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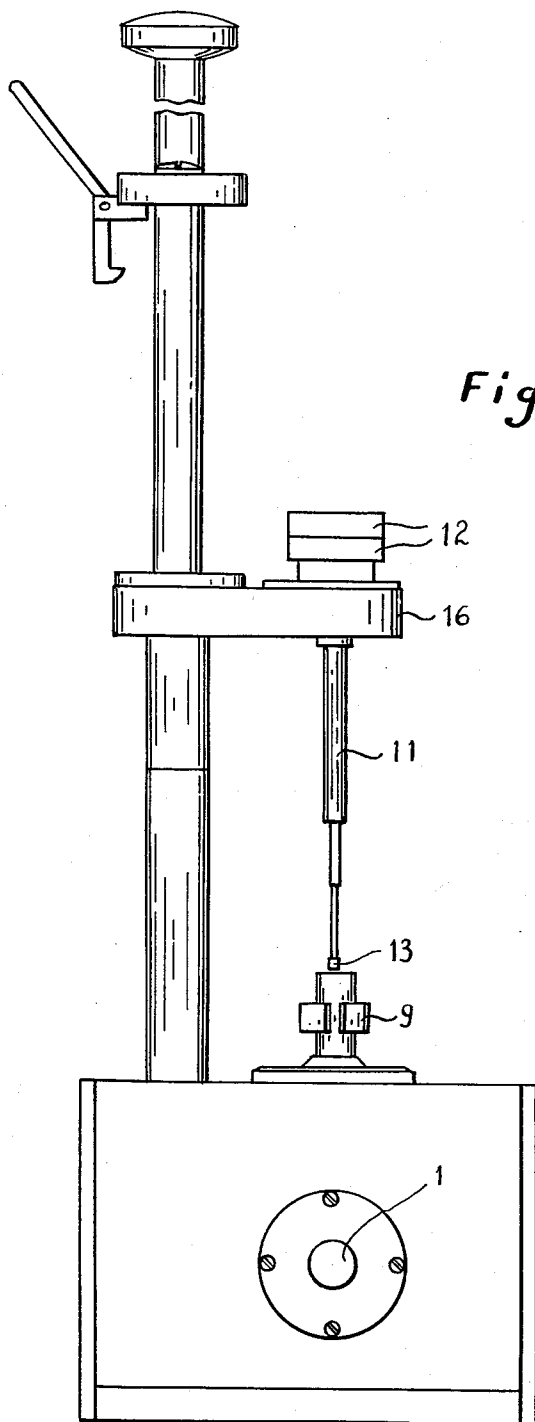
A. STRASHEIM ET AL

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APPARATUS FOR PACKING POWDERS INTO VESSELS HAVING LONG NARROW
CAVITIES, MORE ESPECIALLY CAVITY ELECTRODES
FOR SPECTROCHEMICAL ANALYSIS

Filed Aug. 20, 1958

3 Sheets-Sheet 1



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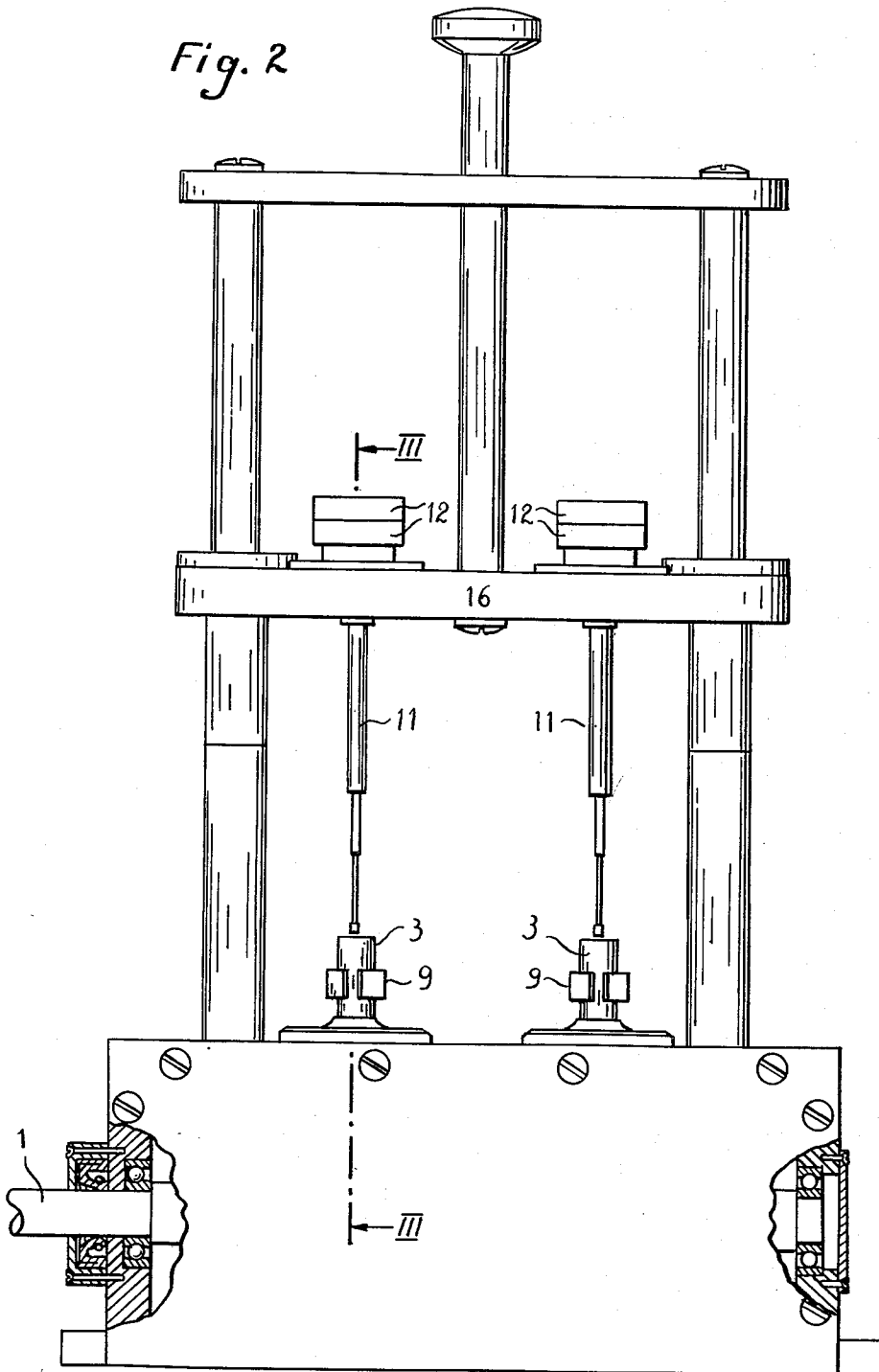
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Fig. 2



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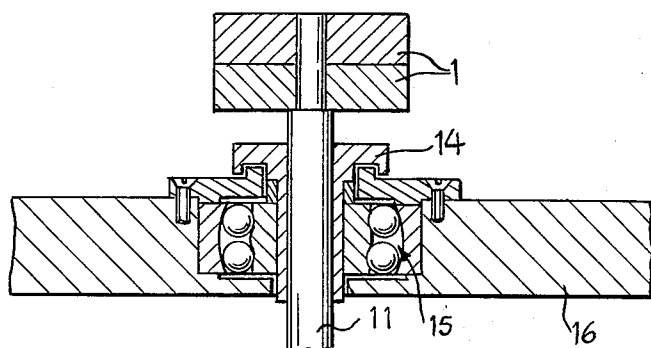


Fig. 3

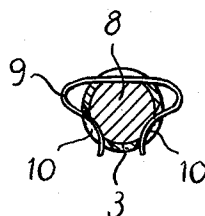
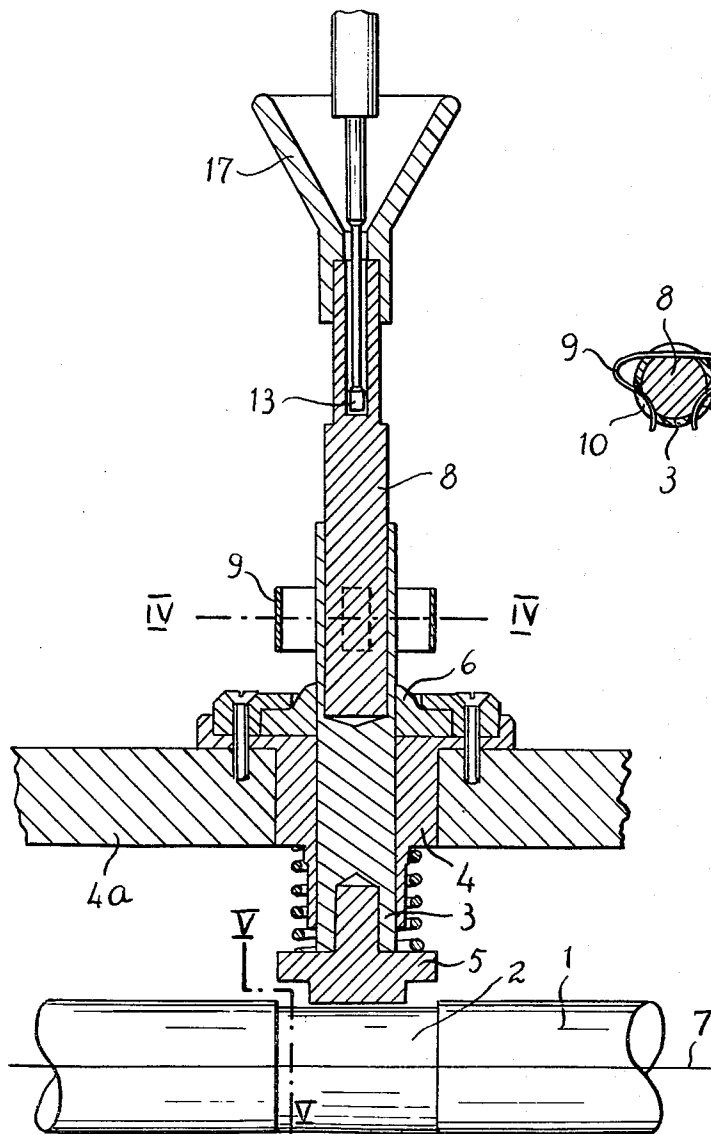


Fig. 4

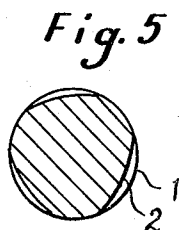


Fig. 5

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APPARATUS FOR PACKING POWDERS INTO VESSELS HAVING LONG NARROW CAVITIES, MORE ESPECIALLY CAVITY ELECTRODES FOR SPECTROCHEMICAL ANALYSIS

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The present invention relates to an apparatus for packing samples for spectrochemical analysis into hollow electrodes, in particular into graphite or carbon spectrochemical cavity electrodes.

A main object of the invention is to provide an apparatus by means of which electrodes may be more evenly, more uniformly and more efficiently packed than is normally possible with the manual procedure.

A further object is the provision of a machine which can pack more material on a weight basis into an electrode of a given size than is possible by hand, and which will do so in a small fraction of the time which the manual operation requires, and with a reproducibility which is greatly superior to that obtained with the manual method.

In particular, it is an object of the invention to obtain more rapid and reliable results from spectrochemical analysis than was possible when the electrodes were hand-packed.

Furthermore it is intended to provide a machine with which a single operator can pack more than one electrode at a time.

The machine or modifications thereof may also be applied to other purposes involving the packing of powders into narrow cavities.

The apparatus in accordance with the invention for packing hollow electrodes for spectrochemical analysis comprises means for setting a vertically held hollow electrode into vertically reciprocating movement relative to a plunger which is adapted to project into the cavity of the electrode and to allow fine particles of the material which is to be packed to move within said cavity to the underside of the plunger during the packing operation.

In the preferred embodiment, the mechanism imparting the reciprocating movement acts on the electrode and the said plunger is independent of this mechanism, its effective end being adapted for free movement in a vertical direction. Some movement is, however, imparted indirectly to the plunger as a result of the movement of the electrode with which the plunger is coacting during the packing operation.

Advantageously the upper end of the plunger member is laterally supported and guided preferably by a self-aligning ball race. Weights may be loaded on to the plunger additional to the weight of the plunger itself, which serve to press the plunger more firmly downwards. These weights depend on the size of the electrode, and may sometimes depend on the type of powder being packed.

The maximum overall plunger weight depends on the electrode cavity. For example, with electrodes having a wall thickness of 1 mm., the weights employed without damaging the electrode may be as follows:

Diameter of electrode cavity:	Weight, g.
1 mm.-----	15
2 mm.-----	70
4 mm.-----	100

Preferably the plunger is dimensioned to leave a small

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clearance between the periphery of the plunger and the wall of the cavity in the electrode which clearance is sufficiently large, say of the order of 0.05 mm. all round, to allow the pulverulent particles to move past the plunger and to accumulate underneath it during the packing operation. The plunger may comprise a stem part and a plunger head, the latter having a slightly smaller outer diameter than the inner diameter of the hollow electrode. Normally the underside of the plunger is flat.

The cavities of the electrodes may have any desired cross-sectional shape. Normally the cavity is of circular cross-section. The cavity may, however, be polygonal, square, triangular, oval or of any other suitable cross-sectional shape. The shape of the periphery of the plunger may, if desired or required, be adapted accordingly. Sometimes an axial stem is provided within the electrode to provide an annular cavity therein. In this case, the plunger must be made hollow, at least for the reception of the stem.

The means for setting the electrode into reciprocating movement may take the form of a cam mechanism, preferably having a stroke of between 0.004 and 0.04 inch, say between 0.01 and 0.02 inch, more particularly of the order of 0.015 inch. The cam mechanism may comprise a revolving shaft of which the cam is preferably an integral part. The cam comprises at least one lifting portion, say three lifting portions. The cam shaft is preferably at least partly covered by oil.

The cam mechanism may also comprise a follower shaft normal to the cam shaft which follower shaft is adapted to hold the electrode. In a preferred embodiment the lower end of the follower shaft is pressed against the cam part of the cam shaft by a spring. This lower end is advantageously provided with a running surface of a material which enhances smooth running of the cam mechanism, e.g. of a synthetic resin such as gear Bakelite.

The reciprocating motion of the electrode may also be effected by an electrical vibrator.

The follower shaft is preferably provided with a cavity to take up the electrode and means for gripping the electrode, e.g. a spring clip or a neoprene ring.

In a preferred embodiment, means for guiding the powder into the electrode are also provided, e.g. in the form of a funnel which tightly fits over the outside of the top of the electrode. This funnel may be made of a synthetic resin, e.g. of the resin known in the trade as "alkathene" or of any other suitable polyethylene or resin of similar properties.

The apparatus specified in the preceding paragraphs may be adapted to pack several electrodes simultaneously in the manner and by the means specified.

The apparatus may be designed to be hand-driven. It may also be connected to or adapted to be connected to any other suitable prime mover. The preferred embodiment is coupled to a fractional horsepower electric motor, suitable means for regulating the speed being preferably provided, e.g., a variable transformer or variable resistance.

The preferred apparatus is designed to be operated with a reciprocating frequency of the electrode of 6,000 to 12,000, preferably 7,500 to 10,000, say 7,500 to 8,000 cycles per minute. As the exact frequency may depend on the type of material being packed, a means for adjusting the frequency is preferably provided.

The invention and how it may be put into practice will be further elucidated by way of example with reference to the accompanying drawings, without thereby limiting the scope of the invention.

In the drawings,

FIG. 1 represents a side elevation of an apparatus in accordance with the invention.

FIG. 2 shows a front elevation of the same apparatus.

FIG. 3 represents on a larger scale a vertical section through a main operative part of the apparatus illustrated in FIG. 2.

FIG. 4 is a horizontal section along line IV—IV in FIG. 3 illustrating the spring clip for holding the electrode.

FIG. 5 is a section along line V—V through the cam shaft.

Referring to the drawings, the machine comprises a camshaft 1 driven by a fractional horse power electric motor (not shown), the speed of which is controlled, e.g. by a variable transformer or variable resistance. The cam part 2 (FIGS. 3 and 5) is an integral part of the shaft and consists of three radially turned forms (or depressions) giving a smooth lift to the follower hereinafter described. The depth of each depression is .015 inch producing a reciprocation of the follower three times per revolution of the shaft. The follower consists of a steel rod 3 housed in a bronze bush 4 and is spring loaded on to cam 2 with a gear Bakelite pad 5 as a bearing face. The rod 3 is sealed above the bronze bush with a soft neoprene hat shaped seal 6. The bronze bush 4 is secured on a supporting plate 4a (FIG. 3) suitably mounted above the camshaft. For smooth operation an oil level 7 is maintained so that the drive shaft is half covered. The top portion of the steel follower is hollowed to accommodate the electrode 8 and the electrode is secured in place by means of a U-shaped spring clip 9.

For this purpose, two slots 10 are provided in the top of the follower 3 through which the clip 9 engages the electrode. A third recess locates the U-shaped clip. In place of the clip, a neoprene ring may be employed.

The plunger consists of a simple steel rod 11 with provision at one end for the addition of extra weights 12. The other end is reduced in diameter and terminates in a pin type head 13 serving as a tamper portion of the form shown in the drawing and having a diameter of .1 mm. less than the internal bore of the average diameter of the cavities of the electrodes. The length of this pin type head is 1.5 mm. The stem of the pin (i.e., the reduced portion of the plunger) is approximately .5 mm. less in diameter than the internal bore of the average diameter of the cavities of the electrodes. For small cavities, e.g. a 1 mm. bore, the difference between the diameter of the stem and that of the head should of course be less.

This plunger 11 slides freely in a bronze bush 14 housed in a self-aligning ball race 15 which is fixed into a movable supporting bracket 16. The purpose of the self-aligning ball race is to give ready alignment to the pin head of the plunger when it enters the cavity of the electrode. The bracket 16 can be raised and lowered to make the electrodes readily accessible.

For filling the electrode, it is clipped in position in the follower shaft 3 and a 60° plastic funnel 17 is slid over the neck of the electrode cavity. Bracket 16 is lowered and the plunger is allowed to rest on the bottom of the electrode cavity. The powder to be analyzed is introduced into the funnel by means of a spatula and the machine switched on. The machine will pack the electrode efficiently on condition that the frequency of the reciprocation is between certain limits, which depend on the magnitude of cam lift and the type of powder and which are normally between 7,500 and 8,000 cycles per minute.

The vertical vibration of the electrode causes the powder to fall past the stem and tamper portion of the plunger and at the same time induces a reciprocation in the plunger itself which causes a percussion packing of powder in very small stages and continues until the electrode is evenly and efficiently filled to the top. As can be seen from the drawing, the funnel 17 of resilient material is so dimensioned that the apex acts as a shield protecting the top of the electrode from damage by the plunger, the inner diameter of the stem being such that the funnel fits over the electrode with sufficient tightness to prevent

the funnel coming loose as a result of the vertical reciprocating movement, while the wall thickness of the stem is so dimensioned in relation to the resiliency of the material that no damage will result to the electrode when the funnel is applied thereto and that the funnel stem can give mechanical support to the neck of the electrode against breaking open during compacting.

When using the machine, the following advantages are observed:

(1) More material (on a weight basis) can be packed into the electrode with the machine than it is possible to pack into the same size electrode by hand, by an experienced assistant. For a 2 mm. diameter cavity electrode the increase is 30%.

(2) Material is packed into the electrode within seconds as compared with minutes by hand.

(3) The amount of material packed into the electrodes depends on the weight of the plunger and is reproducible to 1%. Normal hand packing can achieve a reproducibility in the amount packed into an electrode of approximately 5%.

(4) Electrodes, machine packed, give superior spectrochemical results as compared with results obtained when electrodes are hand packed.

To establish this fact the following experiment was performed. Two operators each packed a standard plant base material mixed with lithium graphite buffer into twenty electrodes by hand. This material was also packed into another 20 electrodes using the machine. All these electrodes were burned under standard conditions in a D.C. arc and the resultant spectra were photographed. After development of the photographic plates the blackening of the individual analysis lines of elements Mg, Na, Sn, Ca, Al and Fe in the individual spectra was measured on a microphotometer. These values were converted to relative intensities and the percentage standard deviation of the individual groups calculated. These results are given in the following table:

Percentage deviations of a series of relative intensities of analysis lines of certain elements

[Twenty samples were excited]

	Na	Sn	Ca	Al	Fe
Operator 1.....	13.8	17.5	9.7	17.7	23.5
Operator 2.....	17.3	16.9	16.4	14.8	21.7
Machine.....	7.8	5.3	6.8	11.9	20.1

From the results in the above table it is obvious that the electrodes packed with the packer machine in accordance with the invention give superior results.

(5) Using the machine, a single operator can pack more than one electrode at a time. A plurality of units can be combined to suit batch requirements.

(6) As regards contamination, the same rules apply as with hand packing.

The machine in accordance with the invention uses a percussion principle involving mechanical reciprocating motion with relative movements between a hollow cavity electrode and a plunger within the cavity of the electrode.

Packing machines for packing hollow electrodes with powders for spectrochemical analysis are known in which the electrode which is in a vertical position is subjected to lateral vibrations. This machine gives results in respect of the packing density and uniformity, and consequent reliability of the spectrochemical analysis results which are not superior and often inferior to the results obtained by hand packing and, therefore, greatly inferior to the results obtained in accordance with the present invention.

What we claim is:

1. An apparatus for packing a hollow electrode for spectro-chemical analysis with a sample of pulverulent material to be analysed, which comprises a holder for holding the said electrode in a vertical position, a reciprocation impartor adapted to impart a rapidly repeated

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vertically reciprocating movement to said holder and any electrode held in this holder, the amplitude of the relative reciprocating movements being small in comparison with the length of the cavity of the electrode, a plunger independent of said holder and said reciprocation imparter, said plunger comprising a tamper portion which is adapted to project into the cavity of the electrode and to allow the pulverulent particles of the material, which is to be packed, to move within said cavity to the underside of the plunger during the compacting action of the plunger and further comprises means for mounting the plunger for free reciprocating movement above and in vertical alignment with the said holder, said means for mounting being located a sufficient distance above the holder for the electrode to give adequate lateral support to the plunger while allowing unrestricted vertical movement of the tamper portion of the plunger at least between the bottom of the cavity and the neck of the cavity of the electrode and allowing at least sufficient lateral freedom of movement to the lower end of the plunger to make up for normal tolerances of an electrode when held in the holder.

2. An apparatus as claimed in claim 1, in which the reciprocation imparter comprises a cam-member adapted to impart a lift of between 0.004 and 0.04 inch to the said holder for the electrode, said cam-member being connected to a prime mover so as to impart between 6,000 and 12,000 lifts per minute to said holder.

3. An apparatus as claimed in claim 1 which further comprises a funnel of resilient material, the apex of which

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is shaped and dimensioned to form a shield protecting the top of the electrode being packed from damage by the plunger and of which the inner diameter of the stem is such that the funnel fits over the outside of the electrode with sufficient tightness to prevent the funnel from coming loose during the said vertical reciprocating movement, while the wall thickness of the stem is so dimensioned in relation to the resiliency of the material of the funnel that no damage will result to the electrode when the funnel is applied thereto with normal care, but that the funnel stem can nevertheless give effective mechanical support to the neck of the electrode against breaking open during compacting.

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