

T.I.C. Meeting in June 1982

It has become the custom for several years for each spring meeting of the T.I.C. to be held in a different part of the world. Accordingly, the next assembly of the T.I.C. will be held in Tulsa, Oklahoma, hosted by Fansteel Metals. The meeting, including the Seventeenth General Assembly of the T.I.C., will span two and a half days from the afternoon of Monday, June 7th, through Wednesday, June 9th. The meetings will be held in the Williams Plaza Hotel in Tulsa on Tuesday and a plant visit will be made on Wednesday to the Fansteel tantalum processing plant in nearby Muskogee.

The programme for the meeting is as follows :

Monday, June 7th — Williams Plaza Hotel, Tulsa.

- Arrival of delegates and guests in Tulsa.
- Registration at the Williams Plaza Hotel.
- Reception for members and guests from 6 to 7 p.m.
- A free evening in Tulsa for dinner and entertainment.

Tuesday, June 8th — Williams Plaza Hotel, Tulsa.

- Seventeenth General Assembly to begin at 9 a.m., open to delegates of member companies only.

- Following a short break, during which delegates from newly elected member companies and guests will join the meeting, there will be a programme of general interest to members of the tantalum community, particularly in regard to some of the factors which will influence the future markets for tantalum.

- Speakers will include :

Dr. William A. Owczarski, Manager of Technical Planning of Pratt & Whitney Aircraft Company, East Hartford, Connecticut, who will discuss high temperature alloys containing tantalum and their end uses.

Mr. Roy Markon, Commissioner of Federal Property Resources Services, General Services Administration, Washington, who will speak on « National Defence Stockpile Strategic and Critical Materials », with emphasis on tantalum.

Dr. Lloyd Brown, marketing and economic analyst, speaking on « The Impact of Electronics in the 1980's ».

Mr. Tom Barron and Mr. Frank Cook of Ayers, Whitmore & Company of New York City, who will explain the details of the newly sponsored T.I.C. study, "Exploration of Tantalum Market Behavior : 1980-1982", a supplement to the 1980 T.I.C. study.

- These presentations will be followed by a panel of members selected to represent a cross-section of the tantalum industry. Each panel member will make a brief presentation of his views concerning the new T.I.C. study. Afterwards the panel will debate the issues and then open the discussion for questions and comments from the floor.

- In the evening, Fansteel invites all the delegates and their ladies to a banquet. Music for the evening will follow the "Western U.S." theme and entertainment will include colourful American Indian dances.

Wednesday, June 9th — Muskogee.

- Bus transport to Muskogee from Tulsa will leave the Williams Plaza Hotel at 8,30 a.m., for participants and ladies.
- Tour from 10 a.m. to noon of the Fansteel tantalum processing plant. All delegates are welcome to take part in the visit to Muskogee and the plant site.
- Luncheon barbeque in Muskogee, closing the meeting.
- Bus transport back to Tulsa.

The Ladies' Programme on Tuesday will consist of a tour conducted by "Wild Wild West Tours", providing a scenic view of Tulsa. After viewing the art-deco buildings of downtown Tulsa, visits will be made to the Gilcrease Museum (containing the largest private collection of western art in the United States), mansions in the area, Oral Roberts University, shopping centres and other points of interest. On Wednesday, the ladies are invited to join the trip to Muskogee and either to visit the Fansteel plant or to see some of the interesting parts of the town, famous as a centre of Indian lore.

Rooms have been reserved in the Williams Plaza Hotel for the accommodation of participants. There is a major airport in Tulsa served by several airlines from all directions. Transport is readily available, the trip to the Williams Plaza being only a few minutes by taxi.

The June weather in Oklahoma is usually mild with daytime temperatures ranging from 18° to 25° C. Although the rainy season will be past, it is best to be prepared for an occasional shower.

Invitations are being sent to representatives of all member companies by the Secretary of the T.I.C., from whom further information concerning the meeting may be obtained.

T.I.C. SEVENTEENTH GENERAL ASSEMBLY

The Seventeenth General Assembly of the Tantalum Producers International Study Center will be held as part of a meeting from June 7th to 9th in Tulsa, Oklahoma, U.S.A., hosted by Fansteel Metals.

The General Assembly will be convened at 9 a.m. on Tuesday June 8th in the Williams Plaza Hotel in Tulsa. The Agenda for the meeting will be :

1. Opening by the President, Mr. Conrad L. Brown.
2. Minutes of the Sixteenth General Assembly.
3. New membership.
4. Report of the Executive Committee.
5. Accounts for 1981.
6. Budget for 1982.
7. Proposal for full-time employee in Brussels.
8. (a) Production statistics for 1981.
(b) Status of process statistics reporting.
9. Eighteenth General Assembly, place and date.
10. Other business.

Following the formal business of the association, restricted to delegates of member companies, the meeting will be opened for attendance by newly elected members and guests. There will be an address by the President and presentations covering subjects of interest to the tantalum community.

The new T.I.C. Study will be reviewed and a panel of industry representatives will discuss it.

On Tuesday evening, Fansteel will host a banquet for all delegates and guests and their ladies. This will be followed on Wednesday by a trip to the Muskogee plant of Fansteel Metals, a major plant which processes tantalum from raw material through reduction to semi-finished products.

President's message to the membership

With attention to the views of members as expressed at the last General Assembly, it occurred to me that an effort should be made to communicate with the overall membership more often than just at the two meetings held each year. This article represents a first step in that direction and establishes a practice I plan to follow in future "Bulletins" during my term as President. Hopefully, succeeding Presidents will consider it beneficial and will do the same.

First, I would like to express my appreciation for the honor of serving as President and I shall put forth my best effort to uphold the tradition of my predecessors and the objectives of the T.I.C.

The T.I.C. was chartered in 1974 under Belgian law and the charter has been amended twice since. The present purposes of the Association cover a number of subjects but, in general, its principal objective is the promotion of common interests and welfare of the tantalum industry. Since the T.I.C. was chartered, it has grown to sixty-one members of international acclaim and new applications are still being received. The membership is comprised of miners, smelters, processors, consumers and end-users and is indicative of the wide-spread interest and esteem held by the T.I.C.

Following the Sixteenth General Assembly, the Executive Committee authorized Ayers, Whitmore & Company of New York City to perform a new study, "Exploration of Tantalum Market Behavior: 1980-1982". It is believed that this study is justified as the decline in tantalum demand has exceeded the anticipated levels set forth in the last "Worldwide Tantalum Study", also made by the Ayers consultants and published in October 1980. The new study is scheduled for completion in late February and copies will be mailed to the membership shortly thereafter and, in fact, may already be in hand by the time this "Bulletin" is received. The cost will be met from the T.I.C. general fund, so no special assessment from the members will be necessary.

There has been some discussion regarding the engagement of a full-time employee to work in and out of the Brussels office of the T.I.C. Some members have expressed strong feelings in this direction and it will be discussed further at the Seventeenth General Assembly. Please give this matter serious consideration prior to the next meeting as we would like to know your well-thought-out feelings when it is brought before the membership.

We are in the process of relocating the T.I.C. office in Brussels as we received notice, along with other organizations, to vacate 1 rue aux Laines. We are attentive to the cost of doing so, but we believe a more modern facility will improve service to the membership. A new address will be announced as soon as the change occurs.

The Seventeenth General Assembly will be held June 7, 8 and 9, 1982, in Tulsa, Oklahoma, and the programme planned is found elsewhere in this issue of the "Bulletin". We encourage attendance and look forward to a large turnout, and believe that the programme which is being put together will be of interest to all participants.

The Executive Committee will do their best to respond to any questions or concerns you may have regarding administration of the T.I.C.

Warm regards,

Conrad L. Brown, President

T.I.C. publications

Two of the publications of the Tantalum Producers International Study Center are now generally available at reduced prices:

- "International Tantalum Symposium — 1978", a bound book of 200 pages containing fifteen papers and addresses presented at the First International Symposium on Tantalum held at Rothenburg ob der Tauber, West Germany from May 10th to 12th, 1978. The price is now US \$ 5 per copy.
- "Worldwide Tantalum Study: Assessment of Availability and Price, 1980-1985", a T.I.C. sponsored study prepared by Emory

Ayers Associates, Inc. in October 1980, an analysis of the tantalum demand and supply and a forecast through 1985. Price now US \$ 600.

These publications may be ordered through Mrs. J.A. Wickens, Secretary, Tantalum Producers International Study Center, 1 rue aux Laines, 1000 Brussels, Belgium. Please enclose payment with your order.

It is suggested that members and others with an interest in tantalum consider purchase of these publications for donation to technical and university libraries in their area as a further effort to make information available about tantalum to readers and researchers outside the immediate tantalum community.

U.S. Stockpile acquisition of tantalite

The current U.S. Stockpile plans were reported in issue no. 28 of the T.I.C. "Bulletin". This article covers the result of the tender made by the General Services Administration in September 1981.

The tender made by the General Services Administration initially became the source of confusion and controversy. Concern about the tightness of the specification and a comment by the G.S.A. that this might be relaxed on future tenders led to speculation that some relaxation might be permitted on the current tender. The G.S.A. agreed to accept offers for synthetic tantalite even though the tender solicitation specified "natural" minerals. Within a few days, however, the G.S.A. reversed its decision and stated that synthetic material would be "unsuitable for the Stockpile".

Fourteen eligible bids were received and opened on October 26th. The award, however, was not publicized until the middle of December when the contract was signed by Norore Corporation of New York. The G.S.A. agreed to purchase 36,630 pounds of contained tantalum pentoxide at a price of \$ 36.8466 per pound. The material is to be delivered to the G.S.A. depot within six months. Market information indicates that the other bids received from traders and producers were all close in price offered to the finally negotiated price.

There has been no further information released by the U.S. Government agencies as to future plans for further acquisition of tantalum for the Stockpile.

The Stockpile status on November 30 1981 was (in 1,000 lb. units Ta):

Material	Goal	Total Inventory	Authorized for disposal	Sales 11 months
Carbide				
Powder	—	29	—	—
Metal	—	201	—	—
Minerals	8,400	1,399	—	—

In addition to the data shown, the Stockpile contains a negligible quantity in nonstockpile grade metal and 1,152,000 pounds in nonstockpile grade minerals.

Mr. Paul Leynen, co-founder of the T.I.C.

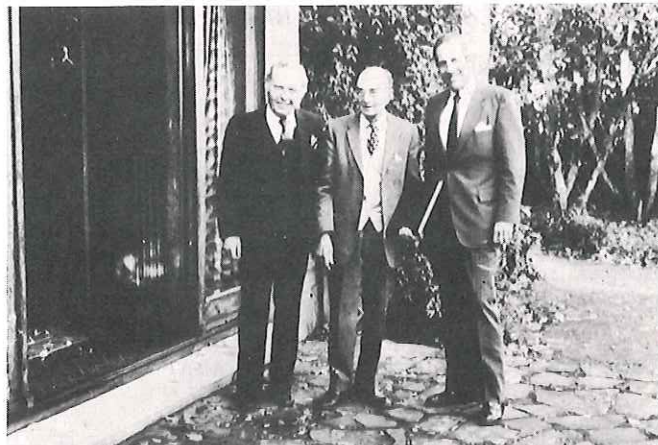
In 1973, Mr. Paul Leynen of Geomines in Brussels, Mr. Herman Becker-Fluegel of National Resources Trading in New York and Dr. Cornelius Herkstroeter of Billiton Handelsgesellschaft in Lucerne jointly developed the concept of an international organization of tantalum raw material producers. The purpose of the organization would be to spread information about tantalum and to promote the common interest and welfare of the producers, especially with public and private authorities, organizations and agencies. They gathered together several representatives of producers to work out the principles and charter of such an organization. From their effort, the Tantalum Producers International Study Center was chartered as an Association under Belgian law on October 24 1974.



Presentation to Mr. and Mme Leynen.

Mr. Leynen devoted much effort to the formation of the working functions of the T.I.C., in the first few years arranging and hosting the semi-annual meetings in Brussels and providing all the necessary logistic support. Through his efforts an efficient and effective Secretariat was established and staffed in Brussels.

Then Mr. Leynen was elected President of the T.I.C. at the Seventh General Assembly in May 1977 and served until June 1978. During his term in office, the T.I.C. sponsored the First International Symposium on Tantalum at Rothenburg ob der Tauber, West Germany from May 10 through May 12, 1978. The complete



Dr. George Korinek and Mr. Herman Becker-Fluegel presenting the elegant tantalum plaque to Mr. Paul Leynen.

success of this international meeting was due in a great part to the efforts of Mr. Leynen.

After his term as President, Mr. Leynen remained a key figure in the T.I.C. and served as a member of the Executive Committee until June 1981. At that time his health required a reduction in his activity and he resigned.

In expression of appreciation to Mr. Leynen for his continued dedication to the assurance of success of the T.I.C., a special plaque was designed, made of tantalum. The inscription on the plaque states "To Paul Leynen, Thanks for Long Years of Devoted Service, from All your Friends in T.I.C., May 19, 1981".

The plaque was presented to Mr. Leynen at his home in the outskirts of Brussels on October 29 1981.

Fansteel and the Muskogee plant

Fansteel was founded in 1907 and was incorporated in 1917; 1982 will see its 75th anniversary. The company is engaged in the manufacture of metal products, principally those requiring a high

degree of metallurgical technology. The company were pioneers in the production of refractory metals — tungsten, molybdenum, tantalum and columbium. In 1922 the company was the first in the United States to produce tantalum and, in 1928, was the first in the world to produce columbium.

Today, Fansteel processes the four refractory metals and a host of other metals including titanium, special steels, aluminium and advanced alloys. The operations cover the entire spectrum of metal processing from base extraction from ores to the fabrication of high-quality intricate and complex hardware for a large variety of industrial markets. The products of Fansteel probably require a greater range of high technology processing with a greater number of high performance metals and alloys than those of almost any other company in the world.

Fansteel is organized into four Divisions which perform their operations in fourteen plants throughout the United States. The Metals Division is the producer of tungsten, tantalum and columbium. Starting with various raw materials, Fansteel Metals extracts these metals, purifies and consolidates them through proven techniques to their final form as powder, wire, sheet, foil, tubing, rod and chemical equipment. They market these products to industry and to other Fansteel Divisions for further fabrication.

The Metals Division plant for the basic processing of tantalum and columbium is located in Muskogee, Oklahoma. The recognition in 1955 of the rapidly increasing demand for tantalum and columbium led to the construction of this plant, which was opened in November 1958. Although the site is almost seven hundred miles from the centre of Fansteel's metal operations in North Chicago, Illinois, it was chosen because of the ample supply of water, power and fuel. Many other factors, including the availability of labour, contributed to the selection.

The Muskogee plant is located on 110 acres of land lying on the west bank of the Arkansas River, a navigable waterway leading directly to the ocean ports. There are five major manufacturing buildings and a number of other buildings for supporting functions. Most evident in the aerial view are the extensive storage ponds for waste water which assure the retention of all environmental pollutants.



The plant is the basic manufacturing facility for producing tantalum and columbium ingot, bar, powder, alloys, carbides and other compounds. The first step of the processing is the reduction of raw materials to metal. The raw material is digested, separated and purified in a liquid-liquid process developed and patented by Fansteel technologists. The resulting high purity solutions are processed through a variety of sophisticated chemical, thermal and mechanical operations resulting in high purity oxides or salts for metal reduction.

The tantalum salts react with liquid sodium to yield tantalum metal. Disposition of the powder is made to three basic product lines: (1) powder metallurgy or sintered bars, (2) electronic or capacitor grade powders and (3) electron-beam melted ingots.

Sintered bars are produced by first compacting them at very high pressure in a hydrostatic press. They are then sintered in vacuum-resistance sintering furnaces at high temperatures. These bars are shipped to North Chicago for production of various metal products.

The electronic or capacitor grade powder feedstock is processed either by hydriding and sizing the sodium-reduced powder or by hydriding a high purity electron-beam melted ingot. Both products are also shipped to North Chicago for further processing.

The electron-beam furnaces are used to melt and purify ingots. They can produce tantalum ingots up to 8" in diameter by 120" long, weighing over 3,600 lb., or columbium ingots up to 11" in diameter weighing over 3,400 lb. An arc-furnace is also available for the casting of refractory metal alloy ingots while simultaneously ensuring homogeneity and grain size control. The electrodes for columbium ingots are prepared by melting columbium metal which has been produced by the conversion of columbium oxide by aluminothermic reaction.

The Muskogee plant also has complete facilities for recycling tantalum and columbium scrap back into usable material.

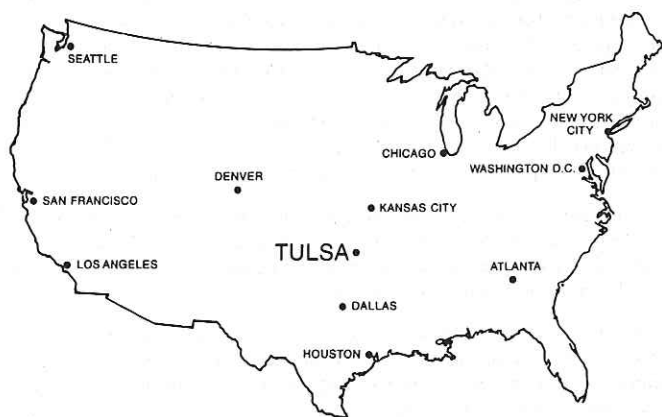
Throughout the processing, emphasis is placed on rigid process control and analytical measures to assure the utmost in quality.

Recent expansion and improvements have greatly increased the many capabilities of the Muskogee operation. In addition to the capacity and quality improvements, the plant has consistently upgraded its pollution control equipment. The large quantities of hydrofluoric acid and other chemicals which must be used to process tantalum require sophisticated clean-up systems.

In summary, the Muskogee plant of Fansteel Metals, one of three in the Division, is a basic manufacturing facility for producing tantalum and niobium in semi-finished form as raw materials for other Fansteel plants and for other industries.

Oklahoma

Oklahoma is located in the south-central United States within one hundred and fifty miles of both the geographic centre (of the forty-eight contiguous states) and the population centre of the Nation. Tulsa, the site of the T.I.C. meeting, is in the northeast corner of Oklahoma.



Oklahoma is a large state about equal in area to the combination of England and Scotland. Three million people live there, making it as sparsely settled as Norway, Sweden or Finland in Europe, Brazil or Chile in South America, Zaire or Mozambique in Africa.

The terrain and style of living in Oklahoma vary greatly. The eastern part is graced with mountains, forests and swift running streams. It is also the centre of manufacturing as well as that of petroleum and natural gas resources. The rolling prairies of the west, the so-called "panhandle", are wheat and cattle country. The northern region, settled from Kansas, has more of the flavour of the Middle West, while the southern portion, the state's cotton belt, resembles neighbouring Texas. Oklahoma was a part of the dustbowl of the 1930's and tenant farmers who moved west as migrant labourers became known as "Okies".

The history of Oklahoma as a settled area, however, is comparatively short, however, because throughout most of the nineteenth century it remained a federally administered Indian territory. De

Soto and Coronado, Spanish explorers, both explored Oklahoma in 1541, claiming it for Spain. La Salle included it in the vast Louisiana Territory which he claimed in 1682 for the King of France. This claim held and Oklahoma was purchased by the United States from France in 1803 as part of the Louisiana Territory purchase. There were no settlements for two centuries until 1830 when the territory was set aside under treaties signed with the Indian tribes for a permanent home for "as long as grass grows and water runs". Five tribes of Indians, 15,000 people in all, were resettled there from Eastern States between 1830 and 1842. These tribes (the Choctaw, Creek or Muskogee, Seminole, Cherokee and Chickasaw) located in the eastern portion of the territory around what is now the town of Muskogee. The "Nation of the Five Civilized Tribes", as they became known, established a true nation there with laws, courts, elected officers, schools, churches, newspapers and all the other institutions of civilization. Even the name of the State was of Indian origin, "Oklahoma" being the Choctaw word for "red people".

The first encroachments on the Indian Territory were for transport purposes, stage-lines, railroads and cattledrives crossing the territory. But pressure to open up these frontier lands for settlement led to the revocation of the Indian rights in part of the Territory in 1889. At noon on April 22nd, a pistol shot set off a charge of 50,000 homesteaders and speculators into the so-called "Unassigned Lands".

By evening almost two million acres had been staked out and claimed. Some groups secretly crossed the starting line the night before and were called "Sooners" which gave the state its nickname of Sooner State. Later most of the land was taken over by the settlers. In 1907 the Territory was admitted into the Union as the 46th state.

Tulsa was founded in the 1830's as a village of Creek Indian refugees who named it after their former village in Alabama. There was slow growth, less than 1,400 people in 1900. But when the "Glen Pool" of petroleum was discovered ten miles south of Tulsa in 1905, its future importance was assured and it rapidly expanded.

Today Tulsa is the "Oil Capital of the U.S.". Over 30,000 people work for more than 1,000 oil and oil-related firms. But other manufacturing is also strong, particularly the aviation and aerospace business. The Tulsa Port of Catoosa, the nation's newest inland water port, links Tulsa to the Mississippi River via the Arkansas River and to the rest of the world.

Combining a proud Indian heritage and a foundation of the Old West, Tulsa has developed as a modern cultural centre. There is a symphony orchestra, opera and ballet companies, as well as a professional theatre. The many city parks, museums and universities have made it a focal-point of Mid-America.

Muskogee, too, has had a celebrated history. It was natural that the confluence of the Arkansas, Verdigris and Grand Rivers about 50 miles-south of Tulsa should become the location of the U.S. Indian Agency which administered the needs of the relocated Indian tribes. A small settlement grew around the Agency and the town of Muskogee was officially founded in 1872. Although it is today a port on the navigable Arkansas River and an important manufacturing center, its tradition has lived on as a centre of Indian culture. There are museums, parks and gardens dedicated to the Indians which are a Mecca for Indian buffs from all over the world.

International Symposium Niobium 81

The First International Symposium on Niobium, "Niobium-81", was held in San Francisco from November 8th to 11th, 1981. The Symposium was organized by Dr. David G. Howden, Professor of Metallurgy at The Ohio State University, and Dr. Harry Stuart, Executive Vice President of Niobium Products Co., Ltd. Sponsors included professional technical societies from eight countries. Encouragement and financial aid to support the Symposium were provided by a number of companies interested in assuring the advancement of niobium technology.

The programme, spread over three days, was divided into major categories as follows:

Mining and Extraction — six papers presented, all but one focused on the geology, mining and processing of pyrochlore deposits in Canada, Brazil and the U.S.S.R.

Production/Processing and Metallurgy of Niobium-based Materials — two papers relative to the production and fabrication of niobium and niobium alloys plus three papers covering the metallurgy of niobium alloy systems.

Applications of Niobium-based Materials — nine papers detailing the use of niobium in superconductors, in corrosive and catalytic applications, in acoustics and electro-optics, in optical glass, in high temperature applications and in cemented carbides.

Applications of Niobium as a Micro-alloying Element — thirteen papers dealing with the effects of the use of niobium in steels.

Applications of Niobium as an Alloying Element — three papers involving the use of niobium in stainless steels, tool steels and superalloys.

Niobium in the future — three papers covering emerging uses of niobium and the markets in the 1980's.

Dr. Allen Gray, Technical Director of the American Society of Metals, was the guest speaker at the banquet held on the evening of the second day of the Symposium. His presentation covered the "Supply-Demand Picture for Special Metals". The Symposium was acclaimed to be a great success by the 200 participants from all parts of the world.

Copies of the papers presented are available upon request. They can be obtained by writing to

Niobium Products Co., Ltd.
Building 2, Four-forty Parkwest
Cliff Mine Road
Pittsburgh, PA 15275, U.S.A.

or by calling area code 412, 787-9620. The complete proceedings of the Symposium are being published and will be available by June 1982.

Anodizing tantalum for art purposes

This is the completion of the subject article published, in the first part, in issue no. 28 of the T.I.C. "Bulletin".

The best method of control is obtained by electrochemical anodizing. Methods have been developed to obtain gradations in colour, uniform area coverage, or localized colour effect. To anodize, careful preparations have to be made.

- A variable voltage d.c. power supply is needed. It should have a continuous variable voltage range from 0 volts to at least 200 volts. The supply should have a constant-current characteristic but the current capacity does not have to be too great. The anodizing current is about 40 milliamperes per square inch of surface. Thus, if one surface treatment with a "paint brush" is used, 20 to 25 milliamps would be adequate. If immersion treatment is used with pieces as large as four square inches, about 0.3 amp. capacity will be required as both sides of the piece anodize.
- Safety precautions are required. Playing around with d.c. power in the 50 to 200 volt range can be dangerous. It is advisable to wear rubber gloves and to place the anodizing apparatus on a rubber (or other non-conducting) mat. A rubber floor mat, on which to stand, is also advisable, or, if sitting is preferred, a wooden stool should be used. Be careful not to touch the two electrodes together as this will cause a short-circuit which can be damaging to the power supply.
- Insulated copper wire leads to connect the power supply to the work pieces. Small wires, about 1 mm. or less, are adequate. But they should be long enough to allow freedom of movement. The ends of the leads should be equipped with squeeze clips and it is advisable that the connections and finger-squeeze points be covered with a short piece of rubber or plastic tubing so that further protection from electric shock is offered.

- The electrolyte used is a solution of phosphoric acid, 0.1 % by weight, in de-ionized water. For best results, the water should be quite hot.

- Pre-anodizing cleaning is essential. The piece should be degreased with acetone and then immersed in a mild alkali-cleaning solution in an ultra-sonic cleaner for 4 to 5 minutes. After removal, it should be thoroughly rinsed in hot running water.

Other equipment depends on the method of "painting" used.

Two methods of colouring have been found to be satisfactory, immersion and surface painting. For the immersion method, a glass beaker is a good vessel to hold the electrolyte. The negative side of the power supply is attached to the cathode (a piece of silver is preferred but stainless steel will work) which is then immersed in the electrolyte solution. The piece to be coloured can be clipped to the positive lead wire or, if it is quite small, it can be hung in the electrolyte and an anode probe used. In the latter case, a pointed piece of tungsten rod about 2 mm. in diameter works well but it must be anodized first to stability so that current leakage from the rod will not cause erratic results.

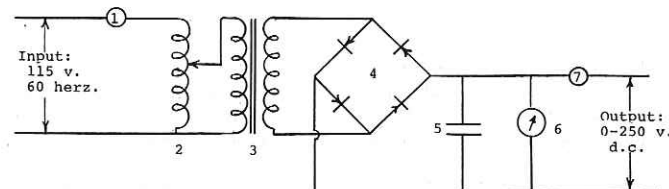
When the connections have been made with the clips or by touching the target piece with the probe, the power can be turned on and the voltage slowly raised to the desired level. The rate at which the voltage can be raised is limited by the maximum current rating of the power supply. Since the current drawn from the supply gradually diminishes as anodizing progresses, the voltage rating can be used to control the current flow. When the desired voltage is reached, anodizing continues and the current gradually drops to zero. When it does, the colour desired will be uniform over the entire surface.

A rainbow effect can be obtained by fastening the anode to a plastic rod which can be used to withdraw the piece gradually from the solution. Thus the film thickness will be greater for the part of the piece that remains in solution the longest. In addition, if only partial colouring is desired on a piece, the areas which should not be coloured can be covered with "photo-mask", the material used for differential etching in the manufacture of integrated circuits and small-scale electronic hardware.

The second technique for painting is to use a camel-hair paint brush, usually a small pointed one. The anode clip can be fastened to the metal ferrule on the brush which provides a current path to the work piece when the brush is loaded with electrolyte solution. The procedure for adjusting voltage is the same as used in the immersion method. Once the desired voltage has been reached, the brush can be moved very slowly to cover an area. Care must be exercised that the brush is not moved so rapidly that the current level builds up beyond the rating of the power supply.

To be successful requires considerable experimental work. No written sources of information have been located which are applicable to using anodizing for art purposes. Care and patience are the essential ingredients for success.

It was found that commercial power-supply units of a suitable type were quite expensive, costing US \$ 250 or more. A satisfactory source was built using commercially available components for only US \$ 100. The circuit used is :



The numbered components are as follows :

1. Line fuse, 1 amp capacity.
2. Variable auto-transformer. Input : 120 v, 50/60 herz; output : 0-120/132 v; 1.75 amp. capacity.
3. Isolation transformer : input : 120 v, 60 herz; 1:2 ratio.
4. Full wave rectifier bridge, 400 v, 4 amp.
5. Capacitor, 125 mfd., 450 v D.C.
6. D.C. Voltmeter, 0-400 v.
7. Output fuse, 0.25 amp. capacity.

Mineral industry survey U.S. bureau of mines

The United States Bureau of Mines released on December 31 1981 the annual "Mineral Industry Surveys — Columbium and Tantalum in 1981". Selected parts of this release are published for the interest of readers who have not had access to the publications. The data provided for the year 1981 are definitely preliminary estimates and are only indicative rather than factual.

TANTALUM (Data in thousand pounds tantalum content, unless noted).

Domestic Production and Use : There has been no domestic tantalum mining industry since 1959. Metal, alloys and compounds were produced by seven companies with eight plants; tantalum units were obtained from imported concentrates and tin slags, and from both foreign and domestic scrap. Consumption in the form of metal, powder, ingot, fabricated forms, and compounds and alloys, had the following end uses: electronic components, 73 %; machinery, 19 %; transportation, 6 %; and other, 2 %. Total estimated value of domestic shipments of metal, alloys, and compounds was \$ 200 million.

Salient Statistics - United States :

	1979	1980	1981
Mine production		None	
Imports for consumption :			
Concentrate, tin slags, and other (1)	1,914	NA	2,100
Exports : Concentrate, metal, alloys, waste, and scrap (est.)	721	706	375
Shipments from Gov't Stockpile excess	—	—	—
Consumption reported : Raw material	1,740	1,863	1,250
Consumption, apparent	1,439	1,187	1,000
Price, tantalite (Ta ₂ O ₅ , 60 %)	\$ 65.50	\$ 103.50	\$ 80.00
Industry stocks : Processor and dealer, yearend	2,753	NA	NA
Employment : Processor (est.)	600	600	550
Net import reliance as a percentage of apparent consumption	96 %	90 %	91 %

(1) Metal, alloys, and synthetic concentrates.

Recycling : Combined prompt industrial and old (obsolete) scrap consumed was over 5 % of total raw materials consumed. Production of new scrap was estimated at about 400,000 pounds, most of which was consumed by processors.

Import Sources (1977-80): Thailand 36 %, Canada 11 %, Malaysia 11 %, Brazil 5 %, other 37 %.

Events, Trends, Issues : Demand and price of tantalum both dropped significantly from 1980 levels. Factors affecting tantalum's principal markets of capacitors and cemented carbides were substitution, reduction in "per unit" use for cost and technological reasons, and lower economic activity by consuming sectors. As demand dropped, prices declined dramatically in the spot market for tantalum concentrates, and sank progressively from over \$ 100

to \$ 50, or less, per pound of contained pentoxide. Falling prices also signified increased confidence about future raw material supply, including that available from quantities of old, relatively lowgrade tantalum-bearing tin slag.

The U.S. Government, through its initiation of a stockpile acquisition programme for tantalum minerals, and the aerospace industry, through development of a new alloy high in tantalum, emerged as growing customers for tantalum. It is estimated that in 1982 domestic mine production of tantalite will be zero and U.S. apparent consumption will be 1.1 million pounds. From a 1978 base, demand for tantalum is expected to increase at an annual rate of about 4 % through 1990.

There are no uncontrollable health hazards connected with the production or fabrication of tantalum metals and compounds. Fumes, gases, dust, and low-level radiation generated by extraction plants can be controlled by modern technology.

World Mine Production and Reserve Base :

	Mine Production (est.) (Concentrate only)		Reserve Base
	1980	1981	
United States	—	—	—
Australia	140	160	10,000
Brazil	280	250	2,000
Canada	229	250	4,000
Malaysia	8	10	2,000
Mozambique	NA	60	NA
Nigeria	74	60	7,000
Thailand	188	130	16,000
Zaire	19	25	4,000
Other Market Economy Countries	40	35	3,000
Central Economy Countries	NA	NA	NA
World Total (Excluding Central Economy Countries)	978	980	48,000

World Resources : Most of the world's resources of tantalum occur outside the United States. On a world wide basis, identified resources of tantalum are considered adequate to meet projected needs. The United States has about 3.4 million pounds of tantalum resources located in identified deposits, which were considered uneconomic at 1981 prices.

Tariff : Item	Most Favoured 1/1/82	Nation (MFN) 1/1/87 *	Non-MFN 1/1/82
Potassium fluotantalate	3.7 % ad val.	3.1 % ad val.	25 % ad val.
Tantalum concentrate	Free	Free	Free
Synthetic tantalum/columbium concentrate	Free	Free	30 % ad val.
Tantalum, unwrought			
Waste and scrap	4.5 % ad val.	3.7 % ad val.	25 % ad val.
Metal	4.5 % ad val.	3.7 % ad val.	25 % ad val.
Alloys	6.5 % ad val.	4.9 % ad val.	25 % ad val.
Tantalum, wrought	7.7 % ad val.	5.5 % ad val.	45 % ad val.

* EDITOR'S NOTE : The tariff rate will decrease on January 1 each year until it reaches the rate shown for 1/1/87.