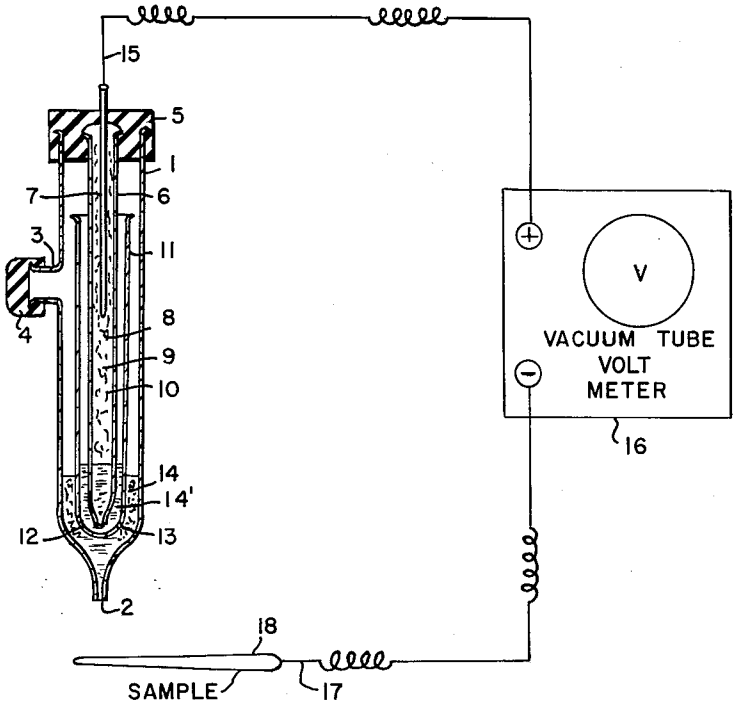
May 8, 1962 VANN YUEN 3,034,050

ELECTRONIC APPARATUS FOR DETERMINING IDENTIFICATION METALS AND METAL ALLOYS

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# ELECTRONIC APPARATUS FOR DETERMINING IDENTIFICATION METALS AND METAL ALLOYS

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The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

This invention concerns an apparatus and a method for accomplishing the segregation of unidentified and misidentified metal alloys with particular reference to aluminum alloys such as those commonly used in aircraft and the like.

A background for the understanding of this invention is provided by the book Metal Data by Samuel L. Hoyt published in 1952 by the Reinhold Publishing Corporation, New York 36, N.Y. at pages 369 et seq.; by the Patents 2,706,712, issued April 19, 1955 to Rolf K. Ladisch for a Portable Polarographic Half Cell; 2,366,844, issued January 9, 1945 to Antony Doschek for a Method Of And Means For Identifying Metals; 2,531,747 issued November 28, 1950 to R. F. Stearn for a Metal Identifier; 2,553,-068, issued May 15, 1951 to E. W. Tucker for an Electrolytic Cell; etc. A calomel electrode in KCl is discussed briefly at page 235 and elsewhere of Storage Batteries by George W. Vinal published in 1955 by John Wiley and Sons, Inc. New York City, N.Y.

A brief summary of the invention follows, indicating its nature and substance together with a statement of the objects of the invention commensurate and consistent with the invention as claimed and also setting out the exact nature, the operation and the essence of the invention complete with proportions and techniques that are necessary for its use. The purpose of the invention also is stipulated. The presentation is adequate for any person who is skilled in the art and science to which the invention pertains to use it without involving extensive experimentation. The best mode of carrying out the invention is presented by the citing of a specific operative example inclusive of the preparation and the use of at least one example of the invention.

This invention provides an apparatus and a process for applying the moist tip of a new and improved probe to a clean metal surface and from a voltage reading that is characteristic of the metal so contacted quickly and easily identify the metal without in any way damaging it.

A probe that embodies a part of the present invention with its connections and an associated instrument, is shown in an elevational axial sectioned view in the single FIGURE of the accompanying drawing as an improved single electrode system or a half cell.

The probe is shown connected through leads to a vacuum tube voltmeter and in position for making contact with a sample alloy. The probe contains a saturated calomel electrode with a liquid junction. The improved electrode embodies a gas shield to prevent a gas lock. This is a unique advantage when used with a hydrogen peroxide containing electrolyte solution.

The calomel electrode that is disclosed herein is an improvement over the Beckman special types of electrodes, such as the calomel electrode designated H–29330 in the 1955 Harshaw Scientific Catalogue, published by the Harshaw Chemical Company, 1945 E. 97th Street, Cleveland, Ohio. The Beckman electrode H–29330 is a double junction type wherein a permanently charged calomel-mercury column is sealed into an intermediate tube filled with a KCl saturated solution.



The method proposed herein for the identification and the segregation of aluminum alloys is not intended to replace chemical and spectrographic analysis. Its application is rather the sorting and the identifying of commonly available alloys based on their electrical characteristics in a rapid, easy and an economical manner without damage to the alloy so identified.

In the accompanying drawing is shown a probe or an electrode assembly that embodies the present invention. The electrode assembly comprises an upwardly open glass outside shell **1** that terminates downwardly in a small apertured tip **2**. An electrolyte is supplied to the outside shell **1** through a lateral mouth **3** that is removably closed with a rubber cap **4**. A plastic cap **5** closes the open upper ends of the outside shell **1** and of an inside shell **6**. The cap **5** supports at its center a platinum wire **7** that extends axially down into the inside or innermost shell **6**. The inside shell **6** contains a mixture of granular calomel **8** and potassium chloride **9** dispersed through liquid mercury **10** around the platinum wire **7**.

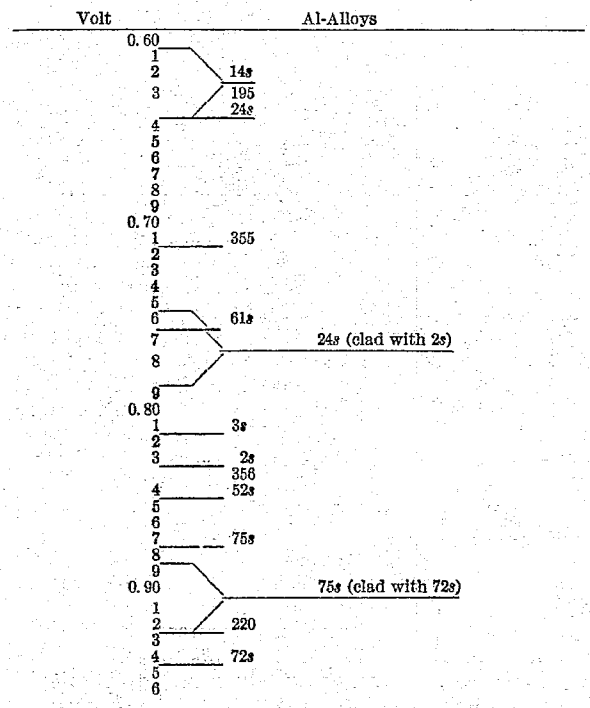
The innermost shell **6** has its upper end secured in the plastic cap **5** and its lower end apertured to open into the permeable lower part of an intermediate gas shield third shell **11**. The gas shield, intermediate or third shell **11** opens upwardly below the plastic cap **5** and within the glass outside first shell **1**. The intermediate shell **11** is downwardly permeable, as by the apertures **12** and **13**, or the like, in ample number to avoid a gas block in circuit. Fiber glass **14** and **14'** serves to space the lower portions of the shells **1**, **6** and **11** with respect to each other.

An output lead **15** has one of its ends connected to the positive terminal of a vacuum tube voltmeter **16** and its opposite end is secured by solder or the like to the upper end of the platinum wire **7**. The negative terminal of the vacuum tube voltmeter **16** is connected by the lead **17** to the alloy sample **18**. An illustrative vacuum tube voltmeter is shown in FIG. 15–1 on page 598 of the Theory and Applications of Electron Tubes by Herbert U. Reich, published in 1944 by the McGraw-Hill Book Company, New York city.

The electrolytic solution to be added through the lateral mouth **3** of the outside shell **1** is prepared by mixing by volume four parts of a saturated water solution of potassium chloride with one part of a 30% hydrogen peroxide solution and should be prepared immediately before it is used. The introduction of the electrolyte into the outside shell **1** with its tip **2** in contact with the sample **18** causes the electrolyte to pass through the apertured tip **2** and to moisten the surface of the sample **18**, or a drop of the electrolyte may be placed on the alloy sample **18** at its point of contact with the tip **2** of the probe.

The position of the needle on the scale of the voltmeter **16** indicates a potential reading that is characteristic of many alloys, such as those used in the structure of aircraft and the like. Representative potential meter read-

ings for particular alloys identified in the cited Hoyt text and established by repetitive experimental confirmation are listed in the following chart:




The chemical compositions of the cited aluminum alloys appear at pages 369 and 370 of the Hoyt text.

In the above chart it will be noted that the aluminum alloys designated 14s and 195 display on the vacuum tube voltmeter **16** a voltage of from 0.60 to 0.63 volt as a potential that is characteristic of this group of alloys. In other words, in the event the tip **2** of the electrode shown in section in the accompanying drawing in circuit is caused to contact an alloy 14*s* or 195, the voltage reading on the vacuum tube voltmeter **16** will be in the range of from 0.60 and 0.63 volt. The voltage reading 0.63 is a potential characteristic of the aluminum alloy 24*s*.

In a similar way the voltage reading 0.71 indicates and is a characteristic of the aluminum alloy 355. The alloy 61*s* has a characteristic potential reading of 0.76. A voltage reading that falls within the range from 0.75 to 0.78 indicates the alloy 24*s* clad with the alloy 2*s*. The voltage reading 0.81 volt is characteristic of the aluminum alloy 3*s*. The alloys 2*s* and 356 both are characterized by the voltmeter reading 0.83. The alloy 52s is indicated by the voltage reading 0.84 and the alloy 75*s* is indicated by the voltage reading 0.87. Readings on the voltmeter **16** between the range from 0.88 to 0.92 volt are characteristic of the aluminum alloy 75*s* clad with the alloy 72*s*. The voltage reading 0.92 indicates the aluminum alloy 220 and the voltage reading 0.94 indicates the alloy 72*s*.

From the foregoing experimental findings it will be apparent that, with the improved half cell described and shown in the accompanying drawings, other alloys, metals and the like will also display their characteristic voltages that in a similar manner may be used to identify the alloys, metals etc. with a minimum of effort and time consumption.

The process that embodies the present invention is to clean a spot on the surface of a piece of metal of unknown composition, contact the clean surface of the unknown with the electrolyte exposed at the opening in the tip **2** of the probe outside shell **1** in circuit, and to read the indicated voltage on the vacuum tube voltmeter **16**, the indicated voltage is the electrical characteristic of the metal of unknown composition.



It is to be understood that the structural details of the probe that is disclosed herein and of the circuit in which it is used are illustrative of a successfully functioning apparatus and method and that similarly functioning apparatus and method steps may be substituted for those disclosed herein without departing from the invention.

I claim:

1. A probe comprising an upwardly open glass outside shell that terminates downwardly in a small apertured tip and that is provided with a mouth for the introduction of an electrolyte within the outside shell, a plastic cap closing the open upper end of the outside shell, a platinum wire with its upper end exposed to outside the assembly by extending through and being secured to the plastic cap and the platinum wire extending axially within the glass outside shell, an inside shell with its upper end closed by the plastic cap and terminating downwardly in a small apertured tip, a mixture of granular calomel and potassium chloride dispersed through liquid mercury within the inside shell, a downwardly permeable gas shield intermediate shell extending downwardly below the lower end of the inside shell and between the inside shell and the outside shell, a first fiber glass means interposed between and maintaining spacial relationship between the inside shell and the gas shield intermediate shell adjacent the lower ends thereof, a second fiber glass means interposed between and maintaining spacial relationship between the gas shield intermediate shell and the outside shell adjacent the lower ends thereof, and an electrolyte consisting of a mixture by volume of four parts saturated water solution of potassium chloride and one part of 30% hydrogen peroxide solution within the lower ends of the inside shell and the gas shield intermediate shell and the outside shell and the electrolyte being accessible to outside the probe through the apertured tip at the lower end of the outside shell.

2. The probe in the above claim 1 wherein the upper end of the inside shell is secured in the plastic cap.

3. The process for segregating one unknown from an indeterminate group of metals by its electrical characteristic by cleaning the surface of the unknown, contacting the cleaned surface of the unknown with an electrolyte that consists of a mixture of by volume four parts of a saturated water solution of potassium chloride and one part of a 30% hydrogen peroxide solution, and contacting the electrolyte of potassium chloride and hydrogen peroxide with a saturated mixture of granular calomel and potassium chloride as the dispersed phase through liquid mercury as the dispersing medium, and determining as a physical characteristic of the unknown the potential value of the electrolyte in contact with the unknown and in contact with the granular calomel and potassium chloride in liquid mercury.

4. The process of determining the electrical potential characteristic of an unknown mixture of metals as an alloy identifying physical constant thereof that is accomplished by electrically contacting in a series connected potential indicating electrical circuit the unknown mixture of metals with an electrolyte of the composition by volume of four parts of a saturated water solution of potassium chloride and by volume one part of 30% hydrogen peroxide solution, and connecting in series therewith a saturated mixture of granular calomel and potassium chloride dispersed through liquid mercury for obtaining a potential reading that is characteristic of the unknown mixture of metals.

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