after we had finished with it. This is fairly standard American design. Here the wires are made up in bundles ahead of time. In all fairness, we can say that the B-57 cockpit is a little bit better organized.

Chart 22, page 32.--This next illustration is very simple, but again significant. In all British airplanes, everything is made out of bar stock with machined sections. We use forgings. This explains, more than anything else, why we had to create 100 percent new drawings.

Chart 23, page 33.--Let us review some of the items. The British used 0.028 offset on flanges; because our tools are all different, we used 0.032. Just opening it up four-thousandths made all the difference. We had the same thing in the rivet spacing. The British used the minimum rivet spacing to edge. We can't afford to do it. We had to use an entirely different spacing. We can't put a rivet in that close to the edge on a production basis. The British edge distance was 0.550; the American 7/16. As for the overall tolerances on drawings, the British used plus 0.020, minus nothing. That is no way to give tolerances. The American tolerance is plus or minus 1/32 of an inch. These are some of the reasons why we redesigned the airplane--outside of the fittings.

Chart 24, page 34.--Here we have one of the most critical of the B-57 parts--the main spar fitting which carries the wing structure. This is the Garden Gate fitting, drawn within a phantom fuselage--just to give you an idea of its size. The British started out with a solid billet about the size of a large conference room table and started hogging away at it. Oftentimes, because of the very thick billet, on getting halfway through, they would find a flaw in the billet--and have to start all over again.

Chart 25, page 35.--This was intolerable, so far as we were concerned, so we cut the billet in half--as shown--made it into two sheets thin enough so that we didn't have to hack them out. We sawed them out and bolted them together.

CHART 20

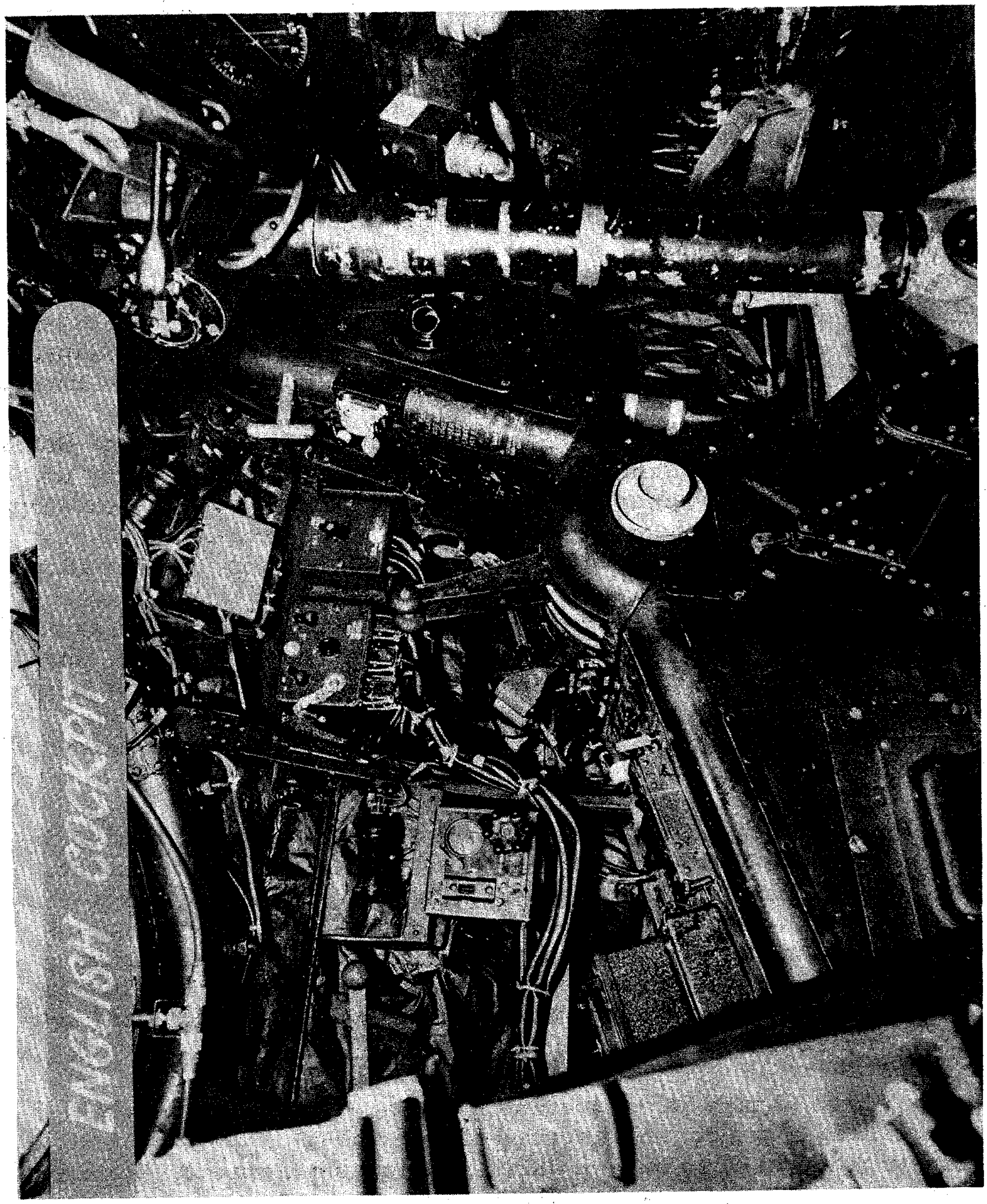


CHART 21

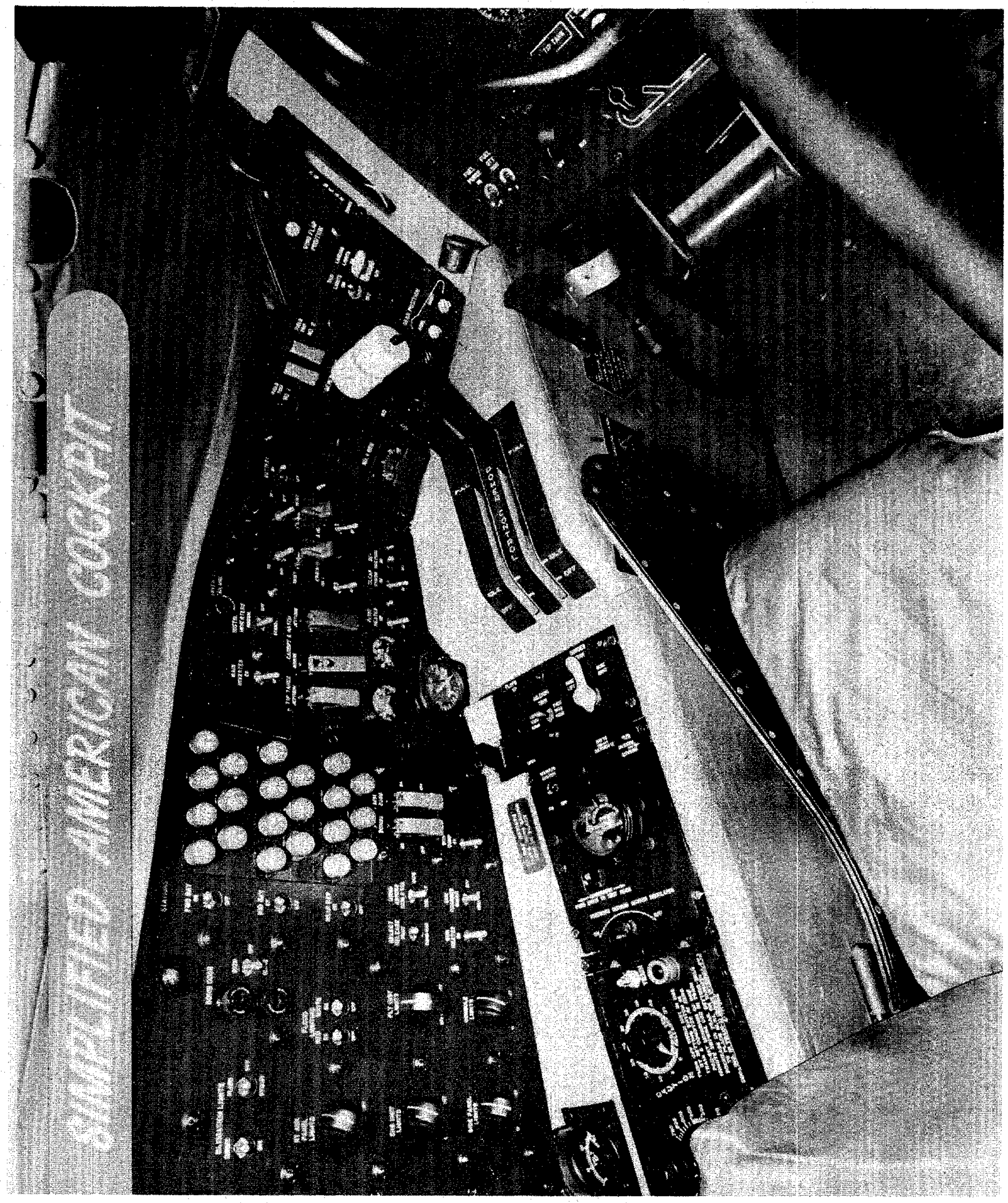


CHART 22

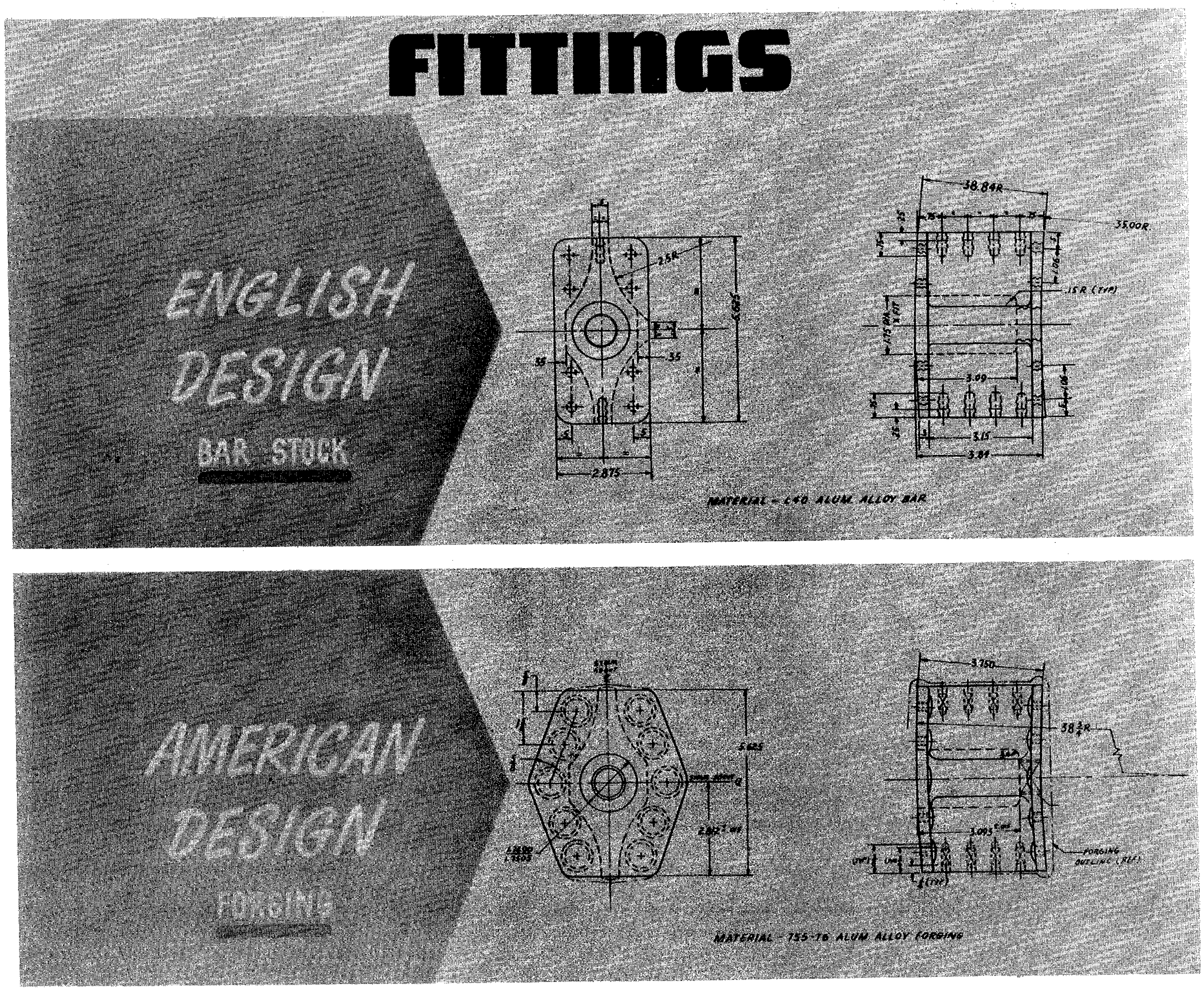
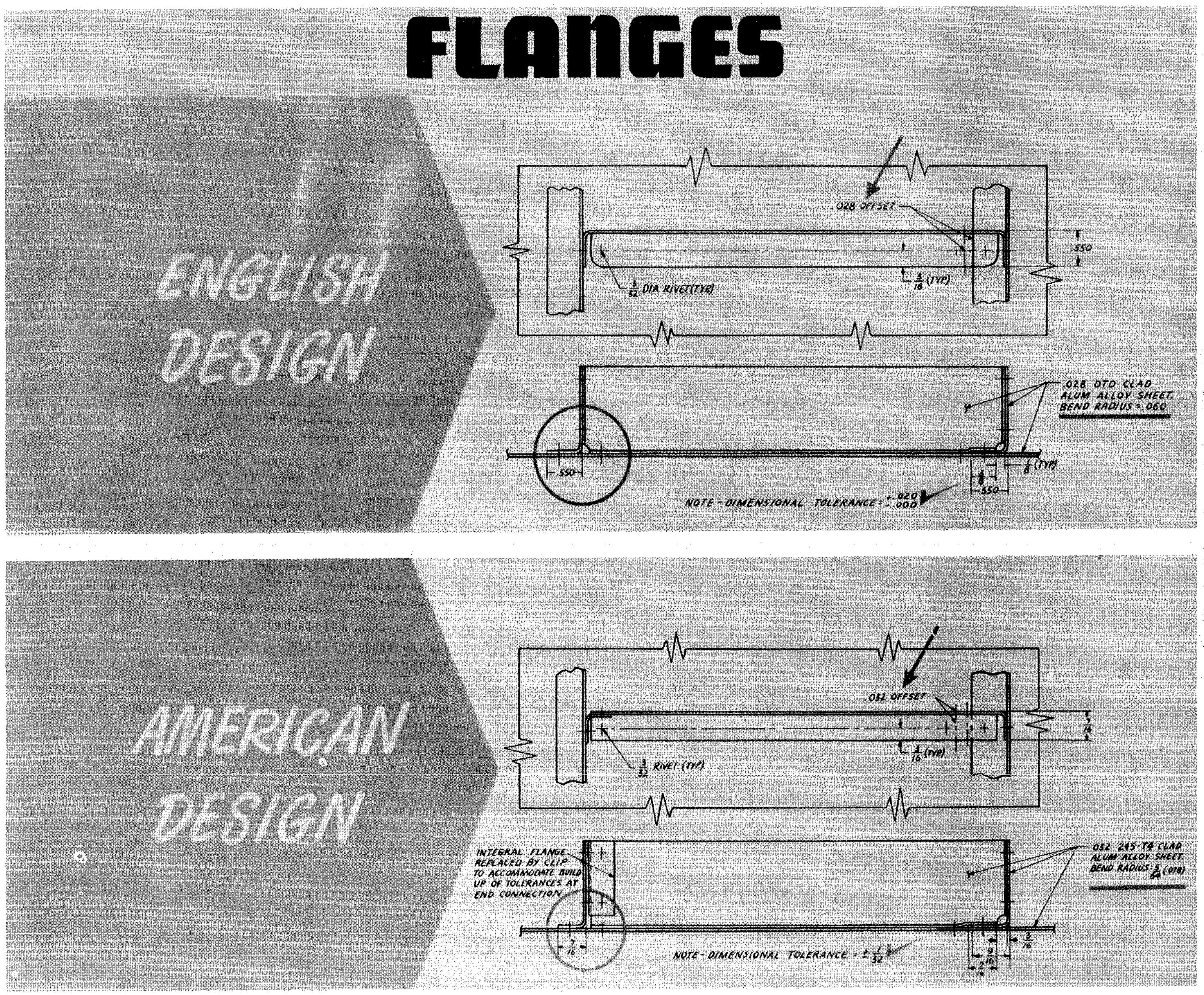

FITTINGS
ENGLISH DESIGN
BAR STOCK
2.875
2.5R
38.84R
35.00R
.15 R (TYP)
3.09
3.15
3.84
MATERIAL - L40 ALUM. ALLOY BAR
AMERICAN DESIGN
FORGING
5.625
3.750
58 ½ R
FORGING OUTLINE (REF)
MATERIAL - 75S-T6 ALUM. ALLOY FORGING

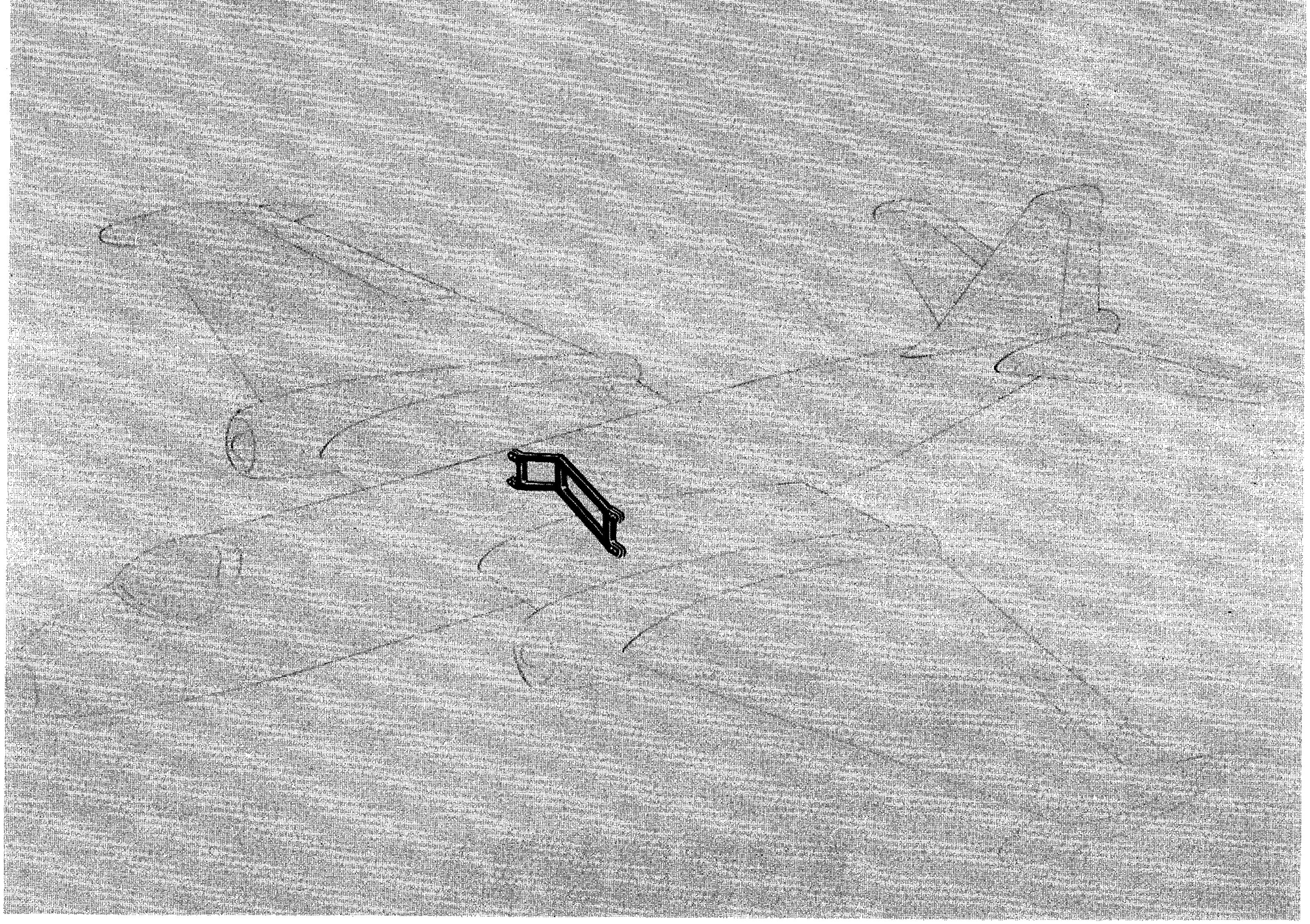
CHART 2[illegible]

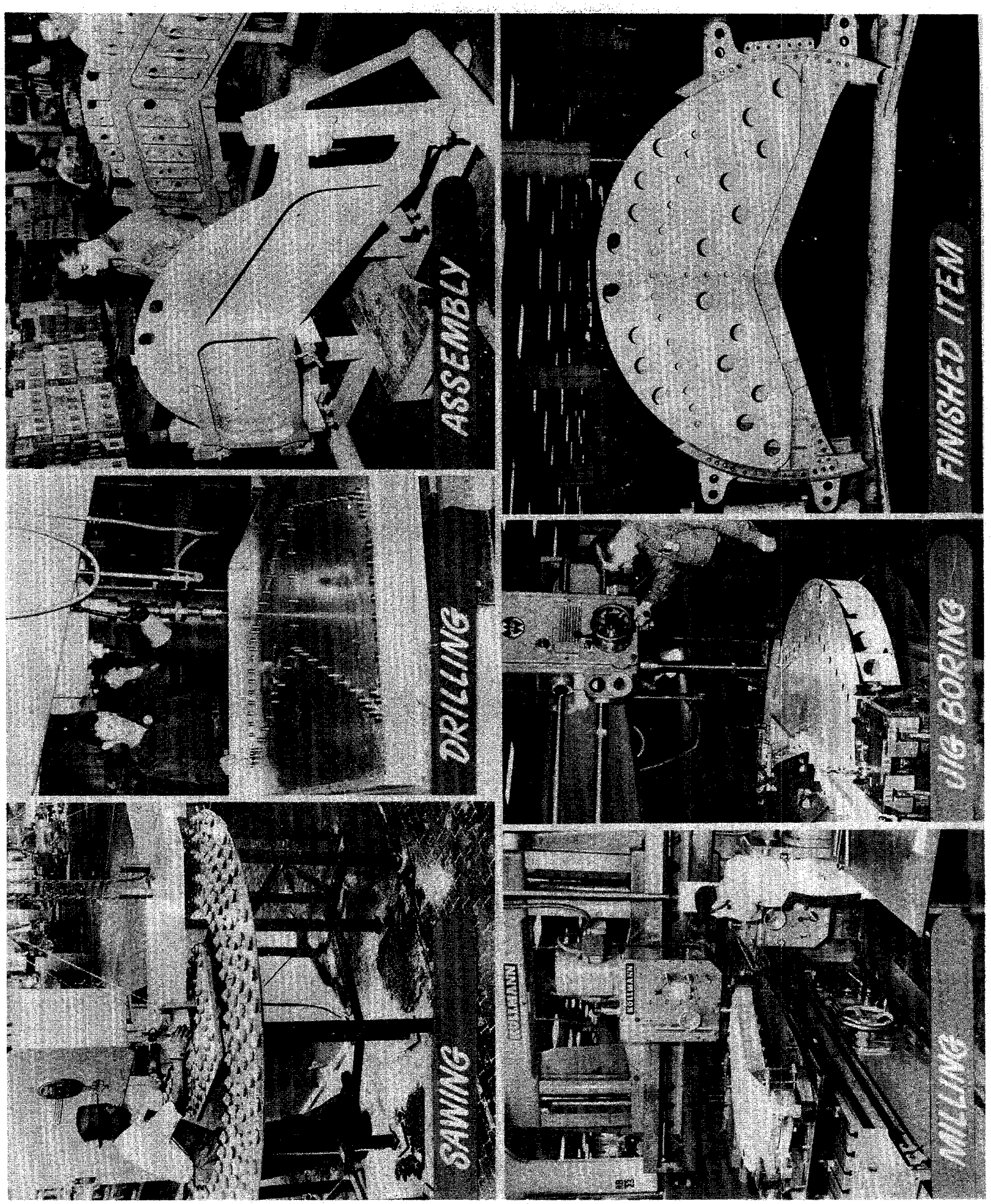

FLANGES
ENGLISH DESIGN
.028 OFFSET
3/32 DIA RIVET (TYP)
3/16 (TYP)
.550
.028 DTD CLAD
ALUM ALLOY SHEET.
BEND RADIUS = .060
1/8 (TYP)
NOTE - DIMENSIONAL TOLERANCE = +.020 -.000
AMERICAN DESIGN
.032 OFFSET
3/32 RIVET (TYP)
3/16 (TYP)
.032 24S-T4 CLAD
ALUM ALLOY SHEET.
BEND RADIUS 5/64 (.078)
INTEGRAL FLANGE REPLACED BY CLIP TO ACCOMMODATE BUILD UP OF TOLERANCES AT END CONNECTION
7/16
9/16
3/16
NOTE - DIMENSIONAL TOLERANCE ± 1/32

1353

CHART 24

LOCATION of CRITICAL WING FITTING




ASSEMBLY
FINISHED ITEM
DRILLING
JIG BORING
SAWING
MILLING

Finally, to get into the assembly process, the British would bring a great number of detail parts to the final assembly jig, in making the nose section, for example. Noses are always very hard to build--they are so small. In contrast, we make more subassemblies than the British do and use less details in final assembly. Thus, we use fewer people in final assembly than do the British.

Among other things--and I must admit this was a surprise--we found that we could actually build this airplane at much less than our own predicted weight.

Chart 26, page 37.--Based on the changes we put in, the airplane was supposed to weigh 54,000 pounds. As it came out--and we are building three variations of the airplane at the moment--it weighs 52,200 pounds. As compared to the 54,000 this represents an underweight of 1,800 pounds, which is quite unusual. There were a lot of reasons. On electric wiring alone--the cockpit is a good example--we saved 700 pounds. In short, outside of such items as the guns--which we added--the American plane is lighter than the British equivalent, design item for design item.

Chart 27, page 38.--Finally, this last picture shows you that the B-57 does indeed fly.

CAPTAIN HALE: Sir, this was right down the beam and it looks as if we are glued to Martin from now on. Thanks a lot.

(17 June 1954--450)S/ijk

CHART 26

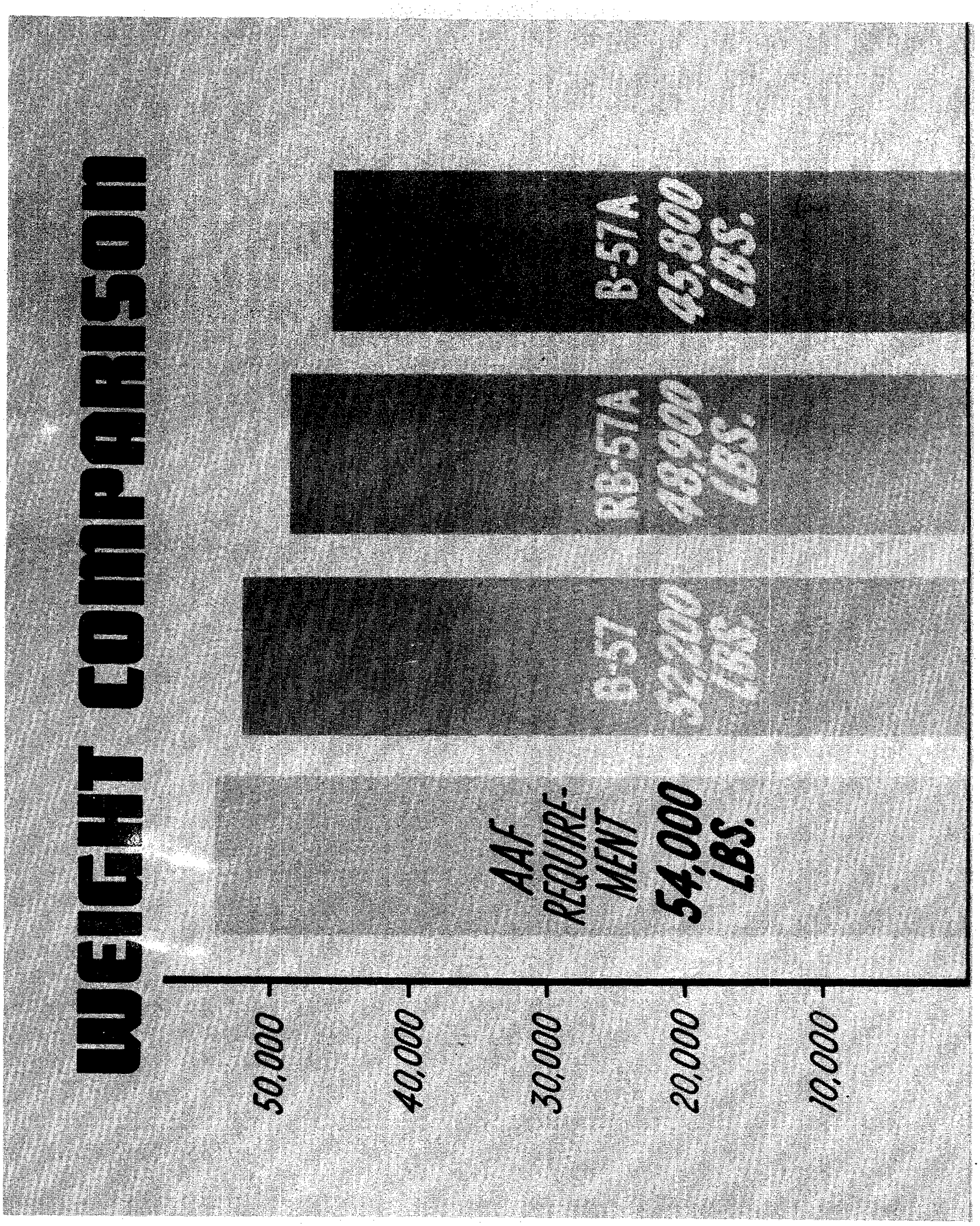

WEIGHT COMPARISON
50,000
40,000
30,000
20,000
10,000
AAF REQUIRE-MENT
54,000 LBS.
B-57
52,200 LBS.
RB-57A
48,900 LBS.
B-57A
45,800 LBS.

CHART 27