April 8, 1969 M. I. KANTOR 3,436,785

APPARATUS FOR CLEANING ELECTRICAL CONTACTS

Filed Nov. 30, 1964 Sheet 1 of 3

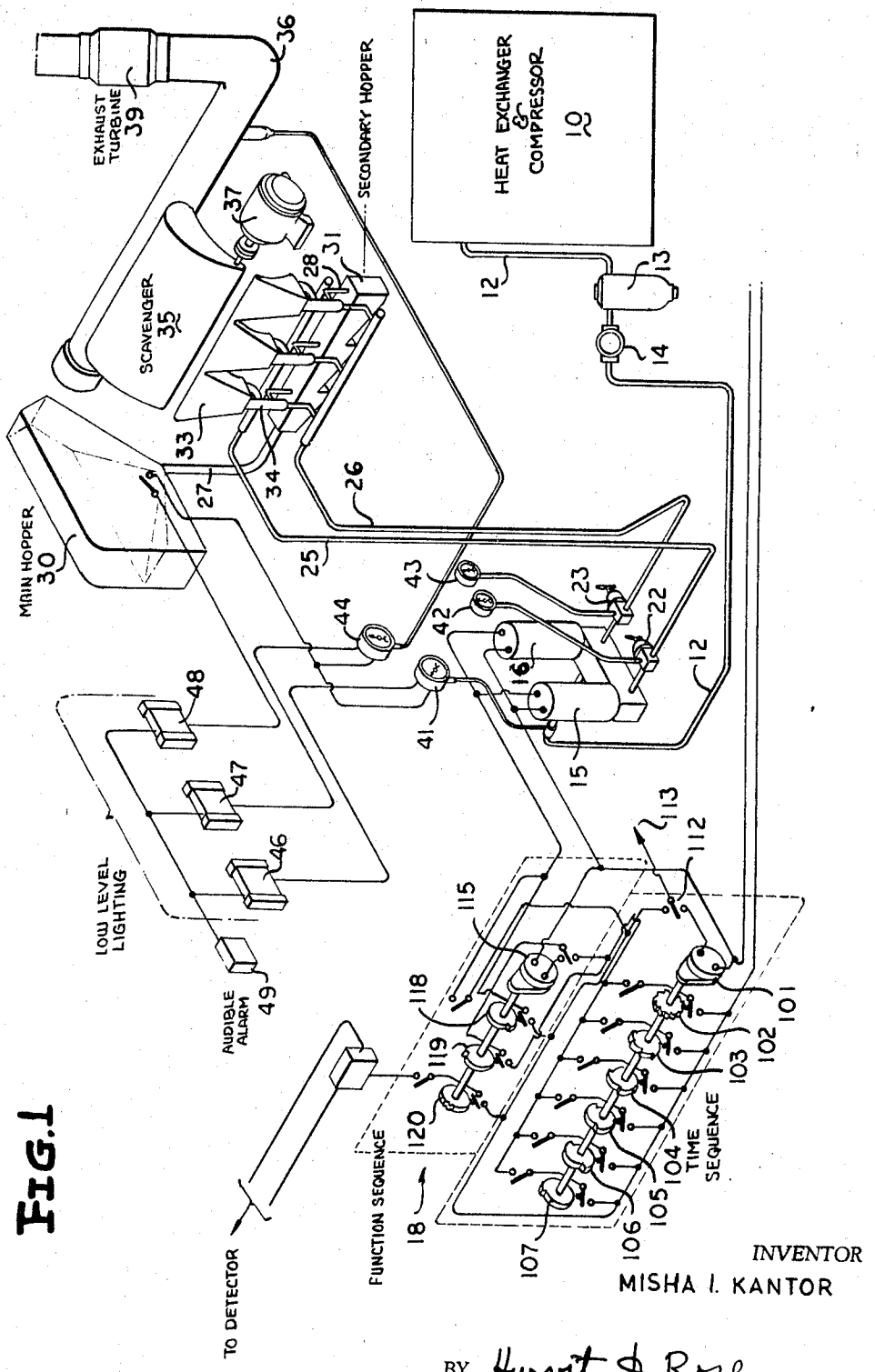


FIG. 1

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FIG. 2

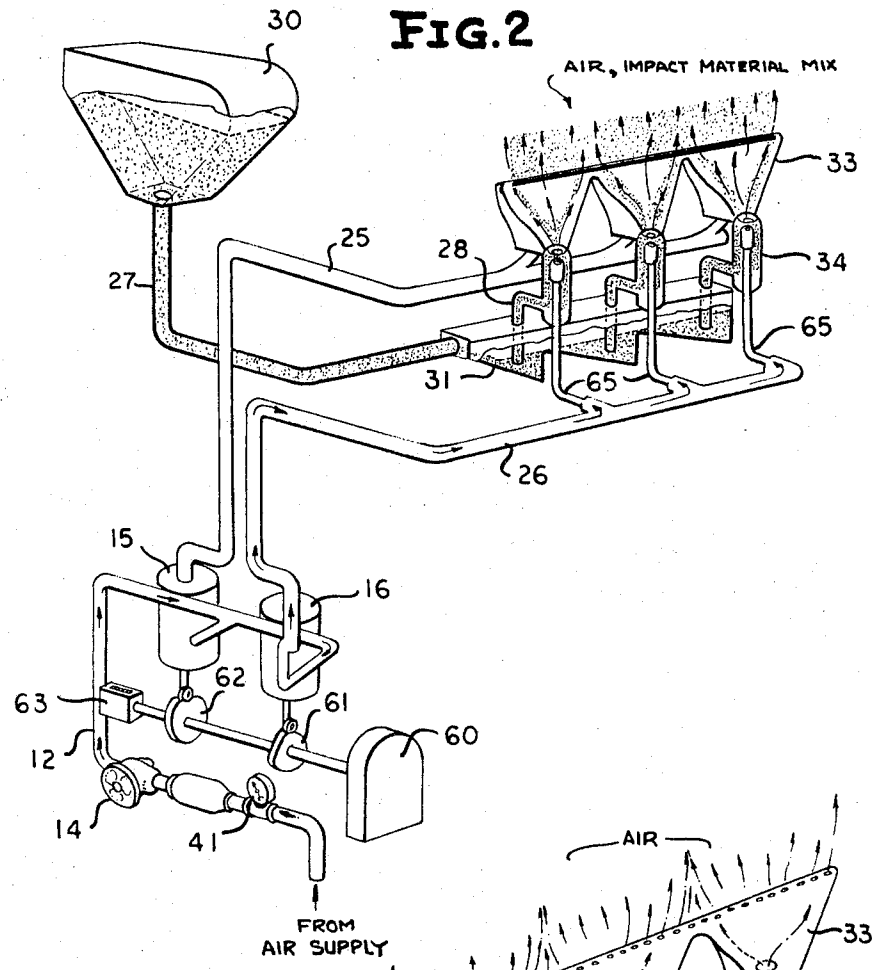
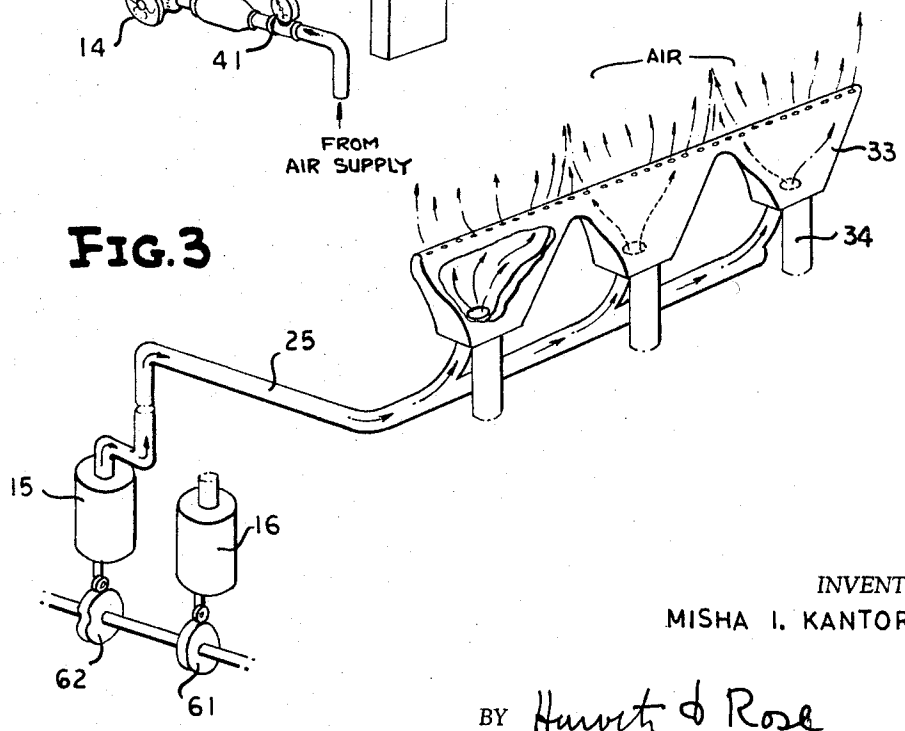


FIG. 3



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FIG. 6

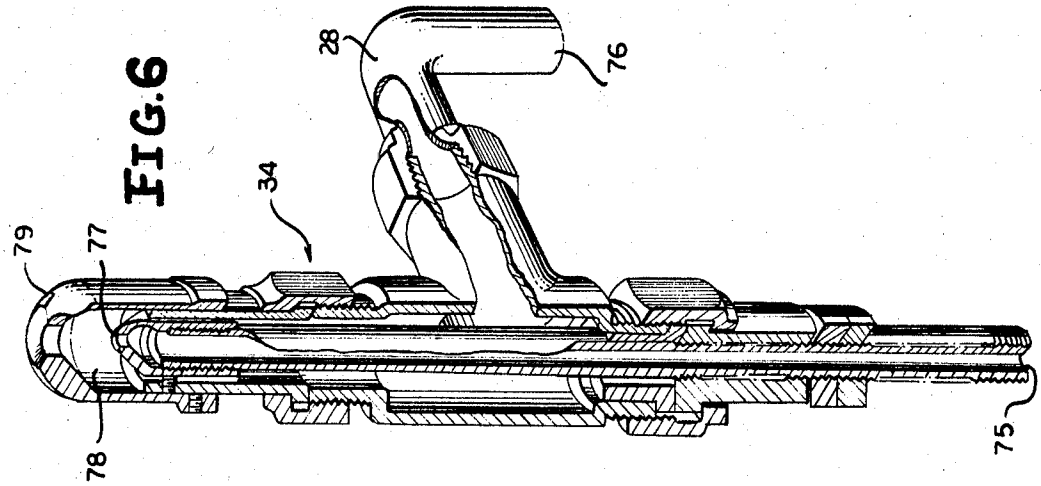


FIG. 5

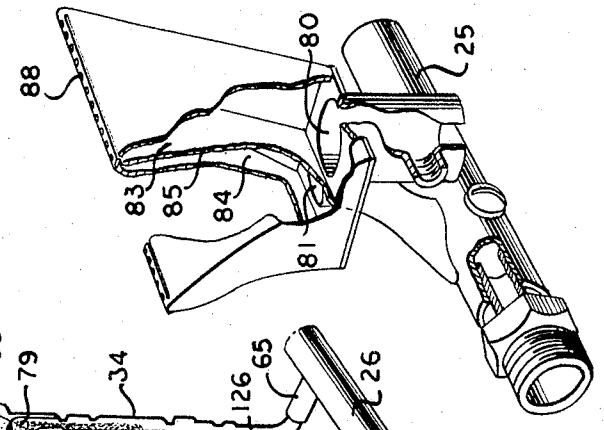
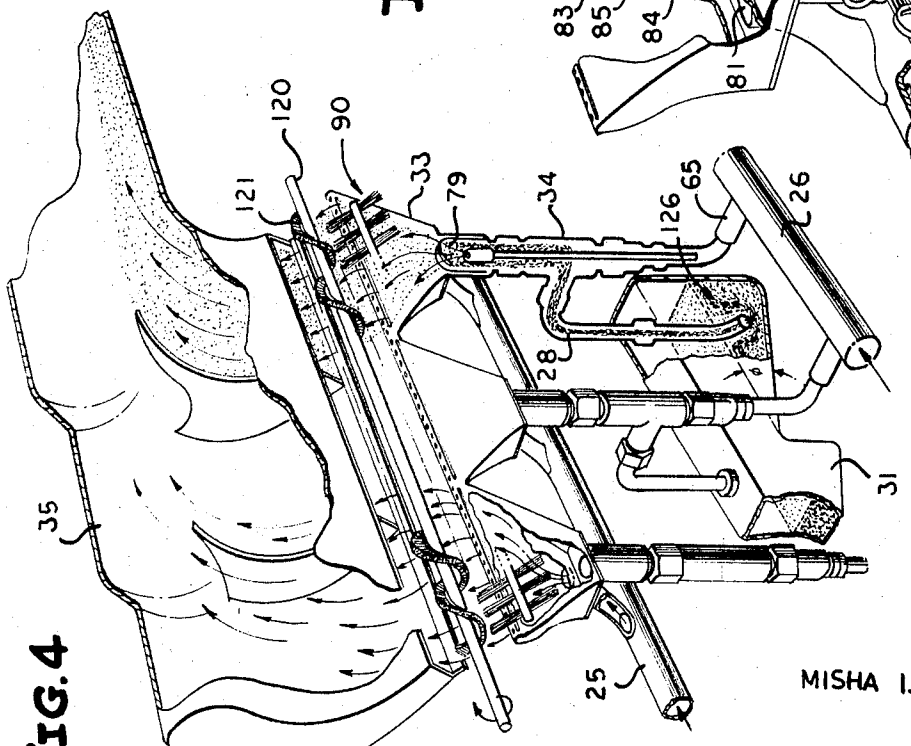


FIG. 4



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APPARATUS FOR CLEANING ELECTRICAL CONTACTS

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3 Claims

ABSTRACT OF THE DISCLOSURE

Cleaning of electrical contacts is accomplished by subjecting the contacts to alternate blasts of cooling air and non-abrasive impact material. Brushing of the contacts is performed concurrently with the impact cleaning operation to dislodge residue and impact material. The dislodged deposits are collected and removed from the region occupied by the contacts by use of a vacuum exhaust scavenger system.

The present invention relates generally to cleaning systems for electrical contacts, and more particularly, to cyclic impact cleaning and cooling systems for multistylus assemblies and other electrical contact assemblies wherein the assemblies or contacts are loacted in close proximity to moving machine parts.

In certain exemplary embodiments, the cyclic cooling and cleaning system of the present invention is used in connection with multistylus assemblies for electro-sensitive printers. In the following description, it will be understood, however, that systems in accordance with the present invention may be employed wherever it is necessary or desirable to clean a plurality of delicate electrical contacts, which are subject to build-ups of residue and/or to high temperature operation, and which may require the efficient collection and removal of impact material used in the cleaning process and dislodged residue to prevent interference with adjacent operating machine parts.

The multiple stylus assembly of an electro-sensitive printer or recorder is exemplary of equipment in which the need for an efficient system of cleaning is of paramount importance. In operation, the printer supplies a recording or chart of desired information by virtue of the marking of an electro-sensitive medium, generally a sheet, by the styli. More specifically, the multiple stylus assembly carries electrical current to the electro-sensitive medium on which it is superposed, to decompose portions of the medium and thus to record the desired data. Such printers are extensively used to provide very accurate hard copies of analog and digital data and for the high speed production of alpha-numeric print from computer outputs. As a consequence of the decomposition or burning away of the electro-sensitive sheet, the styli are subjected to a relatively rapid deposition of residue thereon which, if not removed, results in a fouling of the styli and a consequent deterioration of the marking process. In addition, because of the electrical currents carried by the styli and because of the friction between styli and the electro-sensitive medium within which they are in contact, the multiple stylus assembly is subjected to high operating temperatures with a resulting abrasion of the stylus tips and an increased adherence of the residue deposits thereto.

The composiiton of this type of residue accruing from such printer operation is such that it is extremely difficult to effect a removal thereof from the contacts or stylus tips by conventional cleaning methods. These prior art methods have included continuous brushing, subjection to air pressure or to vacuum, or a combination thereof, all of which have proved inadequate to permit continuous operation of the printer over a period of hours. The provision of an adequate cleaning method is made more difficult by the fact that several hundred styli may be used in a single printer with the record-marking operation being performed in proximity to moving or rotating mechanical parts. In addition, the styli themselves are typically of a very delicate construction, and thus, added care is necessary in effecting the removal of the residue. Effective cleaning of these delicate parts has ultimately required a shut-down of printer operation, resulting in a loss of valuable time in the recording, for example, of computer output data. Further, additional downtime has been necessary for the periodic adjustment and eventual complete replacement of the stylus assemblies as a consequence of wear during the high temperature operation to which they are subjected.

In accordance with the present invention, there is provided apparatus and method by which styli or other electrical contacts which are subjected to deleterious contamination by residue and to high temperature operation may be cyclically cleaned and cooled while in operation without impairing or interfering with the operation of adjacent mechanisms or with the marking and recording operation itself. The styli are alternately subjected to timed blasts of cooling air and of non-abrasive impact material. An automatic brushing operation performed simultaneously with the impact cleaning operation removes the contaminating residue and any impact material particles which may momentarily lodge between the contacts. The dislodged deposits are rapidly and continuously collected and removed from the stylus area by a scavenger exhaust system to prevent any subsequent refouling of the styli and/or interference with associated moving mechanisms, or with the recording operation.

In the following description of an exemplary embodiment and its operation, the term "impact material" is used as opposed to "abrasives." Abrasives are generally considered to be harder than the material with which they come in contact and therefore ultimately result in a cutting or wearing away of the material which is to be cleaned. The impact material used in conjunction with the present invention is relatively soft, and cleaning is effected from the force of the impact rather than from the abrasive nature of the cleaner. The impact cleaning feature is also important in view of the fact that the contacts or styli may be located adjacent rotating and moving machinery parts which would normally be damaged by the harder abrasives.

Other significant features of the present invention include a mixer nozzle to lift impact material from a supply bin by creation of a vacuum, and to mix this materiel with an air stream; a distribution manifold which precisely and separately meters and directs first cooling air and then the air-impact material mixture, or vice versa, upon the multiple stylus assembly; a scavenger exhaust system for immediate collection and removal of the impact cleaning material and dislodged residue from the stylus marking area.

It is, accordingly, a principal object of the present invention to provide improved apparatus and method for cleaning electrical contact assemblies.

It is a further object of the present invention to clean and cool electrical contacts by the cyclic application thereto of blasts of impact material and cooling air.

Another object of the present invention is to prevent faulty operation of electro-sensitive printers and recorders by removal of residue build-up and by reduction of high temperatures in the multiple stylus assemblies thereof.

It is a still further object of the present invention to clean multiple stylus assemblies while the printer or recorder is in operation, without the requirement of downtime.

It is another object of the present invention to provide

substantially continuous cooling of the styli or contacts to reduce adhesion of the decomposition products of the recording operation and thereby to reduce the duration and frequency of the impact cleaning cycle.

Another object of the present invention is to remove used cleaning material and dislodged residue from the locality of the contacts and to deposit such materials in a remote area for convenient disposal.

Other objects, features and attendant advantages of the present invention will become apparent from a consideration of the following detailed description of certain exemplary embodiments, especially when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a perspective view, partially in electromechanical schematic form, of a complete cyclic cleaning and cooling system in accordance with the present invention;

FIGURE 2 is a perspective view of a portion of the system used in the impact cleaning cycle operation;

FIGURE 3 is a portion of the system used in the air cooling cycle operation;

FIGURE 4 is a partial view of the distribution manifold, mixer nozzles, impact material secondary hopper, and scavenger exhaust system;

FIGURE 5 is a detail perspective view, partially broken away, of the distribution manifold; and

FIGURE 6 is a detailed perspective view, partially broken away and partially in section, of the mixer nozzle.

Referring generally to the drawings, and more particularly to FIGURE 1, a compressor and heat exchanger, designated generally at **10**, for supplying cool, dry air under pressure, are coupled by a flow line **12** through a suitable line filter **13** and pressure regulator **14** to a pair of air valves **15** and **16**. The valves are solenoid operated, under the control of time and function sequence apparatus designated generally at **18**, electrical power being supplied through suitable connecting cables **19** and **20**. Air flow through the valves and supply lines **25** and **26** is regulated by pressure regulators **22** and **23**, respectively. The air flow through supply lines **25** and **26** is cyclic, as will hereinafter be explained, to provide sequentially alternating air streams to the distribution manifold, designated generally at **33**, and to mixer nozzles **34**. Impact cleaning material is supplied from main hopper or bin **30**, via a gravity feed line **27**, to a secondary hopper or set of hoppers **31** and subsequently to the mixer nozzles via secondary feed lines **28**.

The scavenger exhaust system includes a hooded exhaust manifold **35**, removal duct **36**, and exhaust turbine **39**. A motor **37** is used to rotate a spiral brush **121** (FIGURE 4) against the styli **90** adjacent the exhaust manifold. Suitable pressure indicators **41**, **42**, **43**, **44** may be employed to indicate air pressures in supply lines **12**, **25**, **26** and the exhaust vacuum in duct **36**, respectively. In addition, it may be desired to provide alarm indicators, as for example pressure indicator light **46**, vacuum indicator light **47**, and impact material light **48**, electrically connected to the detectors and to an audible alarm **49**. Such apparatus provides an indication of one or more critical conditions existing in the various portions of the system. The impact material indicator light **48**, for example, may be controlled by a low level switch **50**, in the main hopper **30**, to indicate the need for additional impact material.

Operation of the system will be better understood by consideration of FIGURES 1, 2, 3 and 4. The timing sequence of the overall operation may be established by use of a timer **101**, driving a series of cam operated switches, **102**, **103**, **104**, **105**, **106** and **107**. Each cam is arranged to operate its associated switch at precise intervals and in accordance with rotation of the shaft to which the cams are connected. As an example, timer **101** may be set to operate at a speed of 0.1 r.p.m. while the cam operated switches are set to operate at intervals of one to ten minutes. Thus, any particular time interval within the prescribed limits may be selected by operation of one of switches **110**. Power is supplied to timer **101** via switch **112**, through cable **113**, during the time the transport carrying the electro-sensitive sheet is in motion.

The timing sequence apparatus in turn controls the frequency at which the function sequence occurs. A second timer **115** drives a series of cam operated switches **118**, **119** and **120**, for example, to effect the cyclic opening and closing of valves **15** and **16**, as well as to operate appropriate detection apparatus to indicate that operation is proceeding in a proper manner. Cam operated switch **118**, when cyclically opened and closed, permits power to be supplied to the solenoids in air valves **15** and **16**, thus causing them to be energized and de-energized. One of the valves, for example **15**, may be set for a normally open condition, while the other is set for a normally closed position, such that energization and de-energization of the solenoids will produce a cyclic operation of the valves, one valve alternating between closed and open condition while the other alternate respectively between open and closed condition.

Cyclic operation of the system will be more clearly understood by reference to FIGURES 2 and 3. An alternative valve control arrangement is shown in these figures, although the system otherwise operates as indicated in the description of FIGURE 1. A time **60** rotates a pair of cams **61** and **62**, associated respectively with valves **16** and **15** to open and close the valves. A counter **63** may be used to record the number of cyclic operations occurring in a given period. While the control arrangement depicted in FIGURE 2 does not have the time and function sequence features of the control arrangement of FIGURE 1, it is adequate to provide the desired cyclic operation. It will, of course, be understood that various other electrical and mechanical devices or a combination thereof may be employed to control the air valves. Electronic time delay circuits, for example, may be employed in place of the switching control arrangement shown in FIGURE 1. The cams shown in FIGURE 2 have rotated through a position in which valve **16** is open and valve **15** is closed. Pressurized cool air is thus permitted to flow from supply line **12** through valve **16** and into supply line **26**, from which it is fed through lines **65** to mixer nozzles **34**. Each mixer nozzle is arranged to create a vacuum therein, as will be explained with reference to FIGURE 6, such that impact cleaning material is lifted from the secondary hopper **31** to feed lines **28** and thus up into the nozzle where it mixes with the air stream. In this manner, a mixture of forced air and cleaning particles is directed through the distribution manifold to impinge upon the styli.

In FIGURE 3, the system is in the cooling cycle condition since cam **61** has disengaged and cam **62** has engaged through rotation of the shaft coupled to timer **60**. Thus, air valve **16** closes as valve **15** is opened. In this condition, the cooling air flows from supply line **21** through valve **15** and into line **25**, where it is directed through distribution manifold **33**. The air stream is expelled from the distribution manifold in an appropriate pattern to cool the styli.

Examples of the construction of the mixer nozzle and the distribution manifold are shown in FIGURES 6 and 5 respectively. Nozzle **34** has associated therewith an inlet **75** through which an air stream or flow is directed from supply line **65** at a suitable pressure, for example 60 to 100 p.s.i. A second inlet **76**, connected to the nozzle through a T junction permits the introduction of impact material. The air stream is expelled from a nozzle **77**, at relatively high velocity. Chamber **78** surrounds the duct between inlet **75** and nozzle **77** to the point of connection of the impact material feed line **28**. As the high velocity stream passes from nozzle **77** through chamber **78**, it impinges on air in the chamber and carries it away, creating a vacuum therein for sucking cleaning material into the mixer nozzle from the feed lines. The impact cleaning material is granular in form and of a sufficiently fine

mesh and a low density to be lifted by a combination of the vacuum created in chamber **78** and the turbulence of the air in secondary hopper **31**, the latter also caused by the passage of the air stream through nozzle **77** into the chamber. The impact cleaning material is thus mixed with the air stream in the chamber and expelled through orifice **79**.

The vacuum action of mixer nozzle **34** eliminates the need for a separate control valve and air line to force the impact material from a storage bin and thus reduces wear to a minimum. In addition, the use of a vacuum as an impact material lifter also eliminates packing in the secondary bin and possible consequent clogging of the transfer line. Further, the rate of flow of impact material may be adjusted within desired limits by simply adjusting the air pressure feeding into the mixer nozzle through regulator **23**. Typically, air or other fluid carrier fed into the nozzle at inlet **75** will be adjusted to a pressure between 60 to 100 p.s.i.

Exemplary details of construction of the distribution manifold are illustrated in FIGURE 5. Each manifold has a pair of inlets **80** and **81** and a pair of chambers **83** and **84**, separated from each other by a wall **85**. The chambers are provided with a triangular cross-section suitable for alternately directing the flow of the air-impact material mixture and cooling air toward the narrowly defined area occupied by the styli. To this end, a pair of orifices for each chamber are separated by wall **85** to provide exits for the cooling air and cleaning mixture. The air chamber orifice may comprise a row of apertures, while the mixture chamber depicted for the orifice is preferably of a slotted shape. That portion of the mixer nozzle **34** including orifice **79** is arranged to fit into inlet **80** such that it extends into chamber **83** (FIGURE 4).

The dual chamber construction of the manifold permits dry cooling air to be directed in a stream over the contacts or styli during one portion of the cycle and the impact cleaning mixture to be directed toward the contacts or styli during the other portion of the cycle without interference therebetween. That is, the manifold construction insures that no impact material will be distributed during the cooling cycle. The mixture chamber **83** has a shape arranged to produce minimum interference with the mixture flow expelled from the mixer orifice **79**. The latter may be constructed to provide maximum distribution of impact material over the widest range of air pressures. For example, an appropriate fan-shaped distribution of approximately 4.4 grams per second of impact cleaning material was produced with a mixer nozzle having a nozzle opening **77** of .126 inch, orifice **79** width of .045 inch, and manifold orifice **88** of approximately .070 inch. Each of the figures which has been described shows a three unit nozzle and manifold system, but it will be understood that any number of units may be employed as necessary for a particular application.

The combination of impact material hopper **31**, mixer nozzles **34**, supply lines, distribution manifolds **33**, and exhaust system is illustrated in greater detail in FIGURE 4. Granular impact cleaning material, generally designated at **126**, is supplied to the secondary storage bins **31** by gravity feed from the main hopper or bin **30**. The angle of repose, θ, of each of the slanted sections of flooring of the secondary bins **31** is selected to maintain a sufficient supply of impact material around suction feed line **28** to nozzle **34** without permitting undue packing density.

The cleaning material is selected in accordance with the requirements that (1) it should not cause abrasive wear in the rotating parts of the machine in which it may come in contact; (2) it should not abrade the stylus material or the distribution nozles; (3) it must be of sufficiently low density to be lifted into the nozzle without clogging and to be carried away by the scavenging exhaust system; (4) it must be sufficiently strong and hard to remove residue from the stylus tips upon high velocity impact; (5) it must be of a sufficiently fine mesh to pass between the styli, but should not be dusty; and (6) it must be low in cost and readily available. Silica and most of the other oxides available in appropriate mesh sizes have been found to be too abrasive for the cleaning of delicate electrical elements adjacent rotating machinery. Crushed walnut shells of 80 to 120 mesh are exemplary of materials meeting the above requirements for use as the impact material. Other suitable materials are various types of crushed nut shells or ground fruit pits, such as ground apricot pits, provided that appropriate adjustments are made in the air pressure regulators in accordance with density, weight and mesh of the particular material used.

During the cleaning cycle, the impact particles are lifted from the secondary bins **31** under suction in feed lines **28**, and mixed with the air stream from lines **65** in mixer nozzle **34** in the previously described manner. The mixture of air and cleaning material is then directed through the orifice slot **79** from chamber **78** in a fan-shaped pattern. Construction of distribution manifolds **33** permits metering of the proper amount of the mixture to impinge upon the stylus tips, generally designated at **90**, while maintaining the flow pattern. A rotating spiral brush **121** is mounted on the shaft **120** driven by motor **37** (FIGURE 1) to aid in dislodging residue and any cleaning material which may temporarily lodge on the stylus tips. This debris is immediately collected in the scavenger exhaust manifold **35**, by virtue of the vacuum created in duct **36**, to prevent its being blown about the work area. To this end, sufficient velocity is imparted to the materials by turbine **39** in the exhaust line to effect their efficient collection and removal to a suitable area for subsequent disposal. While FIGURE 4 conveniently illustrates both the flow of air during the cooling cycle and the flow of the air-impact material mixture during the cleaning cycle, it will be understood that these operations will occur alternately rather than simultaneously.

It is also again to be emphasized that while throughout this specification reference has been made to use with multiple stylus assemblies in electro-sensitive writing processes, systems in accordance with the present invention may be readily used in conjunction with the cleaning of other types of electrical contact assemblies which may be subjected to contamination by residue from any source. It will further be realized that various fluids, including gases in the broad sense, may be used in place of air.

Thus, while certain preferred embodiments have been illustrated and described, it will be apparent that various changes and modifications may be made without departing from the true spirit and scope of the present invention. It is therefore desired that this invention be limited only by the appended claims.

I claim:

1. Apparatus for cleaning electrical contacts, comprising

distribution manifold means for distributing streams of non-conductive fluid over and onto the contacts to be cleaned, each said manifold means including a pair of separated chambers and a respective orifice associated with each chamber;

storage means for holding particulate material;

a mixer nozzle communicating with one of said chambers;

a supply line coupling said mixer nozzle to said storage means, said mixer nozzle and said storage means being relatively located to prevent gravity feed of said particulate material into said mixer nozzle;

means for supplying fluid under pressure to said mixer nozzle to produce a vacuum condition tending to suck particulate material from said storage means via said supply line into said mixer nozzle, said mixer nozzle including means for mixing said particulate matter into said fluid for ejection of a particle-containing fluid stream from said nozzle into said chamber of

said manifold means with which said mixer nozzle communicates;

power actuated brush means for rotation against said contacts to dislodge debris from said contacts during distribution of said particle-containing fluid stream over and onto said contacts by said manifold means;

means for supplying fluid under pressure directly to the other of said chambers of said manifold means for distribution of a pure fluid stream over and onto said contacts therefrom;

means for operating the first-named and last-named fluid supply means in alternation for cyclic alternating distribution of said particle-containing and pure fluid streams over and onto said contacts; and

vacuuming exhaust means having an inlet positioned relatively opposite said orifices of said manifold means, with said contacts substantially interposed therebetween, for collecting said particulate material following impact with said contacts and for collecting debris dislodged from said contacts by the impacting material and said brush means.

2. The invention according to claim 1 wherein said particulate material is relatively non-abrasive.

3. The invention according to claim 1 wherein said fluid is air.

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U.S. Cl. X.R.

15—3, 345; 51—8; 134—7, 36; 346—74