Progress in Non-Ferrous Metallurgy in 1929

New Developments in Processing, Technology and Application of Non-Ferrous Metal—Copper, Lead, Zinc, Aluminum, Nickel, Secondary and Precious Metals

Progress in Theoretical Metallurgy During 1929

By R. S. Dean,* Washington, D. C.

The theory of hardening by heat treatment was, as usual, the most actively discussed phase of metal working theory and in spite of the fact that it is now recognized, however, that adequate.

A purely mechanical effect of very fine crystallites dispersed in a supercooled solid solution and conglomerate, however fine the particles of the latter. This intermediate stage has not been found in other alloys below the surface of a quenched carbon steel.

Solid solution.

The same gradual change of the lattice of the solid solution accompanied by the possible rejection of the atoms of the dissolved lattice of the solid solution, produced by a distortion of the lattice elements as well as a stabilization of this distortion. No further attempts have been made in this line, however, since the paper by Dean and Gregg in 1927. Gillett has pointed out the possible use of the phenomenon of electron diffraction discovered by Davison and Germer to obtain further data on the nature of surfaces and crystal boundaries and we shall await the results of the indicated experiments with interest.

What may be termed the chemical explanation of anomalous mechanical properties in metals seems to be gaining ground. Dean, Day and Gregg have presented evidence that blue brittleness in iron is due to the solution of iron nitride, and Yensen has suggested that even the allotropic transformation in iron may be due to impurities. Saveur, however, rejects this explanation of blue brittleness in favor of a physical one. In perhaps the same category is the attempt of Hargreaves and Hils to explain work softening by a change of physical structure at the grain boundaries. However, in at least one case discussed, that of lead-antimony, there is ample evidence that work-softening is mostly due to separation of antimony from solution and its agglomeration.

6 Campbell Memorial Lecture. Amer. Soc. Steel Treaters, Cleveland, 1927.

Footnotes:

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Sand Cast Alloys of Copper

By J. W. Bolton,* Cincinnati, Ohio, and S. A. Wigmans,t

CUPOLA melting of bronze alloys received considerable attention in 1929 and a number of installations were made. No really extensive reports regarding the operating characteristics of this furnace have been presented to the technical societies or through the trade press. It would be particularly interesting to note the effects of this method of melting upon the physical properties of known alloys. The process is more drastically oxidizing than the usual foundry melting methods and zinc loss in the furnace is comparatively high. At the present price of the special fuel employed it would seem that costs of melting metal should be low.

A rotary gas retort brass melter was brought out during the past year. This furnace consists of a revolving metallic retort externally fired and inclosed in a refractory shell. Greatly improved efficiency with improved quality is claimed. Another claim is low zinc loss on yellow brass. Burners which proportion air and gas exactly allow close control of furnace atmospheres, with attendant economy and advantage to quality of metal. Newer types are being more widely used.

Recent developments in refractory linings for the Wyatt type induction furnace may allow more extended application of this method of melting to higher copper alloys, such as the red brasses. The indirect-arc rocking-furnace remains the most widely used low-melting loss type of furnace for red brass alloys. Vendors of these furnaces suggest no changes in operating methods. However, some manufacturers have found it desirable to add certain amounts of oxidizing agents to neutralize effects of the normally highly reducing conditions in this furnace. To the writer’s knowledge there have been no extended new applications of the high frequency type induction furnace to red brass melting within the last year. Possibilities of producing unusually sound material by melting under vacuum in this furnace appear interesting.

As usual, a number of new alloys have appeared on the market, but apparently little really new is noted. A possible exception is the work being done with beryllium. No noteworthy improvements in pyrometry of non-ferrous metals have come to the writers’ attention during the past year. This observation also applies to sand-testing methods.

The effects of gas absorption and of small amounts of impurities in bronze are receiving considerable attention. It appears that bronze porosity, in certain cases, is due to melting in reducing atmospheres, and that effects are quite similar to those of oxidation. The precise nature of internal shrinkage is a matter of interest. Gas absorption is the subject of several recent papers. Among foreign papers, that presented by Dews before the 1929 International Foundry Congress deserves the attention of foundrymen and metallurgists. Little that is unusual has appeared relative to corrosion and the effects of elevated temperatures on non-ferrous metals. The advent of tungsten carbide tools allows commercial machining of certain harder alloys and in some cases improved production machining rates on others.

The valuable work of the Institute is reflected in the excellent TRANSACTIONS and well balanced programs.

THE MEETING at Cleveland was of particular interest. The rearrangement of non-ferrous committees of the American Society for Testing Materials promises even more active effort. A proposal to make physical properties mandatory and composition a more secondary consideration for engineering specifications is noteworthy. The American Foundrymen’s Association has grouped its hitherto somewhat scattered non-ferrous committee activities and its non-ferrous membership into a Non-Ferrous Division. Correlation of these activities should prove practical and desirable.

Lead and Lead Alloys

By C. O. Hers, Brooklyn, N. Y.

According to R. S. Dean, “A lead-calcium alloy has been developed which has a very high fatigue strength. That is, it is very resistant to failure from reverse stresses, and it is finding a wide usage as cable sheathing.”

K. S. Seljeseter advances the idea that arsenic which is insoluble in lead and soluble in antimony retards the dissolution of antimony in a 1 per cent antimonial lead containing small amounts of arsenic, and some further work has been done along this line.

Lead and antimonial lead have been given a high rating among the metals by Friend.

The use of lead anodes containing 98.8 per cent lead, 1 per cent silver and 0.2 per cent arsenic, has resulted in the commercial production of an electrolytic zinc of exceptional purity.

Lead-lined articles for chemical equipment were exhibited at the recent Chemical Exposition. An increase in the use of this kind of apparatus would result if production costs could be reduced. Considerable antimonial lead sheet is being used for tank linings for chromium electroplating solutions. It is suggested that when the solution is first placed in these tanks that the tanks be immediately put into use or else given an anodic treatment. Some electroplating engineers suggest that the tank linings be given anodic treatments at weekly intervals. Attention to this matter is apt to result in longer service from lead tank linings, since some of the chromic acid solutions tend to attack lead. Hundreds of lead-lined tanks are in use for chromium plating and have been giving satisfactory service for a period of years.

At the Bureau of Standards investigations of the use of lead in bearing metal alloys are under way and reports have already been published concerning the use of lead in bearing bronze. The Bureau is also studying lead base babbitts at the request of the Assistant Secretary of War in view of the possibility of substituting these metals for tin base metals in order to conserve tin.

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†C. N. Friend: The Results of Four Years’ Exposure in the Bristol Channel, Jnl. Inst. of Metals (1929) 19, 111; also Preprint No. 1058.
E. J. Hall mentions the use of a metal containing 25 per cent lead and 75 per cent copper for bearings in the engines of motor coaches. An investigation of Utah shale as a flux designed to produce uniform mixtures of lead in copper has been made and the results indicate that this material has no merit when so used.  

crease in consumption, 368,000 tons in 1929, whereas retort production decreased 1,162.

The Dispersion of Lead in Copper-lead that this material has no merit when so used'.

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Tainton

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imputus through the rapid growth of the zinc base

casting industry—now a consumer of zinc to the amount of over 30,000 tons a year. The American Society for Testing Materials, through its Committee B-2, Subcommittee XV, has been conducting exhaustive tests on over 80,000 specimens of various zinc and aluminum-base alloys with the aid of various cooperating pro-
ducers and testing laboratories, and when the result of its labors is complete the data obtained will throw considerable light on the character and properties of these alloys, and will be invaluable to the die-casting industry. Exposure of zinc-base alloys to a steam atmosphere at 95° C, with subsequent tensile and impact tests promises to reveal many interesting facts. Results so far published deal only with the physical properties before exposure to steam. Preliminary re-
ports of the steam test results, however, tend to con-
firm the general opinion in the industry that certain impurities in the metal have an adverse influence on the impact, tensile strength, corrosion resistance, and permanence, out of all proportion to their amount. With such high purity metals now available, the question of secondary contamination becomes of consider-
able importance.

NEW PROCESSES

With regard to the newer pyrometallurgical processes, very little has been published during the year. A quantity of high-grade retort zinc of 99.96 per cent purity has recently been placed on the market by the New Jersey Zinc Co. under the name of "Bertha Special," presumably a product from the new Sing-
master, Breyer & Bunce vertical, continuously-operated furnace, which made its debut in a semi-commercial form during 1928, the main features being high columnar retorts of large diameter, using a briquetted charge.

Progress has been made in perfecting experimental details of the ammonium-carbonate process for the preparation of pure zinc and cadmium carbonate from oxide fumes and galvanizer's waste. This process takes advantage of the solubility of these oxides in ammonium-carbonate solution, followed by cementation of the cadmium upon zinc, leaving a pure zinc carbonate, which, it is claimed, gives a very superior zinc oxide on low-temperature calcination.

The question of increasing the use of zinc and devis-
ing new outlets, in order to solve the problem of dis-
posal of the constantly increasing production, has been occupying the attention of the American Zinc Institute for some time. At the meeting held in St. Louis last April, steps were taken to organize a research depart-
ment, presumably along the lines of the Copper and Brass Research Association to further the interests of the zinc industry.

An interesting example of what can be accomplished by research was given in a paper read before the In-
stitute at its fall meeting, by E. A. Anderson, of the New Jersey Zinc Co., in which experiments are de-
scribed which led to the development of a zinc alloy roofing sheet containing 1.0 per cent copper and 0.01 per cent magnesium. A corrugated sheet of 13-gage metal of this alloy will withstand a fiber stress of 10,000 lb. per sq. in. as compared with 5000 lb. per sq. in. on

Review of the Zinc Industry for 1929

By Frank W. Harris, East St. Louis, Ill.

SURVEYING the general position of the zinc in-
dustry at the close of the year 1929, it would appear that the technical advancements have been more directly concerned with production than with consump-
tion. Developments of new and existing orebodies, successful concentration of ores hitherto impossible of utilization, and increased reduction capacity have to-
ger together brought about a condition wherein the potential supply of metal threatens to outstrip the normal in-
crease in consumption, notwithstanding the gratifying possibilities which are opening for the increased utilization of high-grade metal.

In the field of ore dressing and milling practice, con-
tinued progress has been made during the year in selec-
tive flotation of complex ores, and experimental work is being done at the Mississippi Valley Experimental Station of the U. S. Bureau of Mines on large scale flota-
tion of oxidized ores. Hand picking on a large scale has been applied at the Hartley mill of the Interstate Zinc-Lead Co. to low grade Tri-State ores, and is described by C. O. Anderson in the November issue of the Mining Congress Journal.

HIGH GRADE ZINC

Increased interest in high-grade zinc is evidenced by the continued upward world production curve of ele-
ctrolytic as compared with a slightly downward trend for retort zinc. World production of electrolytic zinc increased from 315,000 tons in 1928 to approximately 368,000 tons in 1929, whereas retort production decreased from 1,215,000 to about 1,210,000 tons. In the United States both electrolytic and retort zinc production in-
creased—the former from 160,000 tons in 1928 to approximately 165,000 tons in 1929, and the latter from 434,000 to 444,000 tons. This has been discussed in more detail by Arthur Zentner.

The most significant development in the electrolytic field has been the advent of 99.99 + per cent zinc, which has set a new standard in purity. Two brands are now on the market: "Bunker Hill," made by the Sullivan Mining Co. at Kellogg, Idaho, and "Evanwall," made by the Evans-Wallower Zinc Co. at East St. Louis. Both plants use the Tainton process, the essential features of which are high-current density, high-acid strength, and insoluble lead-silver anodes. The capacity of each plant is 50 tons per day.

While the trend toward purer metals has been taking place for some years, it has received considerable

*Evans-Wallower Zinc Co.


an unalloyed sheet and permits the support spacing to be increased from 37 in. on unalloyed zinc to the 54-in. spacing common in corrugated galvanized steel sheets. This alloy is marketed under the trade name of "Zilloy."

The advent of the high-grade electrolytic zinc of 99.99 per cent purity opens up new possibilities in the die casting, extrusion, wire, brass, dairy, and pharmaceutical industries, to mention a few at random. The change in properties brought about by an almost complete absence of impurities, increased passivity to acids, extreme ductility, and natural uniformity of composition, give to industry what is practically a new metal in many respects.

Cadmium, as a by-product from the electrolytic process, has been in active demand during the year and is being used in increasing quantities in copper alloys, bearing metals, pigments, and the plating industry.

Summing up, it may be said that research and education together hold the key to the problem of maintaining a satisfactory balance between production and consumption. Many energetic competitors have been for some years encroaching on what was once the zinc industry's exclusive field, and persistent and unifying efforts are necessary to brighten the prospects for zinc, and generally to bring a greater measure of prosperity to the industry in 1930.

Aluminum and Aluminum Alloys

By Sam Tour,* New York

Aluminum has been used for some time for such purposes as automobile bodies, coach bodies, metal trim and metal furniture for railway equipment. Recently this use has been extended in the railway field. In this way, railway cars have been built entirely of aluminum from the sill or floor up. As aluminum is used primarily for the purpose of reducing weight, it has long been realized that the greatest weight saving in railway equipment could only be accomplished by use of aluminum in the chassis. For this purpose, however, large structural shapes would be required. Indications were that should large structural shapes be made available, a sufficient market for same would develop to justify the expense of installation of fabricating equipment. Accordingly, the Aluminum Company of America erected a blooming and structural mill at their Massena, N. Y., plant, capable of producing structural shapes 14 in. in depth and 90 ft. in length in strong heat-treated aluminum alloy. They have also developed the casting practice necessary for 2000 to 3000-lb. ingots, and the necessary heat-treating equipment to heat-treat these large structural shapes.

One of the main difficulties with overhead cranes has been the excessive weight of the crane itself causing slow acceleration and slow retardation of the crane in operation. If the heavy steel structural members of such cranes could be replaced with aluminum, a considerable saving in weight would result and greater acceleration and retardation could be accomplished, power consumption reduced and work increased. The erection of the large structural mill referred to above has made possible the production of shapes for such uses. The Aluminum Company of America has installed a large overhead crane in which most of the structural steel parts have been replaced by aluminum with a resulting saving in total weight of crane of approximately 50 per cent. This crane is in operation in conjunction with a similar crane made entirely of steel, and they are already finding the great advantages of a decrease in weight of crane. It is expected that there will be a rather large application of structural shapes of heat-treated aluminum alloy in similar equipment throughout the country.

Aluminum is quite resistant to atmospheric corrosion and requires no coating materials such as paint, etc., to preserve it. It therefore offers a decided possibility for application in the field of architecture and construction in the form of exterior ornamentation of buildings. Two of the largest of such applications of aluminum have been in the Chrysler Building in New York City, and on the Cathedral of Learning in Pittsburgh, Pa.

Aluminum paint has been applied to oil tanks for some time. Aluminum is quite resistant to hydrogen sulfide; therefore it is finding a decided application in the handling of oils. Crude oil as obtained from the ground is not handled in aluminum, however, because the majority of crudes carry brine which attacks aluminum. Refined oils free from moisture do not attack aluminum, however, and as a result, several large all-aluminum storage tanks have been made and have proved quite satisfactory for the purpose. Aluminum is being used successfully for oil refinery pipe lines, condensers, etc., and indications point toward a rapidly increasing application of aluminum in this field. Aluminum foil is also being used for preserving steel in the oil fields and in the refineries, and this application is expected to expand in the future.

All-Metal Aircraft

New developments in lighter than aircraft have been made possible by the use of aluminum. The Detroit Aircraft Corporation recently completed construction of the new dirigible ZMC-2, for the United States Navy. In this construction Alclad aluminum sheet, a composite material consisting of a core of duraluminum type alloy with surface of high purity aluminum, was used to replace fabric as a covering for the aluminum framework. Increasing production in general in the aircraft industry and the tendency toward all metal construction have resulted in large increases in the use of aluminum in this field. Heat-treated aluminum alloy castings and forgings are used extensively in airplane engines.

The application of X-ray equipment for the inspection of aluminum alloy castings and forgings for internal defects has been extended considerably, and in two plants of the U. S. Aluminum Company this method is now being used for control of routine production.

Arc, butt and spot welding of aluminum has been developed to the point that all of these methods are being satisfactorily applied in production. Spot welding, for example, is now being used generally in the fabrication of aluminum cooking utensils.

In the secondary aluminum field there has been formed the Aluminum Research Institute, which consists of a representative number of the largest secondary aluminum smelters in the country. This institute plans a technical study and development program in connection

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with the refining of secondary aluminum materials, the
development of high-grade secondary aluminum alloys,
and the application of these alloys in industries. The
general result of such cooperative technical work can-
not help but be of considerable benefit to the entire
aluminum industry.

The American Society for Testing Materials, Com-
mittee B-2. Sub-Committee XV on Die Casting Alloys
has actively continued its study of various die-casting
alloys over a period of years, and is developing valu-
able information in connection with aluminum and its
alloys as applied in this field. Aluminum die castings
continue to find wider and wider fields of application
and the aluminum die-casting industry continues to
develop methods to produce larger and more complicated
aluminum die castings with satisfactory physical prop-
erties.

A few of the noteworthy articles on aluminum and
aluminum alloys appearing in recent publications are
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Effects of Cold Working on Physical Properties of Met-

Nickel in 1929
By A Member

T
HE consumption of nickel in 1929, in keeping with
the trend of the past several years, shows sub-
stantial increase. Of prime interest to the consumer
is the much enlarged production of higher purity
electrolytic cathode reported by the International Nickel
Co. for use in alloy steels and nickel alloys. This makes
common a form of nickel of a purity well beyond that
available heretofore in furnace products. This trend
toward high purity in nickel should stimulate the pro-
duction of new and higher quality nickel alloys.

Nickel alloy steels for such uses as railroad equip-
ment, agricultural implements, tractors, road building
and contractors' equipment, mining machinery and oil-
field equipment, continue to be the largest consumers
of nickel. A growing interest is noted in other nickel-
consuming materials, particularly the ferro-nickel alloys
which are being widely used in several types of elec-
trical design. The general trend toward more complete
household electrification includes with the demand for
these alloys a broader demand for heat-resisting ma-
terials of the nichrome type.

Increased use of chrome plate has increased the ton-
nage of nickel used in electroplating due to the high
qualities of chrome plate superimposed on heavy coatings
of nickel. The use of nickel in improving the quality
of cast iron has continued its growth and the use of
nickel in brasses, bronzes and aluminum shows some
promise. The field for nickel-silver is substantial and
continues to widen.

HIGH-NICKEL ALLOYS IN 1929

The use of high nickel content alloys for their cor-
rosion resistance has increased steadily during 1929
and certain new alloys have made rapid strides. The
use of nickel in the corrosion-resisting chromium-iron
alloys has become almost universal, resulting in a great
increase in the corrosion resistance and ease of fabrica-
tion of these alloys. They continue to be satisfactory
in chemical uses such as the manufacture of nitric acid
and in various parts of steam power machinery. They
also made their appearance during 1929, in food-hand-
ling and service equipment, laundry machinery, oil-
refinery and dairy equipment. It seems probable that
in the near future their use will be extended into fields
which have not before been considered practical for
nickel alloys. Technical study of the best working
methods, corrosion resistance, and galvanic relations of
these alloys has been fruitful of results.

Two of the newer nickel alloys which have appeared
during the year deserve especial mention: one, nick-
le-iron-molybdenum alloy, seems particularly suited to the
handling of hydrochloric and other acids and the other,
a nickel-chromium-silicon-iron alloy is resistant to sul-
furic acid as used in metal pickling processes.

Commercially pure malleable nickel has again in-
creased by high percentage in tonnage used. Its use in
the evaporation of caustic soda has become standard,
and as tanks for handling caustic soda, milk, and other
materials it is being applied more widely. Its use
seems to have solved the old problem of corrosion at the
bottom of deep oil wells.

Monel metal is still the most widely used of the high
corrosion-resisting nickel alloys. It shows a consider-
able increase both in amount used and in number of
applications during 1929. Some of the most interesting
developments have been its introduction into household
uses for such articles as kitchen sinks, tables and drain-
boards and in architectural metal work. Its use has
increased in food handling and service and a large number of soda fountains have been manufactured of
it. Such fields as chemical uses, electric equipment,
steam power, laundry and dyeing machinery, and steel
pickling have shown healthy growth. The manufac-
ture of certain types of apparatus and shapes has been so governed as to obtain higher strength and greater elasticity of properties than were available formerly. The corrosion resistance of this metal is not impaired by the cold working which produces high mechanical properties.

Non-ferrous Secondary Metals

By E. R. Darby,* Detroit, Mich.

From the recent publications of the Department of Commerce we learn that the value of the non-ferrous metals recovered from secondary sources in 1928 was $277,623,500, representing an increase of more than $21,000,000 over 1927. Fig. 1 shows an interesting comparison and analysis of secondary statistics.

The Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, recognizing the increasing metallurgical importance of the secondary metals, has held two symposiums dealing with the various phases of the subject (February, 1928, and September, 1929). The attendance upon both occasions was very satisfactory and from the genuine and general interest shown, it is evident that there is a real need for dependable technical information concerning the utilization of used and waste metals. The following paragraphs present briefly the more important developments in the handling and use of these metals.

The Bureau of Mines is yearly compiling complete and detailed data on the remelting and recovery of non-ferrous secondaries. Much study† has been given to sampling methods and analyses for evaluating all classes of secondary metals. This has been brought about by consolidation among the secondary smelters and by the increasing attention given to secondary sources by the copper refiners.

The classification of scrap castings and various grades of copper wire, turnings, and new metal clippings, by the secondary metal dealers and large manufacturing plants, has made available for use a large supply of excellent material. In most instances this material may be melted and poured directly into castings, and where the proper selection has been made, it is just as suitable as virgin metals.

Copper wire with excellent properties is being drawn from wire bars made entirely of secondary copper. This has been made possible by a thorough study of the various grades of scrap copper, careful laboratory control, and attention to furnace construction.

The automotive industry, with its many and varied kinds of non-ferrous waste, is giving careful attention to the economical use and disposal of such material so that much of it is directly used in the manufacture of products for that industry.

The contamination of turnings, grindings, and various forms of bronze and brass by-products, by aluminum and other harmful elements, is receiving attention by the secondary smelters. Refining methods are being developed whereby these impurities may be removed and a good, usable ingot metal produced.

The railroads of the country constitute one of the largest sources of secondary metals. All of the common metals and alloys are used. Copper from motors, electric lines, signal and lighting systems; brass from coach trimmings, lamps, ornamental fixtures; bronze from locomotive steam fittings, bearings, car journals; tin-base lining metals from machinery bearings and locomotives; lead-base metals from car journals, tender trucks and storage batteries; nickel alloys from kitchen cars; solders; zinc; all find their way to large central collecting points and represent millions of pounds yearly. The classification and disposal of this material requires an organization of well-trained men under close technical supervision, and the care with which this work is done has a marked effect upon the value of secondaries throughout the country.

The treatment of drosses, slags, skimmings and other forms of oxidized metal is largely confined to the secondary smelters. In some instances large industries and non-ferrous foundries with heavy capacity have found it economical to smelt and refine these classes of secondaries in their own plants. Where quantities of such material are large, and the carrying charges to the nearest smelting company are heavy, such a procedure has been found to effect considerable saving.

References


There has been little published concerning the metallurgy of secondary smelting and refining and the technical control of such work. Undoubtedly there are many engaged in this field of metallurgy who could present interesting and valuable data concerning the theory and practice of these processes. Such data, if published, would be of great assistance to industry in general and its publication would stimulate investiga-

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†References are at end of review.
tion and bring forth improvements and new processes. If producers of secondary metals were more familiar with the work of refining and smelting and the difficulties encountered therewith, they could in many instances prevent costly contamination and keep their waste in a form more valuable to themselves and the smelter.

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**Technology of the Precious Metals**

By George F. Kunz, New York, N. Y., and Edmund M. Wise, Bayonne, N. J.

In a brief résumé it is possible to indicate only a few of the ways in which the precious metals perform their varied, important, and in some cases, vital functions in modern life. Gold and silver have had a very important influence upon the world's history, for the lure of these metals has led men to conquer whole peoples and to colonize the most forbidding wastes; thus furnishing an interesting example of the social values of metallurgy.

**Coinage.** The most important use for gold and silver is their application to coinage. Most of us are more or less familiar with this important product but it is interesting to note that the adoption of these metals as media of exchange many centuries ago, rendered it possible to depart from the old system of barter and made practical the transaction of business between widely separated nations. But for these metals we might still be hoarding great quantities of sea shells, wampum, bark and other materials no longer considered precious.

**Jewelry.** Platinum-iridium alloys, usually containing 5 to 15 per cent, but sometimes as much as 30 per cent of iridium to adequately harden them, occupy their unique place in the fine jewelry field where their beauty and stability render them supreme, even at their high price.

Some small amount of platinum-topped jewelry, consisting of a gold alloy surfaced with a layer of platinum or platinum-iridium, constituting 5 per cent of the weight of the article, is made to fill the gap between the costly solid platinum jewelry and that made of the less expensive white gold.

Gold alloys of various degrees of fineness are available in a variety of colors. Red, yellow, green and white golds can be produced by a suitable choice of the added silver and base metal alloying constituents.

White gold alloys, which were originally introduced as platinum substitutes, are widely used in the less expensive grades of jewelry and are produced in both the solid and filled grades in carat ranging from 10 to 20. These alloys are usually of the gold-nickel-copper-zinc type and the whitest grades are inherently hard and difficult to fabricate. Where better working properties are required the gold-palladium and gold-palladium-nickel alloys are used. Recently an alloy containing 75 per cent gold, 15 per cent palladium and 10 per cent nickel has become quite popular in France, where its rather subdued whiteness and easy working properties have been appreciated.

The color of the softer white golds is not very pleasing and the low-carat gold alloys tarnish to some extent; furthermore, the color of the solders used with these alloys frequently does not match that of the white gold so that a finishing plate of platinum, palladium, palladium-rhodium, nickel, chromium, or tin is often employed to harmonize the colors; but the plating may wear off after a time, dependent on its nature and thickness.

Sterling silver and silver-plated ware continue to occupy their important fields in the household but the tendency of these alloys to tarnish is objectionable. To avoid this, the silverware may be plated with palladium or a palladium alloy which, while not as white as freshly polished silver, has the advantage of remaining bright and free from tarnish. This application of palladium may become rather important.

**Electrical Apparatus.** The use of platinum-iridium alloys, containing 15 to 25 per cent iridium, for contacts in magnetos, particularly those used upon aircraft, is almost universal and is an important factor contributing to the extraordinary reliability of these small ignition units. Similar platinum-iridium alloys, sometimes containing in addition a small amount of rhodium, find important application to a wide variety of electrical apparatus where a reliable, rugged contact capable of dissipating considerable energy is required. Such contacts are now widely employed in high speed telegraph circuits where they are required to operate at 120 breaks per second and function with extreme accuracy over long periods of time.

Experimental work regarding the use of tungsten-platinum alloys, instead of tungsten, in battery ignition systems is under way and it appears that these alloys possess considerable potentialities. Palladium in the form of the pure metal and as a high palladium content alloy is being used in large quantities for electrical contacts in telephone equipment where a contact of high stability is required.

A heavy gold plate is being applied to the interior contact elements of the new "French" type telephone transmitters to protect them from corrosion and maintain a very low contact resistance.

Silver and silver-copper alloys containing up to 20 per cent of copper and sometimes a small amount of platinum find wide use where a contact metal better than copper is required and where the cost of a platinum or palladium contact of the size required would be excessive. A contact "alloy," composed of a matrix of carbon containing small globules of silver scattered throughout the mass, has been on the market for some time. Such contacts appear to be quite satisfactory for relays where freedom from sticking is the primary requirement, as is the case in railway signal equipment.

Platinum, or preferably a platinum-rhodium alloy, is utilized in the construction of high-temperature electric furnaces. Furnaces wound with a suitable
platinum-rhodium alloy may be operated at as high as 1600° C. in an oxidizing atmosphere.

Thermocouples utilizing platinum and platinum-rhodium elements find an important application in the measurement of the high temperatures required in many metallurgical and ceramic processes.

Silver-copper-lead alloy solders containing about 2.5 per cent of silver, 0.25 per cent copper and lead, the remainder melting at 304° C, have been applied to electrical machinery where a melting point materially higher than the usual lead-tin alloy is required.

Silver solders, usually of the silver-copper-zinc type, are used in electrical machinery where very high strength and reliability are required. Similar silver solders are employed in the construction of the cooling coils used in the electric refrigerating units now so popular.

Chemical and Photographic Applications. The use of the Pt 90-Rh 10 per cent alloy for the catalytic oxidation of ammonia to nitric acid is perhaps the outstanding development of the year. The life of such alloys is considerably greater than that of the pure platinum previously employed. It is interesting to note that a small catalyst screen made of this alloy, weighing only 40 oz., will oxidize some 500,000 lb. of ammonia before it is necessary to replace the catalyst. The use of a platinum catalyst upon a silica gel support for the oxidation of SO₂ to SO₃ in the manufacture of sulfuric acid has shown very promising results. Development work destined to utilize the extremely active catalytic properties of palladium as a hydrogenation catalyst is in progress and appears to offer attractive possibilities in certain organic syntheses.

Gold-platinum and gold-palladium alloys find an important application in the form of spinnerets used in the production of rayon, the substitute for silk. The use of silver in photographic materials continues to constitute the most important application of silver to chemical processes. Incidentally, it may be noted that the development of the Movietone and similar types of talking films has imposed extraordinary demands upon the film in regard to uniformity and fine grain size.

The platinitype and palladotype photographic papers were rather widely used prior to the war, but the increase in the price of the platinum metals restricted their use for several years. It is felt that the beauty and permanence of the platinitype and palladotype deserve more general recognition, in view of the fact that the platinum metals are now available at lower prices.

A compact portable device for indicating the presence of combustible gases has been developed. This instrument utilizes the change in the temperature of an electrically-heated platinum wire to indicate the presence of combustible gases and serves to detect their presence in mines, the holds of ships, gas storage tanks, etc. A somewhat similar device has been developed to measure the thermal conductivity of gas mixtures by measuring the change in the resistance of an electrically-heated platinum wire surrounded by the gas and thereby indicate any change in the composition of the gas mixture.

Metal sponges made of metals of the platinum group are used in catalytic lighters for igniting alcohol vapor or gas-air mixtures.

Silver solder is frequently employed in the production of the strong corrosion-resistant joints required in chemical tanks constructed of nickel, monel metal, nickel-chrome iron, or a chrome-iron alloy.

Dental Uses. Platinum hardened with iridium or copper has been employed in the form of tooth pins, clasps, etc., but has largely been replaced by more or less satisfactory substitutes. Platinum and palladium are important constituents of gold-base dental alloys, where they serve to increase the melting point, lighten the color, and increase the hardness and response to heat treatment. Certain of these alloys possess a tensile strength in excess of 150,000 lb. per sq. in., after suitable heat treatment.

Recently considerable interest has developed in white casting alloys consisting essentially of palladium-gold-silver and copper with the palladium content ranging from 14 to 25 per cent. The appearance of these alloys in the mouth is far less conspicuous than the yellow gold heretofore used, so that increasing interest in such alloys is to be expected. Palladium-base wrought alloys, high in melting point and very responsive to heat treatment, have been developed which harmonize with the alloys above mentioned so that complete white restorations can be produced.

Palladium-silver alloys and high palladium content alloys are finding increasing use as a base for artificial dentures. The palladium-silver alloys are used in conjunction with either vulcanite or one of the Bakelite type of condensable resins, while the high-palladium alloys are used as a base upon which porcelain is fused.

Mechanical Uses. Silver solders are being used for the production of strong joints between both steel and the copper alloys and this excellent material is being used in increasing quantities for producing reliable joints in the all-important fuel and oil lines for aircraft. Silver content copper alloys are used in the hydrogen brazing process where it is not desirable to heat the parts to the temperatures required to fuse pure copper.

Methods and Equipment. The introduction of a small gas-fired hydrogen atmosphere annealing furnace has been a boon to the jewelry manufacturer, for this furnace permits the annealing and soldering of jewelry without the production of scale or "fire" and dispenses with the need of pickling, washing, and drying numerous small parts. Small hydrogen-atmosphere electric furnaces are now available which retain the good features of the furnace above mentioned, plus the added convenience and cleanliness of electrical heat.

Salt baths have been used for annealing precious metal alloys but are not very convenient to operate and usually attack some of the alloys. In any case the necessity of washing and drying the annealed materials is somewhat troublesome.

Methods for electrodepositing the platinum metals, platinum, palladium, rhodium, and their alloys have been considerably improved within the past year. Baths are now available that will produce satisfactory deposits of these metals when operated at room temperature. Methods for the production of gold alloys by electro-deposition have been considerably improved recently so that deposits of any desired color and carat may be produced.

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**Silver Alloys**


**Electroplating (Silver Plating)**


**For Handling Electric Cable**

In underground and pit operations motor cables, machine cables, and electric loader or shovel cables must frequently be handled in wet and dangerous places. A hazard is thus presented when men handle these cables without providing insulation for themselves, especially so since the cable insulation itself is quickly abraded by the hard usage it receives.

One company that operates large electric shovels in an open pit where the ground is wet and where the shovels are frequently moved, necessitating much handling of the cable, has practically eliminated accidents from that source by using a simple cable tongs of the type sketched, that can be made in any shop.

![Wooden Handles](image)

**Safety Cable Tongs**

The strap iron pincer jaws are shaped semi-round where they grip on the cable, has practically eliminated accidents from that source by using a simple cable tongs of the type sketched, that can be made in any shop.

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