

MONTHLY *Business Review*

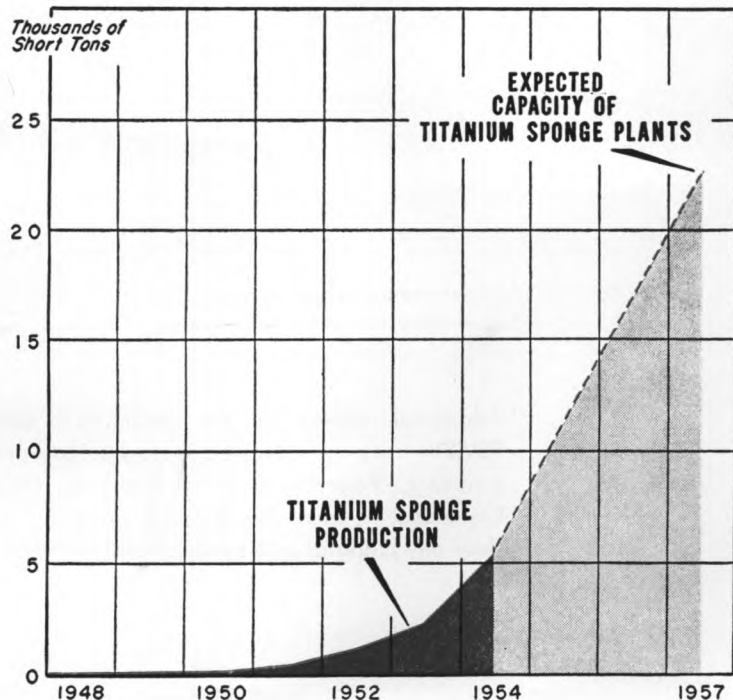
FEDERAL RESERVE BANK of CLEVELAND

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IN THIS ISSUE

Titanium: A New Growth Industry . . . 3

Department Store Trade Since 1953 . . . 7



Titanium sponge plants now under construction will boost this infant industry's 1957 production potential to about four times the 1954 output, making it one of the most rapidly growing industries in the country today.

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Titanium: A New Growth Industry

TITANIUM is the newest member of the structural metals family — a small but lustily growing youngster. As with any infant, new traits are being discovered almost daily and it is becoming increasingly easier to handle and to understand as it gets older. But, the metals family still has much to learn about their precocious child.

Actually, titanium is “new” only in that methods of reducing the mineral into metallic form have been developed on a commercial scale within the past few years. Titanium dioxides have been used commercially for over 20 years to provide the whiteness in paints, papers and other products. However, production of titanium in metallic form has focused attention upon its lightness, strength and resistance to corrosion.

As recently as 1950, the titanium industry’s output was measured in pounds. But, by 1954, production of titanium sponge metal totaled 5,300 short tons as compared with about 3 tons in 1948. Defense goals call for a 35,000-ton capacity by 1957. In other words, titanium could mature rapidly into a full-fledged member of the metals family.

Uses and Advantages of Titanium

Titanium is a baby born of defense needs. It is as strong as steel but weighs only about half as much. It is six times stronger than aluminum, yet weighs only 60 percent more. It has excellent resistance to corrosion, completely withstanding attacks by salt water and many other chemicals. It is ductile and retains its strength at temperatures up to 800° F.

Many applications of titanium are still in the experimental stage. Its major use to date has been in the structural members and skins

of jet and supersonic aircraft, where the lightness of titanium permits the planes to cover greater distances at higher speeds.

Titanium’s excellent corrosion resistance provides the metal’s chief attraction to civilian users at present. Small quantities are being used in various marine applications, in the chemical and food industries, and for various orthopedic devices. The high cost of the metal currently limits its civilian uses, but as prices come down, broader nondefense markets seem assured for such a versatile material.

Titanium Ores

Titanium is the fourth most plentiful structural metallic element in the earth’s crust, being exceeded only by iron, aluminum, and magnesium. Although it is present in practically all crystalline rocks and in many minerals, only a few minerals contain sufficient titanium to have economic importance.

The principal titanium ores are rutile (TiO_2) and ilmenite (FeTiO_3). Rutile is the richer ore, but ilmenite is the more plentiful. Pure rutile contains about 60 percent titanium while ilmenite contains from 20 percent to 30 percent titanium.

In the United States, ilmenite is presently recovered from deposits in New York, Idaho, Virginia and Florida. Substantial amounts of ilmenite concentrates are also imported from India and Canada. Rutile, however, is produced in this country only from the beach sands of Florida. Australia is the sole foreign supplier of rutile at present, but one of the major steel companies of this Federal Reserve District is developing extensive rutile deposits in Southern Mexico that appear to be the richest yet uncovered in the Western Hemisphere.

Making Titanium Sponge

All of the titanium sponge⁽¹⁾ produced commercially today is made by the magnesium reduction of titanium tetrachloride, called the Kroll process after the Luxemburg scientist who first developed it.

Basically, the transition from ore to sponge is accomplished in three stages. First, the ore is concentrated to at least 90 percent pure titanium dioxide by chemical or other beneficiation means. Secondly, the concentrated ore is reduced by chlorination of the titanium dioxide to titanium tetrachloride, a colorless liquid in its pure form. Finally, the titanium tetrachloride is reduced with molten magnesium, in an argon or helium atmosphere, to sponge metal. The sponge, about 99.5% titanium, is the raw material which is melted into ingots and processed into mill products.

(1) Sponge is a small, hard, metallic mass similar in appearance to coral rock.

Sponge is produced commercially in this country in only two plants at present, having a combined capacity of 7,200 short tons a year. Plants now under construction will bring the industry's capacity to 22,500 short tons by 1957. The location of plants in operation or under construction is shown below.

PLANT LOCATION	ANNUAL CAPACITY (short tons)	COMPLETION DATE
Newport, Del.	3,600	April 1954
Henderson, Nev.	3,600	October 1954
Chattanooga, Tenn.	6,000	Mid-1955
Midland, Mich.	1,800	Mid-1956
Ashtabula, Ohio	7,500	1957

All the foregoing plants utilize the Kroll reduction process (or modifications thereof) except the plant being built at Ashtabula. The latter will produce sponge by the sodium reduction of titanium chloride. Five years of research went into the development of the new reduction process to the pilot plant stage in Niagara Falls, N. Y.

Negotiations between the General Services Administration and private companies now nearing conclusion reportedly call for an additional 18,200 short tons of titanium sponge capacity. These plans have not been completed, however.

Domestic sponge output is supplemented somewhat by imports from Japan. During the first 10 months of 1954, Japanese sponge imports totaled 136 short tons as compared with domestic produc-

THE TITANIUM INDUSTRY May 1955



tion for the entire year of about 5,300 tons.

Melting and Rolling Titanium

At temperatures considerably below its melting point, titanium combines readily with oxygen, nitrogen and hydrogen, making it quite brittle. Therefore, melting the sponge into metal is done in special crucibles in an inert gas atmosphere or a vacuum. The sponge may be melted in a water-cooled copper crucible by direct-current arcs or in a graphite crucible by exterior induction coils. Ingots up to 3,500 pounds have been formed.

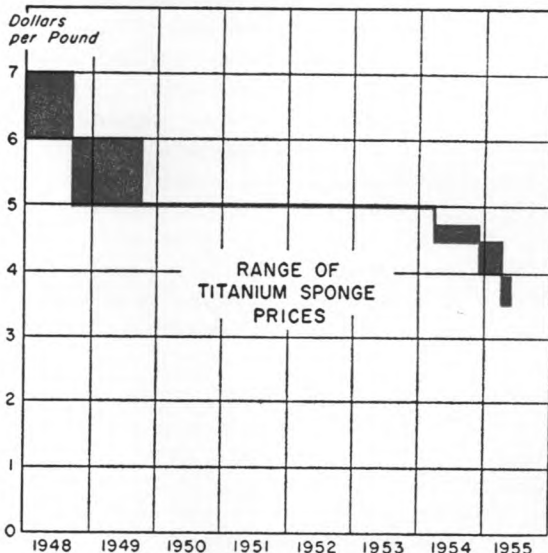
After scalping to remove surface imperfections, the titanium ingots may be hot forged or hot rolled to intermediate mill shapes. Proper heat control is necessary at all finishing stages because of the metal's affinity for contaminating elements at high temperatures.

Much of the titanium production to date has been in the form of sheets, rolled on hand sheet mills, and destined mainly for aircraft skins and frames. Continuous hot and cold strip rolling processes are being developed. In addition, titanium has been successfully forged, rolled into bar and billet shapes, drawn into wire and welded into tubing. Progress is also being made in hot extrusion of the metal.

Only four companies currently produce a variety of titanium mill products. Most of this finishing capacity is located in the Fourth Federal Reserve District. However, no new mills have been built. Rather, melting facilities have been added near existing steel finishing capacity which has been modified to handle titanium. For example, stainless steel mills, with little more than a roll change, are used to roll titanium sheet.

Titanium sponge is being converted into semi-finished and finished mill products at steel mills in Midland, Pennsylvania, and Niles and Canton, Ohio. These three mills depend upon the sponge facility at Newport, Delaware, for their raw material. The fourth titanium converter melts its own sponge from its Henderson, Nevada, plant, finishing it on mills in Brackenridge and West Leechburg, Pennsylvania, and Dunkirk and Watervliet, New York.

The price of titanium sponge has been reduced about 25 percent during the past year as new facilities were brought into production.



Source of data: Bureau of Mines; *Steel* magazine

Growing Pains

Like any rapidly growing infant industry, the titanium industry is beset with a multitude of problems. Many obstacles have already been overcome but many remain.

High costs. The most formidable hurdle the titanium industry has to overcome is the high price of its products. Titanium sheets, for example, are currently quoted in *Steel* magazine at \$15 per pound f.o.b. mill, as contrasted with stainless steel sheets which range from 35c to 81c per pound and carbon steel sheets which cost from 4c to 8c per pound. Of course, titanium weighs only about half as much as steel, but titanium remains a very high priced metal even after allowance is made for the difference in density.

Sponge prices have dropped considerably, as shown by the accompanying chart. Most of the output prior to April 1954 was in small batches made at pilot plants and priced at \$5 and more per pound. With full scale produc-

tion attained at two plants in 1954 (in April and October) prices dropped twice, falling once again this April. A titanium sponge price of \$3 per pound has been predicted by some industry observers. Nevertheless, the present processes of making sponge are expensive and do not hold much hope of making titanium prices competitive with steel or aluminum in the present technological state of the industry.

Inconsistent quality. The quality of titanium sponge has been improved considerably in the past few years. Material shipped only three years ago would not be acceptable by today's standards. Still, complaints of inconsistent quality plague the industry.

The initial quality of the sponge as it leaves the reduction plants is thought to be satisfactory. Some technical experts believe that the answer to inconsistent ingot quality lies in the integration of sponge producing and melting facilities, holding that the moisture picked-up in transit and storage attacks the sponge, causing hydrogen embrittlement of the metal.

Scrap use. Scrap losses are high in titanium production and fabrication but re-use in melting furnaces is lagging. The Government is actively promoting scrap use since it would help reduce the price of titanium and substitute for additional sponge capacity.

Reducing the titanium ingot to mill products results in about 40 to 50 percent scrapage, on the average, of which some 10 to 15 percent is nonrecoverable. This may be compared with a 25 to 30 percent scrap loss at steel mills. Titanium fabricators average 40 percent scrap, ranging from 15 percent on sheet to 85 or 90 percent on forgings.

Use of scrap for remelting varies among producers, running from 5 to 25 or 30 percent of the furnace charge. Most of this is generated by the producers themselves. One producer thinks that sponge of higher purity would allow more scrap to be used in the melt.

The cost of equipment for handling, cleaning and analyzing titanium scrap is the major obstacle to its re-use. Fabricators tend to mix scrap with other metals so indiscriminately that reclamation is extremely difficult. A Detroit dealer who processes titanium scrap puts

a price on it of from \$0.40 to \$1.25 per pound, shipped in boxes rather than freight cars.

Open order books. Orders for titanium mill products fall far short of the industry's capacity. At present, the Government takes 90 percent of the industry's output, setting aside 10 percent for civilian use. But, consumer demand, both Government and civilian, would appear to be substantially below previously estimated levels. Shipments of titanium mill products last year, for example, totaled only 1,250 short tons as compared with sponge output of 5,300 tons. Only about 2½ percent is currently going to nondefense rated orders and the Government is using only about half of its share. The balance in the form of sponge goes into the Government stockpile.

Producers are faced with this dilemma: Expansion programs result in sharp increases in capacity. Engineers (military and civilian) are reluctant to assume that adequate supplies of titanium will be available, but when they see that it is available, they will design accordingly. However, it takes from 6 months to 3 years for the new specifications to affect procurement. The civilian engineer is even more reluctant to specify titanium because he is uncertain about what will be left after defense needs are met.

The fact remains that titanium is a relatively unknown member of the metal fraternity. Fabricators are still learning how to work it. It requires new heating, grinding, drilling and other working techniques. These are being learned rapidly. As more comes to be known about the metal, and as industry specifications become more standardized, consumer acceptance will be translated into effective demand.

Government Aids to Industry

Titanium is an extremely risky venture. The rapid technological advances being made in the industry could make the considerable investment in sponge and melting facilities obsolete virtually overnight. In order to assure sufficient titanium capacity to meet military needs, the Government allows rapid tax write-

Continued on Page 10

Department Store Trade Since 1953

Fourth District

RESURGENCE of consumer confidence and consumer buying has been one of the outstanding features of the current expansion phase of business. Whether or not it was the main factor which sparked the recovery last year, as some observers assert, there can be no doubt about the strategic role of consumer buying in maintaining the current pace of business.

Department store trade, which encompasses a wide variety of commodity lines (although it falls short of the important food and auto sectors) has shared significantly in the retail recovery.

In the Fourth Federal Reserve District, the pattern of decline in department store sales during late 1953 and early 1954, followed by substantial recovery since then, has mirrored the national trend. The extent of the decline,

however, as measured in percentage terms, was somewhat greater in this District than for the nation, at least by several percentage points. The recovery, likewise, was more marked in this District. By April 1955, the relative difference had been largely overcome, and sales in the Fourth District as well as nationwide were comparable with 1953 peaks.

The months since 1953 have not been easy ones for Fourth District department stores. Behind the current optimistic plus signs are several significant changes in the composition of sales, inventories and credit. Furthermore, a prolonged labor dispute in one of the two largest cities of the District (Pittsburgh) had an adverse influence upon the District's sales totals during 1954.

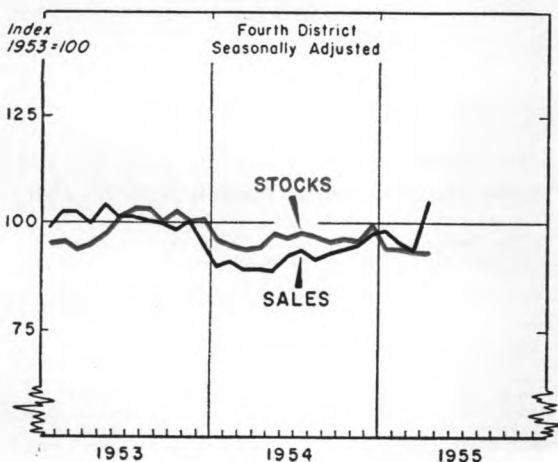
Sales and Stocks

Since last December, sales of Fourth District department stores have been at higher levels than a year ago, but inasmuch as the year-ago period was the bottom of the trade cycle, current plus signs should be interpreted with care.

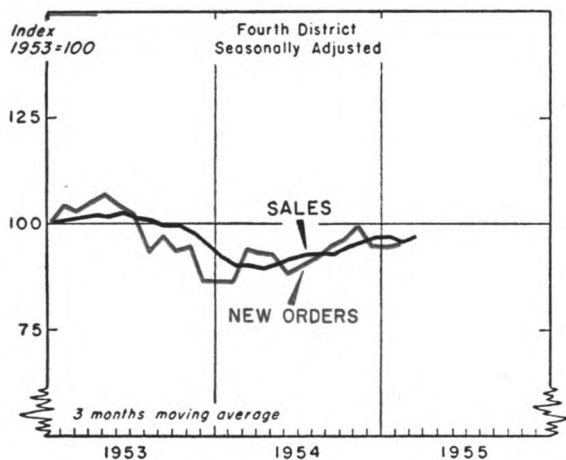
Sales began their downward slide in the latter months of 1953, reaching a bottom at about 10 percent below the 1953 level during the first five months of 1954. (Allowance is made for seasonal variation. See chart.⁽¹⁾) Since May 1954, sales have followed an irregular but upward course; however, they did not succeed in reaching the 1953 average level until April of this year. From the peak in May 1953 through the trough and back to the 1953 levels has taken nearly two years.

(1) The seasonally adjusted index of Fourth District department store sales, which is depicted in two of the accompanying charts, embodies certain tentative revisions of seasonal adjustment factors, based on data drawn from recent years. Announcement of the detailed changes in the seasonal patterns is planned for a subsequent issue of this *Review*.

Fourth District department store sales have been rising since May, 1954; however, 1953 levels were not reached again until April of this year. Stocks are about at their year-ago position.



Fluctuations in new orders placed by department stores of this district have been fairly close to the pattern of sales.

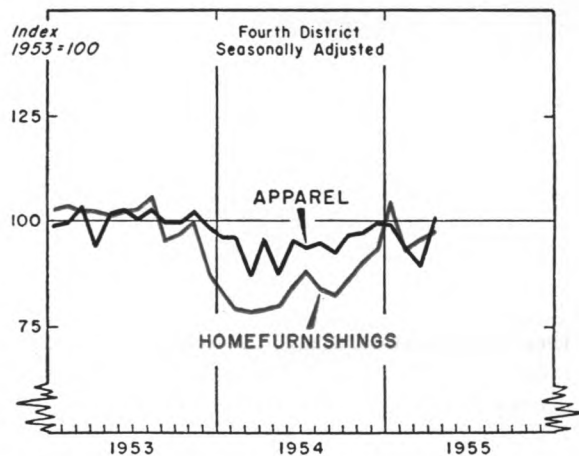


The brisk Christmas season last year raised the level of sales to its highest point for 1954, and the strong Easter trade in April, after a rather poor March, succeeded in raising the level of adjusted sales to the highest point so far in 1955. The lift of sales in the two holiday seasons provided much of the strength of the recovery that has already been made. The present sales level suggests that during the remainder of 1955 the stores should not find great difficulty in equaling or surpassing the targets of *both* previous years.

A prominent feature of department store trade since 1953 has been the orderly and conservative handling of inventories. Wide fluctuations in end-of-month stocks and periods of rapid liquidation have been conspicuously absent.

Inventories (seasonally adjusted) were higher in the latter part of 1953 than they had been during the spring; however, by the end of the first quarter of 1954, the level of stocks had eased about 5 percent from the 1953 average level, as may be seen by the colored line of the chart. Since then, stocks have shown little net movement on a seasonally adjusted basis. So far in 1955 they appear conservative in relation to sales. The orderly pattern of stocks since 1953 has held for most of the

Sales of homefurnishings early in 1954 dropped more than 20% below the 1953 average; since then, they have recovered sharply. Apparel sales have fluctuated less widely.



individual departments of both apparel and homefurnishings.

New Orders

New orders placed by department stores dipped sharply in late 1953. Since then, they have followed the sales pattern fairly closely, as shown by the accompanying chart.⁽²⁾ Since last December, new orders have been at a level approximately 5 percent below the 1953 average, although in the latest month for which data are available, new orders turned sharply upward and approached the levels reached in the spring of 1953.

Apparel and Homefurnishings Sales

Not since the scare-buying days of the Korean War have sales trends in homefurnish-

(2) The "new order" series shown in the chart is derived by combining information on outstanding orders, inventories and sales as supplied each month by a substantial group of cooperating department stores. The sales index depicted in the same chart is based on a somewhat larger sample of reporting stores.

Both series in this particular chart are seasonally adjusted and are smoothed by use of three-months' moving averages. Latest entry for new orders is the moving-average value for February 1955, based in part on March data. (The sharp upward movement in new orders during March is thus not fully reflected in the chart.) Latest entry for the sales index is the moving-average value for March, based in part on April data.

ings differed from apparel sales as greatly as they did in 1954. Homefurnishings sales in 1953 had followed an even course until September, but subsequently, sales went into a decline so that March of 1954 found them 25 percent below the peak reached in the year before, after seasonal adjustment. Apparel sales declined, too, but much less sharply. They reached the bottom of their descent in March 1954 at a level approximately 15 percent below the 1953 highs.

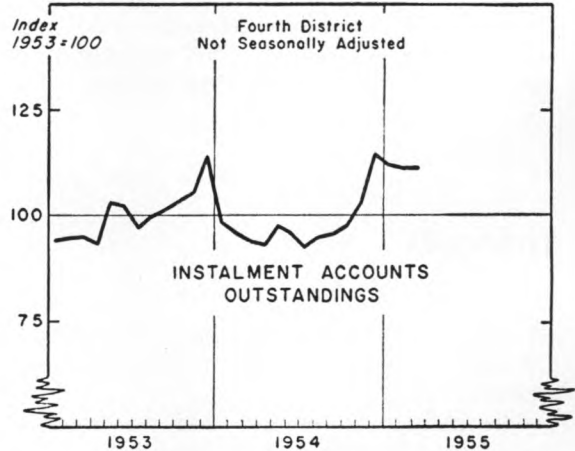
Since the spring of 1954, sales of both homefurnishings and apparel have been on an upward path. Apparel sales recovered much of their lost ground during the strong Christmas season last winter; however, a poor showing during the first quarter of 1955 nearly erased the gains of the previous three months. Very brisk Easter trade finally boosted the apparel departments' sales above 1953 levels.

Sales of homefurnishings so far this year have shown exceptional gains from a year ago. Some of the strength of the plus signs is, of course, due to the depressed levels of early 1954. The adjusted index of homefurnishings sales, through April of this year, has not yet exceeded the average level of 1953 in any month subsequent to that year, with the single exception of January 1955. (Sales in January may have been "borrowed", in part, from the traditional February promotions, as a result of an early start in advertising.) Reports for April, after seasonal adjustment, place homefurnishings sales only 3 percent below the 1953 average.

In the face of a considerable decline in sales volume, prices of homefurnishings showed some downward movement last year, although the average decline for the group appears to have amounted to only about 2 percent from January 1954 to January 1955, judging by official estimates of nationwide trends in department store prices.⁽³⁾ Some individual lines in the group were reduced greatly in price. For example, prices of items sold in the radio and television department declined by an

(3) Based on the department store inventory price index issued by the Bureau of Labor Statistics, U. S. Department of Labor. These figures do not necessarily apply to prices charged by Fourth District stores, although they are suggestive of the major trends.

Instalment-accounts outstandings last December were slightly higher than a year ago. They did not decline by the usual seasonal amounts in January, however, and have remained at high levels since then.



average of 9 percent during the year, while, on the other hand, average prices of householdwares increased slightly. Appliances, along with most other large items such as furniture, declined by 2 percent to 4 percent, according to these estimates of national trends in department store prices. Prices in the apparel and other soft-goods departments of department stores were under less downward pressure during the year and the drop in prices averaged only 1 percent for those departments.

Instalment Credit

During the spring of 1954, sales transacted on an instalment account basis in the District shrank considerably, not only in absolute dollar volume, but also as a proportion of the declining total sales. The decline in instalment account sales closely matched the drop-off in homefurnishings sales, both as to timing and as to severity.

The share of the total represented by charge-account sales has not changed much in the interval since 1953; it has continued to account for approximately half of all sales in the department stores. As a result of the decline

in importance of instalment sales, cash sales accounted for an enlarged proportion of total sales during most of 1954.

With the recovery in total sales, and home-furnishings in particular, the use of credit at department stores has been increasing again. Last December, instalment accounts reached a level 14 percent above the 1953 monthly average, although this position must be discounted

for seasonal factors. In the early months of 1955, the volume of instalment sales, as well as outstandings, failed to decline by the usual seasonal amount. Outstandings in January 1955 were 15 percent higher than in the year-ago month and 19 percent greater than in January 1953. (See chart.) In more recent months, the level of outstandings has remained nearly constant.

TITANIUM

Continued from Page 6

offs for new facilities and agrees to purchase the bulk of the new plants' output at market prices.

The industry's research and development costs have also been partly borne by Federal funds. The Bureau of Mines began operating a pilot sponge plant in 1945 on an experimental basis. One of the latest steps in this direction was the establishment of a metallurgical laboratory at a private, nonprofit research institute in Columbus, Ohio. Operated under contract with the Defense Department, the new laboratory will act as a clearing house, providing free technical information to industry on the production and use of titanium in military equipment.⁽²⁾ Also, the Defense Department and industry representatives agreed

(2) The laboratory is operated by Battelle Memorial Institute.

in April on a new program for expanding research, development and experimental uses of titanium.

Progress is expensive. One expert, figuring research, engineering, development and production costs, estimated that the Air Force has spent about \$200 a pound for the titanium flying in military aircraft today. Military requirements justify the high costs, but progress made in defense applications of the metal will open new possibilities for civilian uses and help lower its prices.

Note on Sources:

Technical, statistical and descriptive material were obtained from the following sources: U. S. Bureau of Mines, *Minerals Yearbooks* and *Mineral Market Reports*; *Iron Age*; *Steel*; and Republic Steel Corporation, *The Titanium Industry in the United States and Republic Titanium and Titanium Alloys*.

FOURTH FEDERAL RESERVE DISTRICT

