

T.I.C. symposium

In 1988 the Tantalum-Niobium International Study Center is organising a technical symposium which will certainly interest everyone concerned with tantalum and niobium.

Papers to be presented will cover production, processing, applications and marketing of the two metals. The programme will be complemented by social events such as a banquet, a cocktail party and sightseeing tours for accompanying ladies, and will include the Twenty-ninth General Assembly of the association. The conference is being sponsored by a number of the principal companies in the industry.

The symposium will be held on November 7th, 8th and 9th 1988 at the Stouffer Orlando Resort, Orlando, Florida. All those interested are welcome to attend; participation is not limited to T.I.C. member companies. Anyone wishing to offer to present a paper is invited to contact the T.I.C.

Further information, and registration forms, may be obtained from the Secretary General, T.I.C., 40 rue Washington, 1050 Brussels, Belgium.

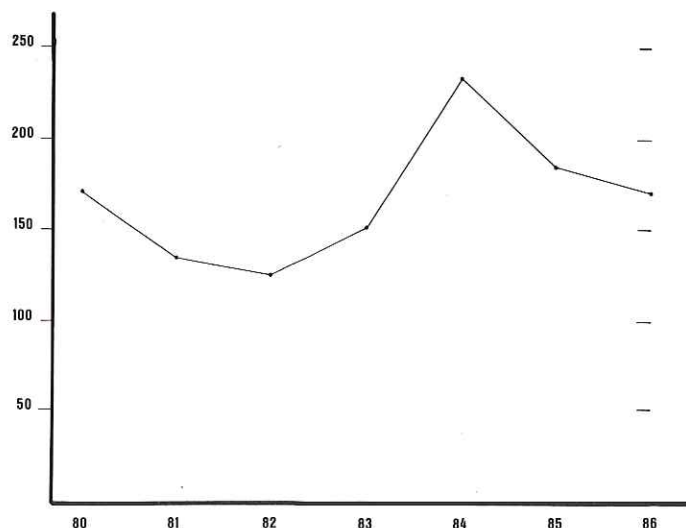
The market for tantalum and niobium in Japan

Demand for tantalum and niobium in Japan has increased at a faster rate than total world consumption over the last two decades, primarily due to the growth of the electronics industry. However, the market in Japan is of a smaller size than the markets in either Europe or the U.S.A. Japan is still a net importer of tantalum and niobium products with no significant exports.

TANTALUM DEMAND

Consumption in Japan was 170.0 tonnes Ta in 1986, down by 7 % from 1985. This demand was divided into : 85.1 tonnes in powder, 50.3 tonnes in compounds, and 34.6 tonnes in other products, mainly capacitor wire and foil. Of this quantity, 48.2 tonnes (around 28 %) was imported. Total demand in 1987 is forecasted to be 133.4 tonnes Ta, the decrease being due to such factors as the usage of high-charge capacitor powders, the longer life of capacitor sintering furnaces because of lower sintering temperatures, and the replacement of tantalum carbides by mixed carbides in cutting tools.

Japanese demand for tantalum (tonnes Ta)

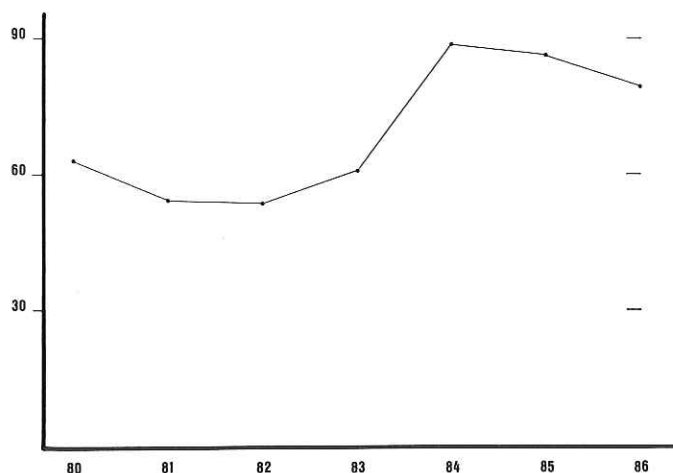


Therefore over 90 % of Japanese usage is accounted for by capacitors and cemented carbides. There is a small demand from chemical, electronic and nuclear equipment, but almost none from superalloys — Japan has no significant aerospace industry. A small and probably declining quantity (less than five tonnes Ta contained) of high-purity oxide is shipped each year for optical lenses.

NIOBIUM DEMAND (NON-FERROUS)

As stated previously, Japan has no major aerospace industry, so demand for superalloy additive is small. The major non-ferrous uses for niobium lie in : optics, ceramic capacitors and electro-optics requiring extra-purity oxides; cemented carbides; and niobium-based alloys for superconducting and anti-corrosion applications. In 1986, non-ferrous demand was estimated at 79 tonnes Nb divided into : 52 tonnes in oxide, 10 tonnes in carbide, and 17 tonnes in alloys (almost all of these alloys were imported from one U.S. producer).

Japanese non-ferrous demand for niobium (tonnes Nb)



A new use for niobium which is being developed in Japan is for the catalysis of organic chemical reactions. The catalyst is in the form of niobic acid (a solid compound). In 1988, a major chemicals company in Japan will begin using niobic acid supplied by CBMM Orient for what is believed to be the first industrial application of a niobium compound in catalysis.

JAPANESE PRODUCERS

The established tantalum powder producer and the major supplier to the Japanese market is **Showa Cabot Supermetals**, a joint venture between Showa Denko and Cabot Corporation (U.S.A.) established in 1972. The plant in Fukushima Prefecture produces capacitor powder by the sodium reduction of imported potassium fluotantalate. In 1986, a new powder plant was built to replace the existing one; plant capacity was maintained at 100 tonnes Ta a year. Showa Cabot also sell tantalum and niobium products from Cabot Corporation in the Japanese market.

By a combination of electron-beam and vacuum arc melting, **Vacuum Metallurgical Company (VMC)** produce tantalum ingots which are further processed into capacitor-grade foil and wire and various metallurgical-grade mill products. VMC also fabricate tantalum components for chemical, electronic and nuclear equipment, as well as importing tantalum powder from NRC Inc. (U.S.A.). The VMC plant in Chiba Prefecture was built in 1972.

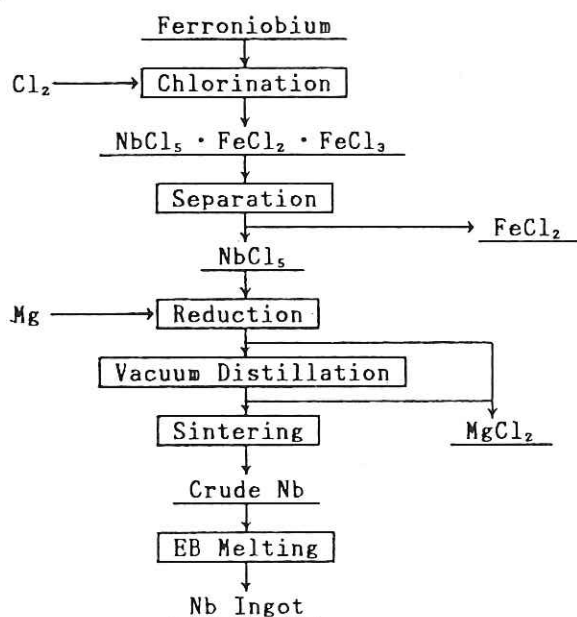
In 1986, **V-Tech Fansteel**, a joint venture between V-Tech Corporation and Fansteel Inc. (U.S.A.), began pilot-plant production of tantalum powder in Japan. By the end of 1987, a plant with the capacity to produce 20 tonnes Ta a year will be operating in Ibaraki Prefecture. Imported potassium fluotantalate will be the starting material for the plant.

Mitsui Mining & Smelting are the sole producer of tantalum and niobium compounds in Japan. Tantalite-columbite concentrates are

converted into oxide by the acid digestion/solvent extraction route, the latter step using the column method not the usual mixer-settler method. Products include: tantalum and tantalum-niobium carbides; optical- and ceramic-grade (99.9 %) oxides; and an even higher grade of oxide (99.99 %) for electro-optic applications. The maximum annual output of the plant in Fukuoka Prefecture is around 90 tonnes of tantalum oxide, 90 tonnes of niobium oxide, 40 tonnes of tantalum carbide, and 25 tonnes of tantalum-niobium carbide.

A major titanium producer, **Toho Titanium**, developed in 1986 a process to convert ferro-niobium into niobium ingot, with the aim of satisfying Japanese demand for niobium-based superconducting alloys which they anticipate will increase. A full-scale facility being planned will be capable of producing 20 tonnes Nb a year. The process involves the chlorination of ferro-niobium at 800 °C to yield iron and niobium chlorides. The chloride mixture is heated at 350 °C to vaporize the niobium chloride which is then reduced to metal lumps by magnesium in a reactor. The lumps are sintered into bars and melted in an electron-beam furnace to produce niobium ingot.

Toho Titanium's route for niobium ingot



Analysis of niobium products (maximum ppm)

| | Lump product | Ingot |
|----|--------------|-------|
| O | 1200 | 80 |
| N | 670 | 80 |
| C | 800 | 55 |
| H | 10 | 10 |
| Fe | 450 | 15 |
| Ta | 1400 | 1000 |
| W | 110 | 110 |
| Zr | 10 | 10 |
| Ni | 80 | 10 |
| Mo | 10 | 10 |
| Si | 50 | 50 |
| Al | 420 | 20 |

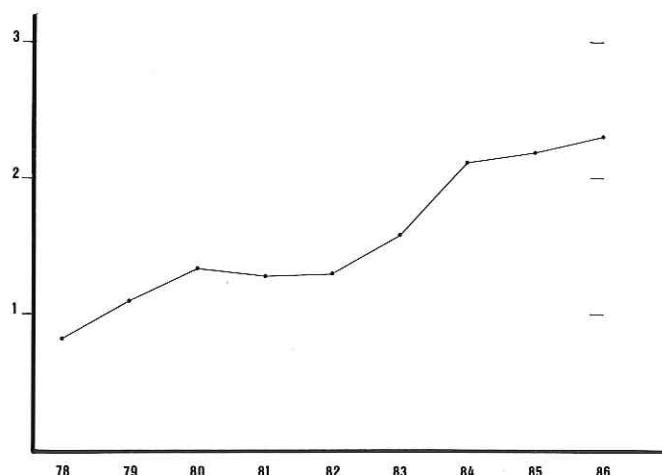
TANTALUM CAPACITORS

In Japan, the major market for tantalum capacitors lies in consumer electronics for such items as video and tape recorders, cameras and car stereo systems; this contrasts greatly with the markets in Europe and the U.S.A. which are mostly oriented towards industrial electronics. Because of this factor, most devices are of the smaller-sized variety, mainly resin-dipped capacitors which gained importance during the 1970's. More recently, the onset of surface-mounting technology in circuit assembly has led to chip devices gaining around 25-30 % of the Japanese market for tantalum capacitors.

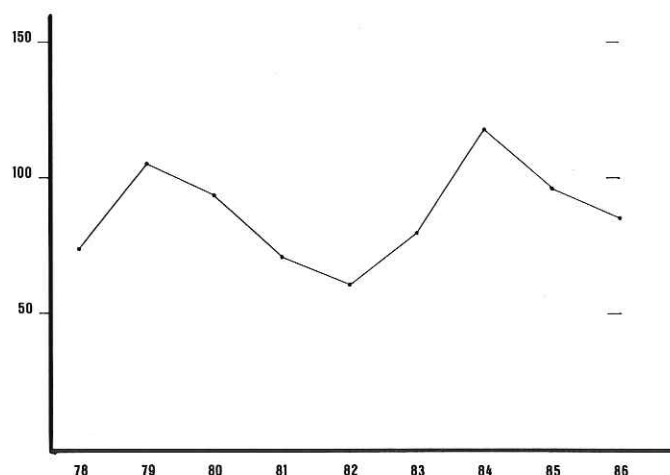
Growth during the 1980's has so far been cyclical but has averaged around 15 % a year. Future growth is expected to average less than 10 % a year, mostly being absorbed by chip devices. The Japanese tantalum capacitor industry exports 20-25 % of its production. Imports of tantalum capacitors are negligible.

Electronic capacitors account for over 60 % of Japan's tantalum consumption when wire (equivalent to around 25 % of powder demand) and foil shipments are included with powder shipments.

Japanese tantalum capacitor production (billion units)

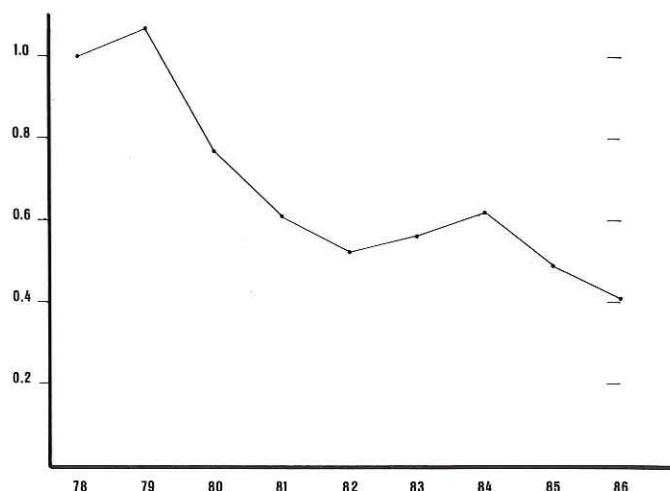


Japanese tantalum powder demand (tonnes Ta)



There has been a gradual reduction over the years in the indexed ratio (from 1978) of powder demand to capacitor production. Doubtless a large part of this originates from the use of high-charge powders leading to a smaller anode size (this trend is expected to continue), but some can be attributed to the increased importance of the smaller-sized resin-dipped and chip devices at the expense of the larger-sized molded and metal-cased devices.

Ratio (indexed from 1978) of powder demand to capacitor production

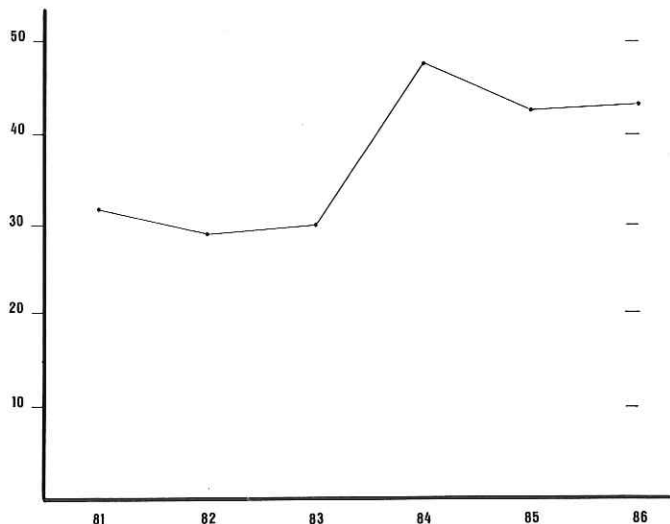


CEMENTED CARBIDES

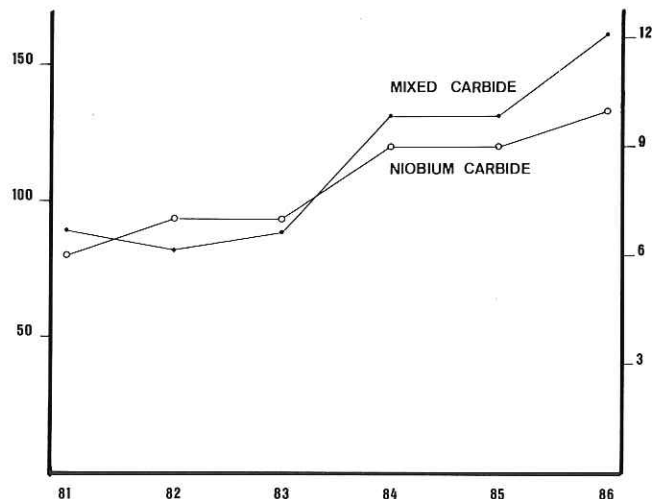
Since 1980, cemented carbide production in Japan has increased at 5-10 % a year. The demand for single tantalum carbide has increased at a slower rate indicating a trend away from its use. Over

the same period, mixed carbides, such as WC-TaC-NbC, have gained remarkably : consumption almost doubled. This trend is mirrored in the increased demand for niobium in these mixed carbides.

Demand for single tantalum carbide (tonnes)

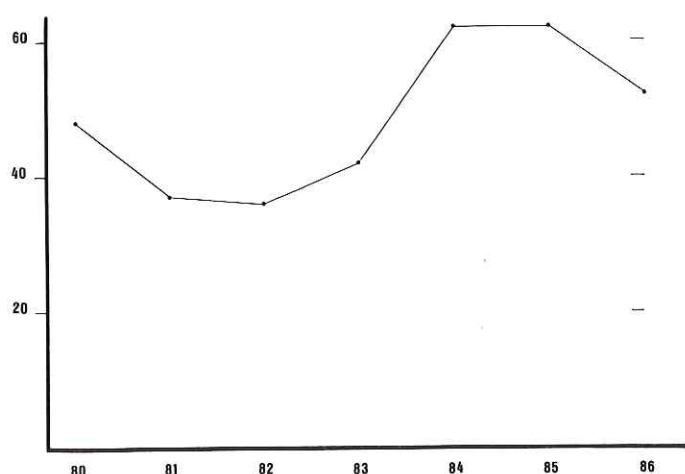


Demand for mixed tantalum carbide (left-hand scale, tonnes) versus niobium carbide (right-hand scale, tonnes) — a very close correlation



Future growth rates for cemented carbides are expected to be below 5 % a year and even to turn negative as ship-building and car production capacities are reduced. One forecast is that total cemented carbide output will be 10-15 % lower within five years than at present.

Demand for niobium oxide in Japan (tonnes Nb)



OPTICS AND ELECTRONICS

The market for extra-purity oxides is the major non-ferrous one for niobium in Japan but a small one for tantalum. Around 50-60 tonnes Nb a year are consumed by this market, significantly for ceramic capacitors and optical lenses with a small quantity (a few tonnes a year) for lithium niobate, an electro-optic material.

Purities of 99.8-99.9 % are required for ceramic and optical applications. Electro-optics requires an oxide grade of at least 99.99 %.

Specification for extra-purity niobium oxides from Mitsui Mining & Smelting (maximum ppm)

| | Optical | Ceramic | Electro-optical |
|--------------------------------|---------|---------|-----------------|
| Ta ₂ O ₅ | 1000 | 1000 | 20 |
| Fe ₂ O ₃ | 20 | 20 | 5 |
| SiO ₂ | 200 | 200 | 10 |
| Al ₂ O ₃ | 15 | 20 | 5 |
| TiO ₂ | 10 | 10 | 5 |
| NiO | 10 | 10 | 5 |
| SnO ₂ | 10 | 10 | 5 |
| Cr ₂ O ₃ | 10 | 10 | 5 |
| MnO | 10 | 10 | 5 |
| L.O.I. (%) | 0.2 | 0.3 | 0.1 |
| Average particle diameter (μm) | — | 0.7-1.5 | — |

It is believed that the demand from ceramic capacitors has remained stable at 20-25 tonnes Nb a year since 1980. There are three main areas of application : barium-titanate-based multi-layer capacitors (MLC's) for grain-growth control and modification of electrical characteristics; strontium-titanate grain-boundary barrier-layer capacitors for grain-growth control; and lead-based dielectrics for MLC's in contents of up to 20-25 %. The second application is practised primarily by one Japanese manufacturer, Taiyo Yuden, and thought to be increasing. The last application, lead-based dielectrics, is recent and has the potential to increase current niobium oxide usage several times over. Because of size and cost advantages, up to 20-30 % of the total MLC market could be gained by these lead-based dielectrics within three to five years.

The optical demand probably doubled between 1982 and 1984 as niobium oxide replaced the then expensive tantalum oxide and began to be used for light-weight ophthalmic lenses. Other important markets lie in camera and photocopier lenses. No dramatic growth in the optical market is foreseen.

RAW MATERIAL SUPPLY

Japanese producers generally prefer to purchase ore concentrates directly from miners rather than through traders. In 1985, large quantities of columbite concentrates were imported from Brazil (90 tonnes) and Nigeria (125 tonnes); this material was probably a tin-mining by-product.

The Metal Mining Agency of Japan, a governmental organisation, recently reached a five-year joint exploration agreement with the People's Republic of China. The minerals included tantalum and niobium in deposits along the southern coast of Guangdong province. The MMAJ will provide technical assistance in exploration and mineral separation.

The MMAJ is also participating in a joint venture with the Thai Department of Mineral Resources to perform a study on the extraction of tantalum-niobium minerals from tin-mining waste ('amang'). A pilot plant was due to be completed by March 1987 in Bangkok.

Kokan Mining, an affiliate of the Japanese steelmaker Nippon Kokan, are to begin mining tin-tantalum deposits in the Pilbara region of Western Australia in 1987. This is a joint venture with Greenbushes.

SUMMARY

There is a healthy and stable market for tantalum and high-purity niobium in Japan supplied by domestic and foreign producers. Although the demand for tantalum capacitors is likely to continue increasing, tantalum metal sales will not rise proportionally because of the use of high-charge powders. The cemented carbide manufacturers will tend towards using mixed carbides, such as WC-TaC-NbC, rather than single tantalum carbide in the future. The demand for ceramic-grade (99.9 %) niobium oxide for capacitor applications will probably grow significantly within the next few years.

Andrew Jones
Technical Officer

Twenty-eighth General Assembly

This meeting was held at the International Association Centre, Brussels, on October 20th 1987.

The members of the Executive Committee were re-elected for a further term of office of one year. Mr Hans-Jürgen Heinrich, Gesellschaft für Elektrometallurgie, was elected President for 1987-88, succeeding Mr Rod Tolley, Datuk Keramat Smelting.

Two companies were elected to membership of the T.I.C. :

- Anglovaal Ltd., a South African company, investigating the possibility of extracting tantalum and niobium from low-grade tin slag produced in South Africa;
- NEC Corporation, a leading manufacturer of tantalum capacitors in Japan.

The total membership of the association then stood at sixty-eight companies.

The General Assembly approved two modifications to the Charter. The first allows the association to choose to hold only one General Assembly in a calendar year, while also permitting a greater number of meetings if these are required. The second makes it possible for a corporate member to designate a suitably qualified person to be a candidate for membership of the Executive Committee, in addition to nominating a delegate to represent it as the authorised representative of the company. The audited accounts for the year ended June 30th 1987 were also approved.

It was announced that a major symposium on tantalum and niobium would be held in Orlando, Florida, from November 7th to 9th 1988. The T.I.C. will be organising this event which will be open to anyone with an interest in the two metals (see announcement on the front page of this issue). Sponsorship is being sought from companies with involvement in tantalum and niobium.

The Technical Officer then reviewed some of his activities : monitoring the supply and demand situation for tantalum and niobium; investigating potential new uses through published literature and correspondence; and disseminating this information by answering inquiries and preparing various articles for publication.

After the General Assembly, presentations were made by Mr Jean Levasseur, Sprague France, on "New developments in tantalum capacitors — business situation", by Mr Theo De Cleyn, Metallurgie Hoboken-Overpelt, on "Metallurgie Hoboken-Overpelt and its present activity in the field of tantalum and niobium", and by Mr Andrew Jones, T.I.C. Technical Officer, on the supply and demand situation.

MEMBERSHIP

Two companies were elected to membership by the Twenty-eighth General Assembly :

Anglovaal Limited,
Anglovaal House,
56 Main Street,
Johannesburg 2001, South Africa.

NEC Corporation,
1120 Shimokuzawa,
Sagamihara,
Kanagawa 229, Japan.

Resignations from three members were accepted :

Coframines
Derek Raphael and Co.
Samincorp

President's letter

Happy new year to the tantalum and niobium family and all our friends from our T.I.C. staff and from myself !

We all hope that it will be a good one for everybody, business-wise and because we are looking forward to a very important event : our International Symposium on Tantalum and Niobium.

In this context we have made some progress in the organisation and the program itself. More detailed information will be sent around during the next weeks and give you the background to promote plentiful assistance to the symposium.

We are still looking for additional papers to make this event more attractive. I shall ask all of you to contribute to our efforts to ensure the symposium's professional success.

Yours sincerely,
H.J. Heinrich
President

New developments in tantalum capacitors' business situation

This paper was presented by Mr Jean Levasseur, Sprague France, at the T.I.C. meeting in Brussels on October 20th 1987.

During the last three years, the worldwide tantalum business has followed almost exactly the forecasts and trends announced at the time by different speakers at T.I.C. meetings. The major factors contributing to this situation have been :

- a relative stability of the business in general — but no significant growth;
- the average price of tantalum also remaining relatively stable.

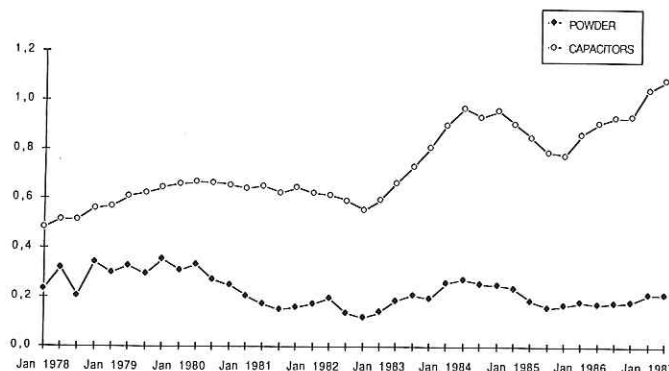
This statement leads to the question whether the future years will see a continuation of this trend or if some particular events could bring significant changes in the market. There are numerous parameters which could effect a turn in the tantalum capacitor market : development of the worldwide market; powder usage; technical improvements; competition from other capacitor technologies; changes in end equipment; and prices of ore concentrates and powder.

DEVELOPMENT OF THE WORLDWIDE MARKET

A chart representing the worldwide capacitor and powder markets since 1978 shows clearly two different periods :

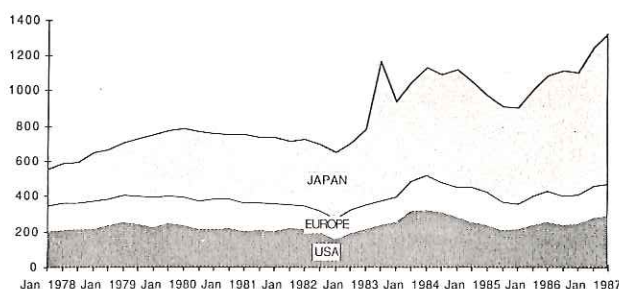
- The first period of 1978 to 1982 was very stable in terms of the number of pieces, but at the same time powder consumption was declining strongly; this was as a result of a desperate effort to reduce the cost of materials (powder and wire) following the strong increase in tantalum prices at the beginning of this period.
- The second period, 1983 to the present, showed a relatively constant increase in the number of units and a stability in powder consumption. The explanation is rather simple : more capacitors per pound of powder; increased usage of smaller-sized capacitors.

World shipments by quarter of tantalum capacitors (billion units) and powder (million lb Ta)



The increase in smaller-sized pieces has been the most significant in Japan. The two other important production areas, North America and Europe, seem to be more traditional and have been slower to adopt the smaller-sized capacitors, particularly chip devices.

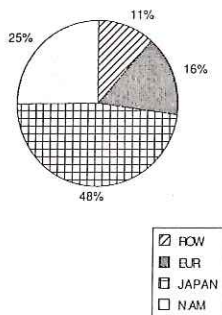
Regional tantalum capacitor production by quarter (million units)



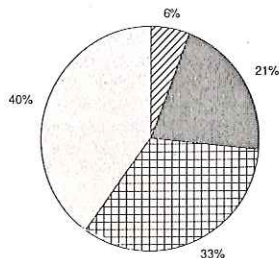
From a comparison of tantalum capacitor shipments by region (to Europe, Japan, North America and the rest of the world) in both units and dollars, it is easy to state that the cost per unit, in direct relation with size, is higher in Europe and North America than in Japan and the rest of the world.

Unit shipments compared to dollar shipments (tantalum capacitors)

WORLD UNIT TANTALUM SHIPMENTS
February ytd, 1987



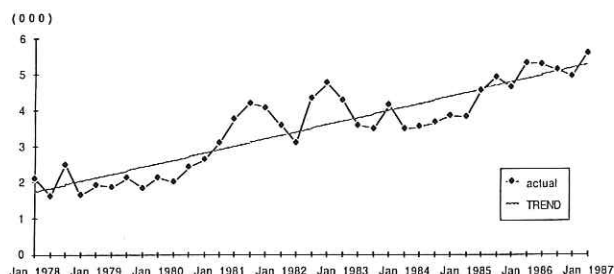
WORLD DOLLAR TANTALUM SHIPMENTS
February ytd, 1987



POWDER USAGE

The powder manufacturers have made considerable efforts in increasing the "CV/gram" performance of powders; the consequence is a general increase in the number of capacitors per pound of tantalum.

Capacitors (thousand units) per pound of powder



However, two different factors are causing this trend : a reduction in powder usage (higher CV) for larger-sized devices; and a reduction in the size of capacitors developed with new high-CV powder. Unfortunately, the available statistics do not allow an examination of the split between the two factors; it would be very significant to obtain this information.

TECHNICAL IMPROVEMENT

The major changes in modern electronics are obviously oriented towards miniaturization. Research is continuous, and the results are to be seen almost every quarter.

The evolution of circuit assembly, starting from the classical leaded-component insertion, has seen a significant improvement in the use of both leaded and surface-mounting components, an excellent compromise for today, and finally the 100 % surface-mounted substrate, on both sides.

This trend is due to chip application in the different segments of the European market : hybrids, military, automotive, industrial and telecommunications/computers.

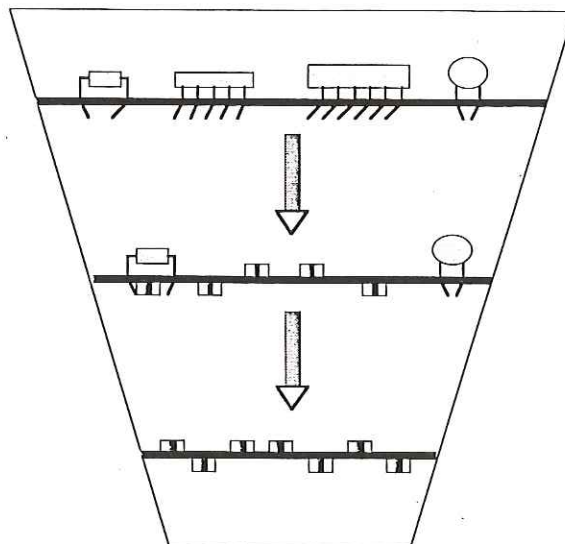
Sprague were the first company in the world to develop a surface-mounting tantalum chip in the early 1970's and are now offering a broad range of this product family, while still developing new ones. Sprague are in the unique situation of having tantalum capacitor facilities in U.S.A., Canada, Japan (the joint venture Nichicon-Sprague) and Europe, where the Tours plant is one of the most important European manufacturers.

The latest "192D" tantalum chip has the advantage over the established "293D" lead-frame molded chip in allowing the possibility of using a much larger anode in the same case size — what is called "extended-range" rating — or reducing the case dimensions for the same ratings. A particular application is in medical devices like hearing aids, for instance.

COMPETITION FROM OTHER CAPACITORS

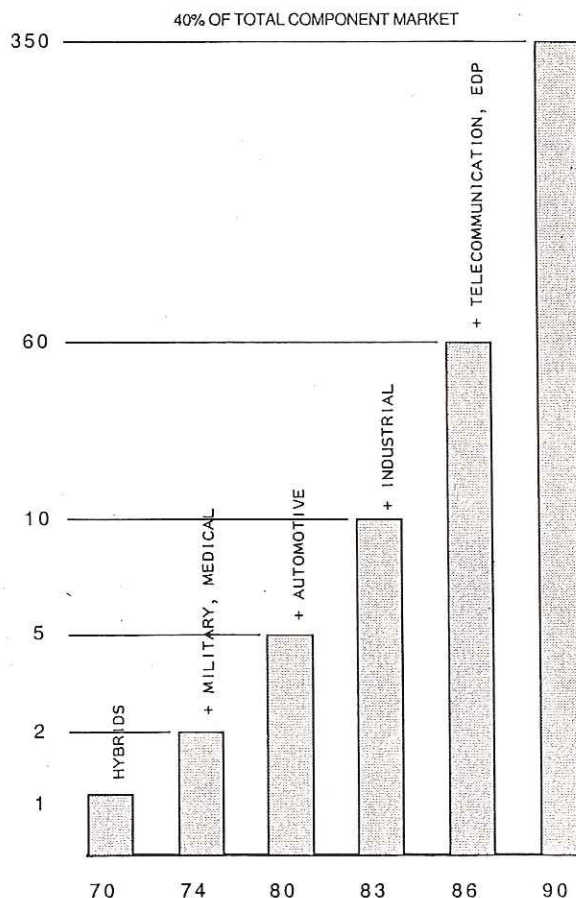
It is well known that there are many dielectrics usable for electronic capacitors. Ceramic chips above 1 μ F become larger and more expensive than the tantalum chip. Aluminium chips have a lower volumetric efficiency; the aluminium technology seems difficult to adapt to surface-mounting devices, while all electrical parameters are inferior to the tantalum's.

Assembly evolution : from leaded to surface-mounted



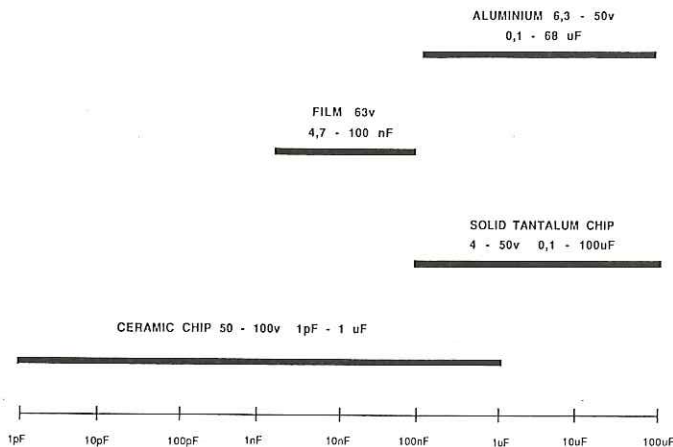
GAIN OF SURFACE.
TWO SIDED MOUNTING.
INCREASED MOUNTING SPEED.
REDUCED COST.
INCREASED CIRCUIT RELIABILITY.
INCREASED CIRCUIT YIELD.

Tantalum chip market evolution in Europe (million units per year)

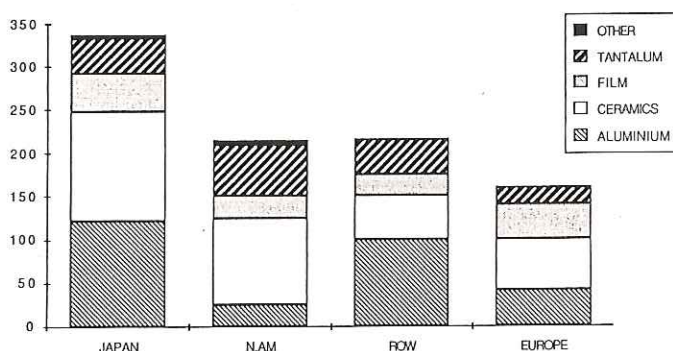


In 1987, tantalum devices accounted for 3.2 % of total world capacitor unit sales, equivalent to 14 % of total dollar sales. So tantalums have an important market share in terms of dollar sales but expansion is certainly limited by their cost, while the other advantages of tantalums should give them priority; these are excellent reliability, temperature stability, and leakage-current performances.

Chip capacitor comparisons - capacitance and voltage ranges



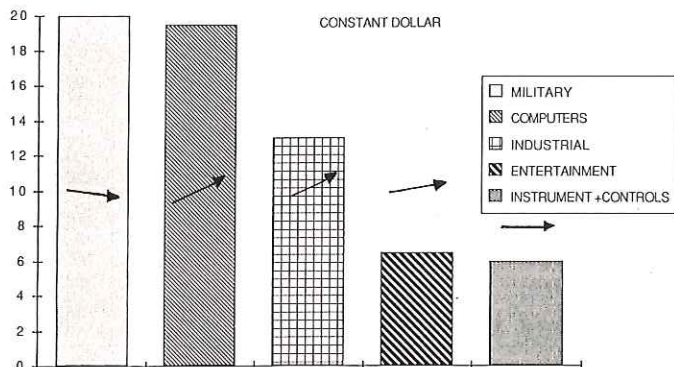
World dollar capacitor sales by region - February year-to-date, 1987 (million dollars)



CHANGES IN END EQUIPMENT

The trend today in military equipment is certainly towards stability, with maybe a decrease. Computers are becoming more and more widespread but will look for the cheapest component prices. The industrial sector is likely to be a very "loyal" market for tantalums, because both high quality and reliability are necessary as well as reasonable price. Entertainment remains a considerable user of tantalum capacitors, particularly for smaller-sized parts, and Japan is presently the leader. The instruments and controls market requires high performance — price is a lesser factor.

End equipment growth rates 1975-85 (average per cent per year) — the arrows indicate the future trend



PRICES OF ORE CONCENTRATES AND POWDER

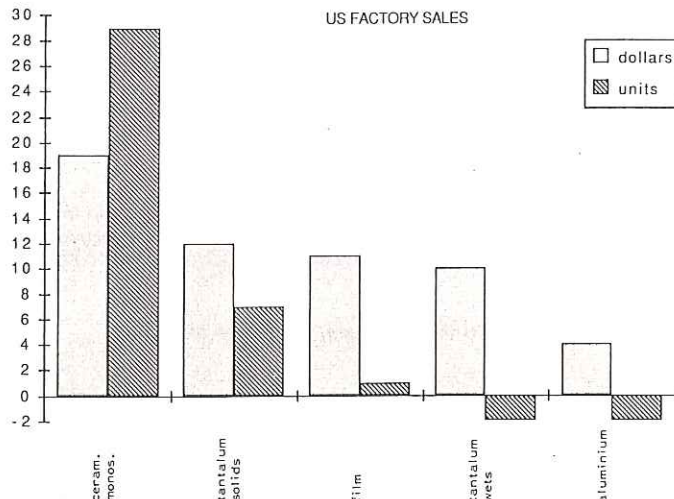
This subject has been studied in previous presentations, and the fact should be stressed that both solid and wet tantalums still have an exciting future, assuming ore concentrate prices remain moderate or become lower.

Ceramic capacitors have the largest growth both in units and value. This competition is very important for tantalum capacitors in the low-capacity range; but it is a two-way competition as tantalum chips are able to compete very well against ceramics at the higher-capacitance values.

It is interesting to notice that wet tantalums are going to use more tantalum, as silver cans will be progressively replaced by tantalum cases.

Other capacitor types have far fewer growth opportunities, and this is why every effort must be made in order to increase tantalum's share of the electronics business.

Capacitor growth rates 1975-85 (average per cent per year)



CONCLUSION

The capacitor industry will ship around 125 billion units in 1987 valued at 5.5 billion dollars. The average price per capacitor is only 4.4 cents — mix change resulting in more ceramics reduced the average from 5 cents several years ago.

Aluminums and ceramics account for 70 % of dollar and 85 % of unit capacitor shipments. In this context, tantalums are truly specialty capacitors selling at roughly four times the average industry price. Even in the "rest of the world" markets, tantalums sell for nearly 10 cents.

Because of the new surface-mounting technologies, and assuming that the capacitor manufacturers are developing smaller parts which are easier to automate and thus relatively cheaper, further development of tantalum usage by larger-volume sales can be expected.

Pyrochlore in the Motzfeldt Centre, southern Greenland

During 1986, the Geological Survey of Greenland released the final report of their investigations of the niobium-tantalum occurrence in southern Greenland known as the Motzfeldt Centre. Field trips to the area between 1984 and 1986 provided rock samples for analytical, petrographic and mineralogical examination. The European Economic Community provided 50 % of the costs.

The Motzfeldt Centre is one of the major central complexes in the Gardar Province of alkaline igneous activity. It is made up of multiple intrusions of syenite with a wide range of textural and compositional characteristics. The syenites were emplaced as two main igneous phases into the Proterozoic Julianehab Granite and the overlying Gardar supracrustal rocks.

The syenites of the early igneous phase occur as isolated bodies which are truncated by the syenite units of the main igneous phase - the Motzfeldt Ring Series. The bulk of the Motzfeldt Ring Series constitutes four major, steep-sided, outward-dipping intrusions of predominantly peralkaline syenite and nepheline syenite which young inwards. The apparent intrusion mechanism was a combination of ring fracture and block subsidence.

Large quantities of the roofing sandstone and volcanics have been incorporated into the outermost unit of the Motzfeldt Ring Series — the Motzfeldt So Formation — where they are preserved as large rafts. The sandstone has, however, been largely assimilated and has given the outer zone of the Motzfeldt So Formation its unique (for the Centre) quartz character. The Motzfeldt So Formation underwent an

extreme in-situ differentiation, probably due to the effective crystal fractionation, which resulted in the formation of peralkaline residua, rich in volatile and incompatible elements. The peralkaline residua gave rise to a complex of late peralkaline sheets of microsyenite, pegmatite and hydrothermal alteration with associated Th-U-Nb-Ta-Zr-REE mineralisation which increases in intensity towards the margins and especially the roof of the intrusion. The mineralisation is probably the result of the combination of an incompatible-element/volatile-enriched magmatic residuum and an influx of silica and meteoric water, which resulted in a dramatic increase in oxygen fugacity, acidity and hydrothermal activity. A volatile-saturated outer shell developed which facilitated the migration, accumulation and precipitation of the incompatible elements.

View of the Motzfeldt Centre



Pyrochlore is the most important economic mineral phase. It is associated with zircon thorite and rare-earth silicates and carbonates. The pyrochlore, characterised by the enrichment of lower rare-earth elements, tantalum and uranium, shows a marked compositional variation depending on its relative depth in the Motzfeldt Formation. The tantalum content and the $\text{Nb}_2\text{O}_5/\text{Ta}_2\text{O}_5$ ratio vary in wide limits, from 1.5 to 10.0 % Ta_2O_5 and from 8 to more than 50 respectively. The pyrochlore at the deeper levels is enriched in tantalum and calcium, whereas the pyrochlore of the higher levels of the igneous column is more enriched in niobium, uranium and lower rare-earth elements.

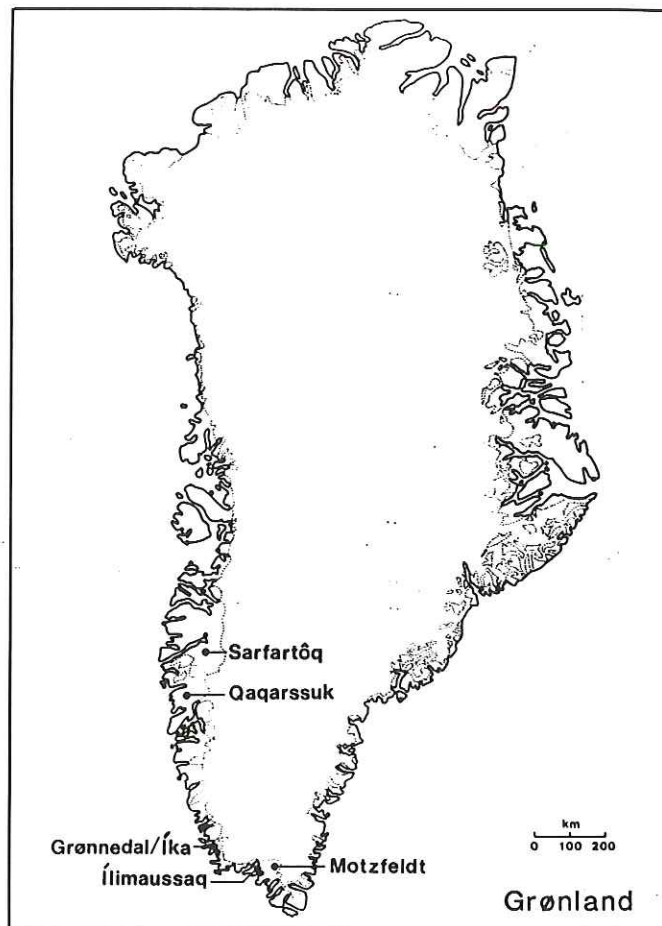
The evidence to date indicates that the niobium content in the mineable rock of the MSF falls between 0.4 and 1.0 % Nb_2O_5 and the ore reserves in the selected localities are tentatively estimated at 130 million tonnes. These rock volumes may contain minor mineable bodies of higher grade (1.0-1.5 % Nb_2O_5 and 0.08-0.15 % Ta_2O_5).

The mineralisation in the peralkaline microsyenite, here estimated at 80 million tonnes of sufficient niobium grade, has a fairly modest tantalum content which in most cases is below 0.03 % Ta_2O_5 . The mineralisation in the MSF-altered syenite is far more attractive as a source of tantalum: the grades in the mineable units can be expected to fall within 0.03-0.10 % Ta_2O_5 and the estimates of the mineable rock volumes in this class total around 50 million tonnes. From the mineral dressing point of view, the mineralisation in the peralkaline microsyenite is almost certainly more problematic due to the fine grain size and the complex mineralogy. The disposal of the extensive amounts of thorium, especially in the microsyenite of south-east Motzfeldt, coming as a by-product of possible beneficiation could be a problem. Because of its composition, appreciable amounts of lower rare-earth elements and uranium could be produced as a by-product of the beneficiation of the Motzfeldt pyrochlore, which may enhance the feasibility of the deposit.

The peralkaline microsyenite of the Motzfeldt Centre constitutes a huge reserve of zirconium in the class 1-2 % ZrO_2 . Similarly, the reserves of lower rare-earth elements and yttrium in the mineralised rocks are large but the grades (<1 % Re_2O_3 and <1000 ppm Y) are likely to be too low to justify the Centre as a potential rare-earth deposit alone. The economic significance of the beryllium in peralkaline microsyenite and sulphide mineralisation in the fault zones and the silicified microsyenite remains to be investigated.

A field trip to the Motzfeldt area during 1985 was attended by geologists representing seven mining companies, both domestic and foreign. The authorities then invited applications for an exploration licence, with a view to activities commencing in 1987. However, it was eventually decided that the Geological Survey of Greenland would continue field work at the site during 1987 in collaboration with Nunaoil A/S, a Danish/Greenlandic mining and oil company owned jointly by the Greenland Home Rule Authorities and the Danish state. Eventually, it is hoped that an international mining company will take some interest in exploring the site.

Location of the Motzfeldt Centre



T.I.C. statistics

QUARTERLY PRODUCTION ESTIMATES

(quoted in lb Ta_2O_5 contained)

2nd quarter 1987

| MB quotation : | US \$ 30 | US \$ 40 | US \$ 50 |
|------------------|----------|----------|----------|
| 3rd quarter 1987 | 236 550 | 256 000 | 422 900 |
| 4th quarter 1987 | 236 550 | 266 000 | 432 900 |
| 1st quarter 1988 | 264 550 | 304 000 | 480 900 |
| 2nd quarter 1988 | 274 550 | 364 000 | 510 900 |
| 3rd quarter 1988 | 274 550 | 384 000 | 520 900 |

3rd quarter 1987

| MB quotation : | US \$ 30 | US \$ 40 | US \$ 50 |
|------------------|----------|----------|----------|
| 4th quarter 1987 | 236 550 | 266 000 | 432 900 |
| 1st quarter 1988 | 264 550 | 304 000 | 480 900 |
| 2nd quarter 1988 | 274 550 | 314 000 | 500 900 |
| 3rd quarter 1988 | 274 550 | 384 000 | 520 900 |
| 4th quarter 1988 | 274 550 | 384 000 | 520 900 |

Note : These estimates are based on information available to date and do not necessarily reflect total world production.

PRODUCTION AND SHIPMENTS

(quoted in lb Ta_2O_5 contained)

3rd quarter 1987

| Material grade | Production | Shipments |
|--|----------------|----------------|
| Tin slag (over 2 % Ta_2O_5) | 153 386 | 164 770 |
| Tantalite and other materials | 51 965 | 25 267 |
| Total | 205 351 | 190 037 |

Note : The response from the companies asked to report was 16/16 and included these producers :

Datuk Keramat Smelting
Greenbushes
Malaysia Smelting
Metallurg Group
Tantalum Mining Corporation of Canada
Thailand Smelting and Refining

PROCESSORS' SHIPMENTS

3rd quarter 1987

| Product category | lb Ta contained | lb Ta ₂ O ₅ equivalent |
|--|--------------------|---|
| Tantalum oxide/K ₂ TaF ₇ | 20 349 | 27 471 |
| Carbide | 132 755 | 179 219 |
| Powder/anodes | 211 604 | 285 665 |
| Mill products | 80 557 | 108 752 |
| Alloy additive | 46 778 | 63 150 |
| Scrap, ingot, unworked metal, other | 8 904 | 12 020 |
| Total | 500 947 | 676 277 |

Notes :

1. The response from the companies asked to report was 17/18 and included these processors :
Cabot Specialty Metals - Electronics
Fansteel
W.C. Heraeus
Kennametal
Metallurg Group
Mitsui Mining and Smelting
NRC
Showa Cabot Supermetals
Hermann C. Starck Berlin
Treibacher Chemische Werke
Vacuum Metallurgical Company
2. Reports were made in lb tantalum contained.

Capacitor statistics

EUROPEAN TANTALUM CAPACITOR SHIPMENTS

(thousands of units)

3rd quarter 1987 127 720

(Data from ECTSP — shipments from European manufacturers to European-located consumers only.)

JAPANESE TANTALUM CAPACITOR PRODUCTION AND EXPORTS

(thousands of units)

| | Production | Of this exports |
|-------------------|------------|--------------------|
| 3rd quarter 1987 | 747 465 | 189 622 |
| (Data from JEIDA) | | |