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AN AUTOMATIC ELECTRODE LOADER AND
POSITIONER FOR EMISSION
SPECTROGRAPHS

J. D. Caylor

RELEASED FOR ANNOUNCEMENT
IN NUCLEAR SCIENCE ABSTRACTS

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

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ABSTRACT

An apparatus has been built that automatically loads counter and crater spectrographic electrodes, positions both to a predetermined analytic gap, and automatically controls the analytic gap during burning. The maximum load of each device is forty samples.

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SUMMARY

An apparatus has been fabricated that automatically loads and positions both counter and crater spectrographic electrodes for ignition. In addition, the apparatus automatically controls the analytic gap during burning.

The apparatus consists of four devices: (1) a device for positioning the counter electrodes, which are standard spectrographic electrodes; (2) a device for positioning the crater electrodes, which contain the samples to be analyzed, and come in a variety of diameters; (3) a photoelectric device for controlling the analytic gap during the burning; and (4) an electronic control panel that provides variable analytic gap spacing and servo control during sample burning.

INTRODUCTION

An apparatus was needed for loading both counter and crater spectrographic electrodes, with automatic analytic gap positioning, during both ignition and burning.

The apparatus was also needed to provide precise control of the analytic gap, plus safe and efficient handling of the electrodes, especially the crater electrodes since they contain the samples to be analyzed and since they require considerable time to prepare.

DESCRIPTION OF THE DEVICE

Figure 1 presents an overall view of the automatic electrode loader and positioner. In the descriptions that follow, reference should be made to the photograph.

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Figure 1. COMPONENTS OF THE AUTOMATIC ELECTRODE LOADER AND POSITIONER.

COUNTER-ELECTRODE ASSEMBLY

The counter-electrode loader body is machined from a one-inch-thick piece of glass-base silicone laminate with lava inserts attached, where needed, to withstand heat and arc erosion. Brass inserts are used to reinforce all threaded surfaces. The functional parts are machined from steel with the exception of the motor mounting plates, which are aluminum, and the stationary portion of the clamping jaws, which is made of brass that is grooved to provide a heat sink. The threaded female portion of the driving shaft is made from oilite bronze to provide lubrication between the threaded surfaces. The loading drum is machined from nylon.

The loading cycle of the counter-electrode loader involves several steps. Forty counter electrodes are loaded into the holes of the loading drum. Loading can be accomplished with the loading drum mounted on the loader body, or the drum can be removed for loading elsewhere. By depressing the load button on the electrode control panel, the position motor is started which, in turn, raises the loader body to the load position. This movement activates a switch that starts the load motor. The load motor drives a shaft that: (1) advances a foot under the spent electrode to guide it into a salvage receptacle, when released; (2) opens the jaws which clamp the electrode during the burn cycle; (3) rotates the loading drum, permitting a new electrode to enter the jaws to be clamped for a new burning cycle. The guide foot consists of two surfaces: (1) a sloped surface to reject the spent electrode, and (2) a flat surface to stop the downward fall of the new electrode. The foot remains in this position until the load motor reverses allowing the jaws to clamp the new electrode. The foot is then retracted to protect it from the arc during the burn.

The body of the counter electrode loader including the load motor is mounted to a bracket and coupled to the position servo motor by rack and pinion gears. This motor, which is driven by an amplifier, fed by a balanced photoelectric device, moves the entire loader body up or down during the burn to maintain proper arc spacing. Contamination of the new counter electrodes loaded in the drum is prevented by a lava protective plate which protects them from the arc.

CRATER-ELECTRODE ASSEMBLY

The crater electrode loader body is machined from a 1 1/4-inch-thick piece of glass-base silicone laminate with brass inserts to reinforce the threaded holes. Other functional parts are machined from steel.

Forty crater electrodes, charged with the samples to be analyzed, are loaded into a slot in the tray of the crater electrode loader. These electrodes, are under pressure from the rear where tension is applied by a constant-tension spring that is mounted in the tray body. The spring passes under the samples and is coupled to a pushing pawl in the rear of the electrodes. Like the loading drum of the counter electrodes, this tray can be removed and loaded elsewhere, if desired.

When the load button on the control panel is depressed, the lower positioning motor (not mounted in Figure 1) is started, thereby lowering the loader body to the load position. This movement actuates a switch that starts the load motor. The load motor rotates a lead screw which drives the tray forward to release a gating pawl from a stop, permitting it to rotate and thus gate the front electrode through. This procedure allows the crater electrode to be pushed forward to the front of the tray by a foot mounted to a spring arm on the return cycle of the tray. The next load cycle carries the electrode, which is now at the front of the tray, forward between the split jaws of the loader. These jaws open by roller cam action that is initiated by a push

rod. The cam action is between the two spring supports of the lower jaws. The load motor reverses, retracting the push rod, and permitting the jaws to clamp the electrode. The tray is retracted to its starting position. During this cycle, the second crater electrode is gated out and moved to the front of the tray preparatory to the next loading cycle. A spring-loaded door, which is opened by the forward movement of the tray, protects the sample on the front of the tray from contamination. Positioning of the crater electrode, which is identical to that of the counter electrode, is accomplished by a balanced photoelectric device feeding a servo balancing motor.

CONTROL DEVICE

The photoelectric control device (Figure 2) consists of three parts. Two parts are identical, with each part containing two photoelectric cells. One set of these cells controls the position of the counter electrode; the other controls the position of the crater electrode. The third part is a single photoelectric device which senses if the arc is lit. If for any reason the arc should extinguish before the excitation period is completed, an alarm is sounded and further analysis is inhibited.

Figure 2. PHOTOELECTRIC CONTROL DEVICE.

The control photocells of each part are connected so that when the illumination on each cell is equal, the voltage output of the combination is zero.

Since the glowing image of the electrode changes due to burning away of the electrodes during analysis, the image position is shifted so that one cell "sees" more light than the other. This condition results in a voltage output from the two cells. The polarity of this voltage is determined by the direction in which the image moves. The voltage is fed to a servo amplifier in the control panel which causes the servo positioning motor to drive in the direction that will produce a balance in the output of the photocells; thus, the same analytic gap spacing is maintained at all times during the burning time.

CONTROL PANEL

The control panel consists of two sections which are identical except for motor phasing. Each section contains switching circuitry that provides individual control of the associated loader, when in either the automatic or manual mode. Included in each section is a solid-state servo amplifier. This amplifier, working in conjunction with a linear-motion potentiometer (Figure 1), which is mounted on each loader body, provides the operator with control-knob selectivity of both the retract-to-load positioning and the gap spacing during ignition.

Small changes in gap spacing during the excitation period while under photoelectric control can also be made using the control knob selectivity. Major changes in gap spacing are made by adjustment screws (Figure 3) which change the space between the two photocell sections.

Also included in the control panel are the firing circuits for the arc, with interlock, and limit circuits which prevent arc firing until the loaders have returned to the pre-fire position.

SUPPORTING EQUIPMENT

The automatic electrode loaders in conjunction with the electrode load and position sequence control panel are compatible with most any type of spectrograph, whether it be the direct-reader (photomultiplier) type or the photographic type.

Two sets of these loaders are currently in use on applied research quantometers at the Y-12 Plant. These instruments are the direct-reader-type spectrographs. One has a 21-element analysis capability; the other a 52-element analysis capability.

When used with this type of spectrograph, the only external signals necessary to the sequence panel are: (1) an interlock circuit including a compartment door interlock which closes upon completion of the readout, and (2) a signal in the form of a contact closure, such as a timer, to indicate that the excitation cycle was of the right duration. This timer signal is used as the load command. If, for any reason, the

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Figure 3. ARC STAND HOUSING.

arc extinguishes before this signal is received, an alarm is sounded and further analysis is inhibited until corrective action is taken.

To completely automate spectrographs of this type, in addition to the automatic loaders, it is necessary to provide some curve-correction device to furnish linear parts-per-million readout for all elements. In this case an IBM output writer was used for data recording.

For photographic-type spectrographs, in addition to the automatic loaders, provisions must be made for automatically racking the plates. Such a device is not too difficult to construct. A racking sequence unit was installed on a 21-foot Jarrell-Ash spectrograph with a Wadsworth mount, working in conjunction with a Bausch and Lomb spectrograph with a Littrow prism mount. Racking is accomplished for both instruments by one sequence unit.

As in the case of the direct-reader spectrograph, two external signals must be furnished to the electrode sequence panel; however, the readout complete signal can be replaced by a racking complete signal since the data are recorded in the form of an exposure on a photosensitive plate.

Good periodic maintenance is most important for obtaining trouble-free service from the loaders. Visual inspection of all moving parts, adjustment screws, and electrical connections (particularly high-voltage connections) is essential. Also, lubrication and cleaning of moving parts must be performed at regular intervals.