Aug. 29, 1967 H. C. LERNER ET AL 3,337,897

VACUUM PENCIL

Filed Oct. 23, 1965 2 Sheets-Sheet 1

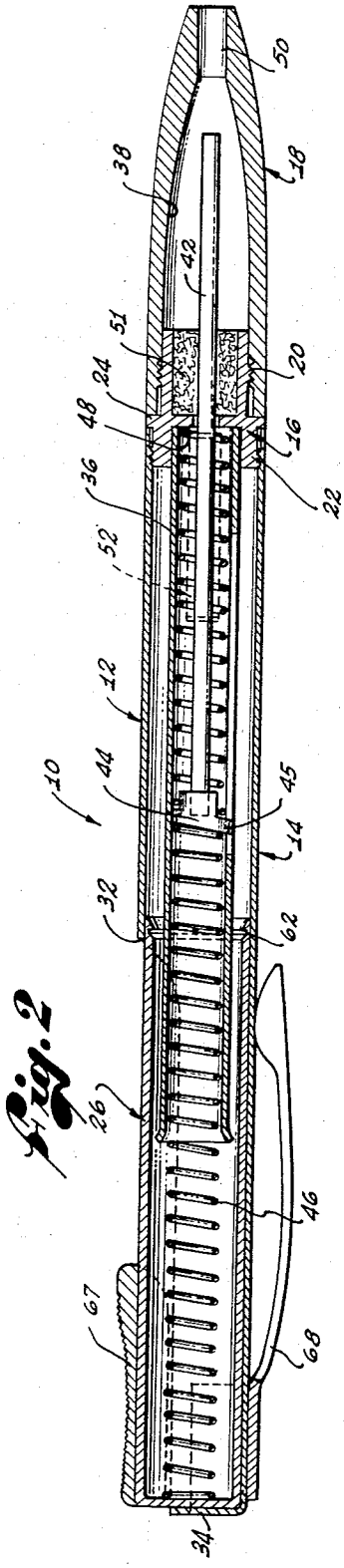


Fig. 2

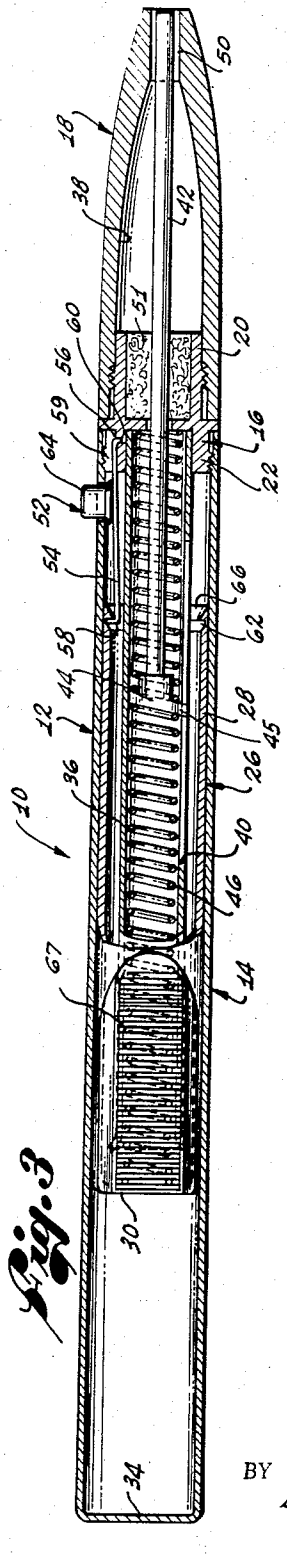


Fig. 3

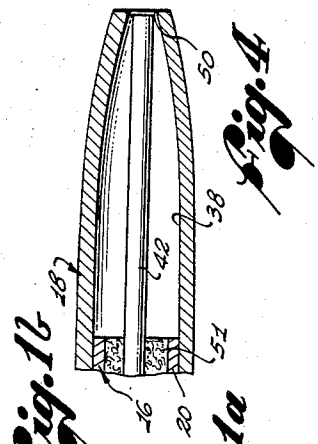


Fig. 4

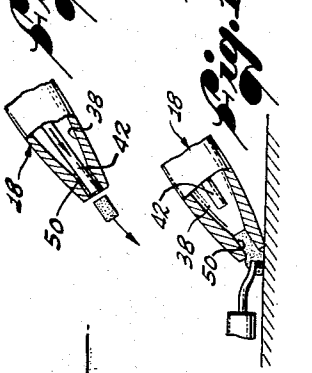


Fig. 1a

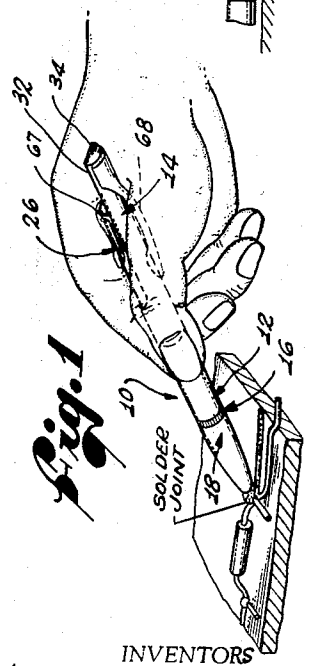


Fig. 1

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2 Sheets-Sheet 2

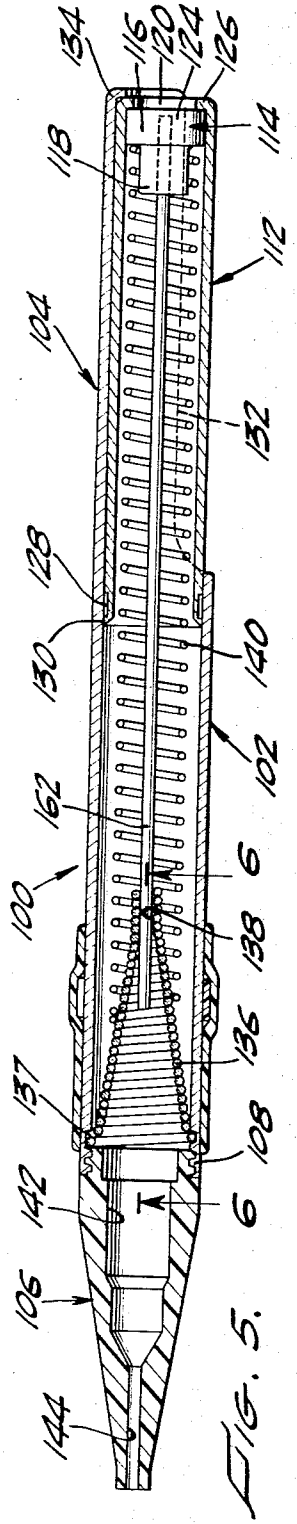


FIG. 5.

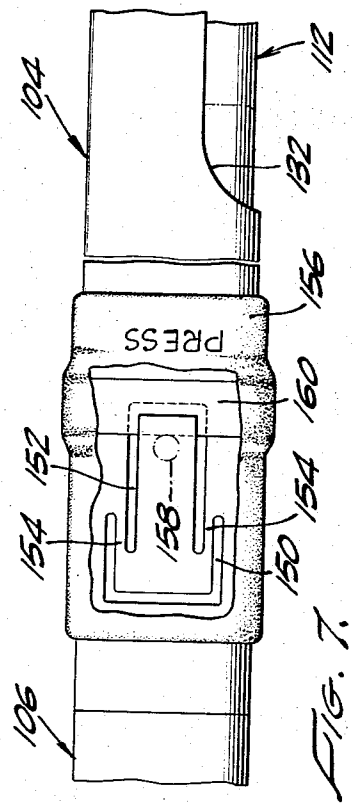


FIG. 7.

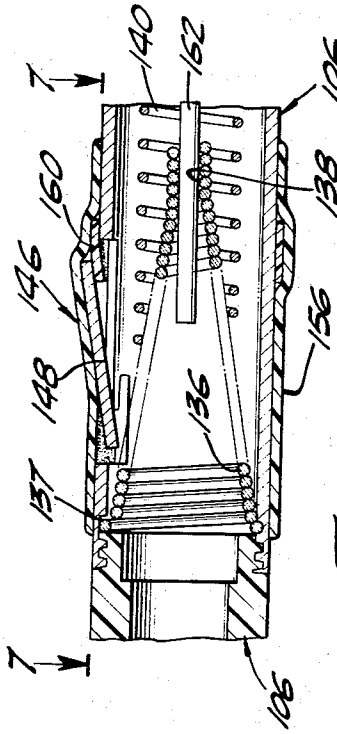


FIG. 6.

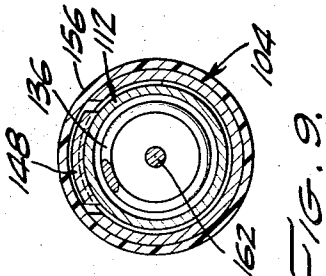


FIG. 9.

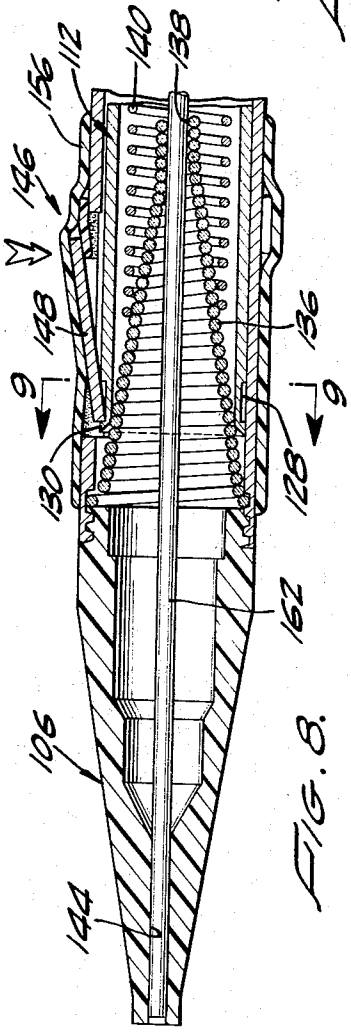


FIG. 8.

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United States Patent Office 3,337,897
Patented Aug. 29, 1967

3,337,897

VACUUM PENCIL

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Filed Oct. 23, 1965, Ser. No. 502,860
5 Claims. (Cl. 15—341)

ABSTRACT OF THE DISCLOSURE

A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, including a pencil-like barrel adapted to be held in one hand of the user, a plunger movable longitudinally within the interior of the barrel, a spring which normally urges the plunger rearwardly inside the barrel, the rear end of the plunger being exposed so that it may be moved forward by finger pressure, a latch fastened to the exterior of the barrel for latching the plunger in a forward position, an open orifice at the forward end of the barrel for receiving the articles or fluids, a screening element disposed within the forward end of the barrel in a fixed position, and an ejector rod secured to the plunger and passing through an opening in the screening element and thus extending through the orifice when the plunger is in its forwardly extended position.

This is a continuation-in-part of our co-pending application, Ser. No. 455,347, filed May 12, 1965, and entitled, Vacuum Pencil.

This invention relates generally to vacuum devices or tools and has more particular reference to a novel unitary, completely self-contained vacuum pencil for retrieving small work parts and removing foreign matter, including both liquids and solids, from work areas, particularly confined work areas which are inaccessible to conventional vacuum tools for this purpose.

The current trend in many phases of the electronics industry is in the direction of miniature and micro-miniature circuit components and assemblies. This trend, of course, is the result of the ever increasing demand for reduction in the size and weight of electronic equipment, particularly electronic assemblies for computers, aircraft, and space vehicles. In many cases, construction of such miniature and micro-miniature electronic assemblies requires soldering of a great number of electrical connections in relatively confined spaces. Soldering operations of this nature present two basic difficulties, to wit, proper application of solder to each electrical connection and removal of any excess solder from each soldered connection. Moreover, during the construction of such assemblies, small work parts, such as miniature and microminiature circuit components are often accidentally dropped into the interior recesses of the assemblies. These parts must be removed and are preferably retrieved for subsequent use. A variety of manual, semi-automatic, and fully automatic soldering devices have been devised which are capable of effectively soldering the many electrical connections in miniature and micro-miniature electronic assemblies. Insofar as I am aware, however, no practical devices have been devised for removing excess solder from the connections, or retrieving small work parts which are accidentally dropped into the assemblies. There are, of course, many devices available for this general purpose. These existing devices, however, are ill-suited to use on miniaturized electronic equipment, particularly micro-miniature electronic assemblies.

One of the existing devices for this purpose, for example comprises a vacuum nozzle which, in some cases, may be mounted directly on a soldering tool and is connected to an external vacuum pump. These vacuum devices, however, are bulky and require a hose connection to the external vacuum pump. As a consequence, the devices are ill-suited for use on miniaturized electronic assemblies. Moreover, it is impossible to retrieve small work parts with these existing vacuum devices since the parts are exhausted into a large filter bag, or the like, containing, in most cases, a large amount of solder and other debris. Another existing vacuum device for this general purpose comprises a self-contained vacuum unit which requires no hose connection to an external vacuum pump. This latter device, however, is also too large and bulky for use on miniaturized electronic assemblies and is hazardous to use. In addition, the existing vacuum devices are relatively heavy and cause rapid fatigue of the operator.

It is evident at this point, therefore, there is a definite need for an improved vacuum device for removing foreign matter and retrieving from miniature and micro-miniature electronic assemblies. This invention provides such an improved vacuum device, or vacuum pencil, as it is referred to herein. As will appear from the ensuing description, however, the vacuum pencil of the invention may be used for numerous other purposes.

It is a general object of the invention, therefore, to provide a novel vacuum pencil of the character described.

Another object of the invention is to provide a vacuum pencil which is relatively small and completely self-contained and, thereby, uniquely adapted for use on miniature and microminiature equipment, such as miniatuirzed electronic assemblies.

Yet another object of the invention is to provide a vacuum pencil which may be held in and operated by one hand.

An important object of the invention is to provide a vacuum pencil which is light weight, typically weighing on the order of 1 oz., and thus does not fatigue the operator.

A further object of the invention is to provide a vacuum pencil which is relatively simple in construction, economical to manufacture, reliable in operation, convenient to use, and otherwise ideally suited to its intended purpose.

With these and other objects in view, the invention consists in the construction, arrangement, and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims, and illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a perspective view of a vacuum pencil according to the invention illustrating the pencil being used to remove excess solder from an electronic assembly;

FIGURE 1*a* is an enlarged fragmentary view, partly broken away, of the tip of the vacuum pencil showing the excess solder being aspirated into the pencil;

FIGURE 1*b* is a view similar to FIGURE 1*a* showing the solder being ejected from the pencil;

FIGURE 2 is an enlarged axial section through the pencil showing a certain plunger in the pencil in its retracted position;

FIGURE 3 is an axial section through the pencil, in a plane normal to the section in FIGURE 2, showing the plunger in its extended position;

FIGURE 4 illustrates a modified tip for the pencil;

FIGURE 5 is an axial section through a modified vacuum pencil according to the invention;

FIGURE 6 is an enlarged fragmentary section through a latch means embodied in a vacuum pencil of FIGURE 5;

FIGURE 7 is a view looking in the direction of the arrows on line 7—7 in FIGURE 6, partially broken away for the sake of clarity;

FIGURE 8 is a fragmentary section similar to FIGURE 6 illustrating the latch means in operative engagement with the plunger of the vacuum pencil; and

FIGURE 9 is a section taken on line 9—9 in FIGURE 8.

The vacuum pencil **10** illustrated in FIGURES 1–4 of the drawings comprises a relatively small, pencil-like barrel **12** which is typically on the order of six inches in length and one-half inch in diameter. The barrel is composed of three separable sections, to wit, a rear cylinder section **14**, an intermediate coupling section **16**, and a front tip section **18**. The coupling section **16** has a front and rear, externally threaded extremities **20** and **22**, respectively, and an intervening shoulder and flange **24**. The rear end of the tip section **18** is internally threaded to receive the front extremity **20** of the coupling section. The front end of the cylinder section **14** is internally threaded to receive the rear extremity **22** of the coupling section. When the three barrel sections **14**, **16**, and **18** are assembled, the rear end face of the tip section and the front end face of the cylinder section seat against the front and rear faces, respectively, of the coupling flange **24**.

Slidably fitted within the rear cylinder section **14** is a plunger **26**. Plunger **26** comprises a sleeve **28** having a rear end wall **30** which seals the rear end of the plunger. The front end of the plunger is open. The rear end portion of the plunger **26** is exposed through an opening **32** in the rear end of the cylinder section **14**. This opening extends laterally through the side wall and axially through the rear end of the cylinder section. The angular extent of the opening **32**, measured circumferentially of the cylinder section **14**, is somewhat less than 180 degrees. The axial length of the opening is somewhat less than the length of the plunger **26**. Accordingly, the rear end portion of the plunger, while being exposed through the opening **32**, is slidably confined by the cylinder section. The cylinder section has a rear, inwardly directed lip or shoulder **34** which limits rearward movement of the plunger in the barrel **12**.

Extending coaxially from and secured to the rear end of the coupling section **16** is a sleeve **36**. The diameter of this sleeve is substantially less than the internal diameter of the plunger **26**. Sleeve **36** extends rearwardly from the coupling section to a position about midway between the ends of the cylinder section **14**. The central passage in the sleeve opens rearwardly through the rear end of the sleeve and forwardly through the coupling section **16** into a chamber **38** within tip section **18**. Opening through the wall of this sleeve is an axially extending slot **40**.

Extending axially through the sleeve **36** and forwardly therefrom, through the coupling section **16** into the chamber **38** within the tip section **18**, is an ejector rod **42**. Rod **42** has a rear head **44** with a detent **45** which engages in the sleeve slot **40**. Encircling the ejector rod **42**, between the latter and the wall of the sleeve **36**, is a compression spring **46**. The ejector rod head **44** engages between two adjacent turns of this spring as shown. At its forward end, the spring **46** seats against a rearwardly presented shoulder **48** on the coupling section **16**. The rear end portion of this spring extends rearwardly from the sleeve **36** into contact with the plunger end wall **30**.

Spring **46** urges the plunger to its rear retracted position of FIGURE 2, wherein the plunger seats against the rear barrel shoulder **34**. The plunger is movable forwardly in the barrel **12**, against the action of spring **46**, to its forward extended position of FIGURE 3, wherein the front end of the plunger is located adjacent the coupling section **16**. It is significant to note at this point that forward movement of the plunger in the barrel compresses the spring **46** and thereby moves the ejector rod **42** forwardly in the barrel. It should also be noted that

rotation of the spring in one direction advances the rod forwardly in the barrel. Rotation of the spring in the opposite direction retracts the rod rearwardly. Thus, the axial position occupied by the rod when the plunger **26** is extended may be adjusted by rotation of the spring. In practice, the rod is axially adjusted so that its forward tip projects through a suction opening or orifice **50** in the front end of the tip section **18** to a position wherein the tip of the rod is about flush with the front end of the tip section when the plunger is extended.

Slidably positioned on the ejector rod **42**, forwardly of the coupling section **16**, is a screening element **51**. As will appear shortly, the purpose of this screening element is to permit air flow through the central opening in the coupling section **16** while preventing passage through said opening of articles aspirated into the forward chamber **38** of the vacuum pencil.

Barrel **12** carries an externally operable latch means **52** for releasably latching the plunger **26** in its forward extended position. This latch means comprises a spring blade **54**, the ends of which are bent in opposite transverse directions to form front and rear shoulders **56** and **58**. The front end of the blade seats in an external axial slot **59** in the rear extremity **22** of the coupling section **16** and is confined between the latter section and the cylinder section **14**. The front shoulder **56** on the blade **54** engages in a recess **60** at the forward end of the slot to confine the blade against endwise movement.

The rear shoulder **58** on the spring blade **54** forms a latch shoulder. This latch shoulder is engageable with a cooperating internal rearwardly presented latch shoulder **62** in the forward end of the plunger **26** when the latter occupies its forward extended position.

The blade is biased to normally retain its latch shoulder **58** in latching engagement with the plunger latch shoulder **62**, thereby to retain the plunger in its forward extended position. Seating against and preferably secured to the outer surface of the spring blade **54** is a button **64** which protrudes through an opening in the front end of the cylinder section **14**. Pressure on this button deflects the blade inwardly to retract its latch shoulder **58** out of latching engagement with the plunger latch shoulder **52**. The plunger is thereby released for rearward movement in the barrel **12** under the action of the plunger spring **46**. The front end of the plunger is internally beveled at **66** to deflect the latch plate **54** inwardly during subsequent forward extension of the plunger thereby to reengage the latch shoulder **58** on the blade with the latch shoulder **62** on the plunger. Plunger **26** has a rear knurled finger piece **67** which projects through the barrel opening **32**.

In use, the barrel **12** of the present vacuum pencil **10** is grasped in one hand and a finger is pressed against the rear, exposed finger piece **67** on the plunger **26** to move the latter to its forward extended position in the barrel against the action of the plunger spring **46**. The plunger is latched in this position by the latch means **52**. Subsequent depression of the latch button **64** releases the latch means, whereupon the plunger **26** is propelled rearwardly in the barrel **12** by the compressed plunger spring. This rearward movement of the plunger in the barrel aspirates air into the pencil thru the orifice or suction opening **50**.

When removing or retrieving an object, such as a micro-miniature component or a fluid such as liquid solder, from a work area, the plunger **26** is latched in its forward extended position and the tip of the vacuum pencil is placed in close proximity to the item to be removed or retrieved, as shown in FIGURES 1 and 1*a*. The latch button **64** is then depressed with one finger of the hand which grasps the pencil, thereby to release the plunger for rearward movement in the barrel **12**. The resulting pressure drop in the front pencil chamber **38** causes an inrush of air into the chamber through the front suction opening **50** in the pencil, which aspirates

the item into the chamber. The retrieved item may be removed from the chamber in various ways. For example, the front tip section **18** of the vacuum pencil may be removed and may be externally knurled for this purpose. Alternatively, the vacuum pencil may be held in an upright position to cause the item to move to a position adjacent the inner end of the suction opening **50**. The ejector rod **42** may then be extended forwardly, to eject the item through the suction opening, as shown in FIGURE 1*b*, by depressing the plunger **26** to its forward extended position.

In the event that the vacuum pencil **10** is to be employed for removing excess solder from miniature and micro-miniature electronic assemblies, for example, the tip section **18** is constructed of a high temperature resistant material to which the solder will not adhere, such as Teflon, and is provided with an elongate suction opening **50**, as in FIGURES 2 and 3, which is proportioned to contain the entire quantity of excess solder which is removed during each operation of the vacuum pencil. In this case, the solder solidifies in the suction opening and may be subsequently ejected from the opening by the ejector rod **42**, in the manner explained above. The diameter of the ejector rod is preferably somewhat less than the diameter of the suction opening in this case, to permit aspirating air flow into the forward pencil chamber **38** immediately upon rearward retraction of the plunger **26** in the pencil barrel **12**. In the event that the present vacuum pencil is to be employed primarily for retrieving solid objects, such as micro-miniature components, the suction opening **50** may have a relatively short axial length, as in FIGURE 4.

It is apparent that when the plunger **26** retracts rearwardly in the barrel **12** under the action of the plunger spring **46**, to aspirate an item into the forward pencil chamber **38**, air flow occurs from the chamber, through the central opening in the coupling **16**, into the cylinder section **14**. This air flow tends to draw the retrieved item into the cylinder section, which is undesirable. The screening element **51** is provided to confine the retrieved item in the forward pencil chamber **38** while permitting aspirating air flow from the chamber into the cylinder section. This screening element may comprise a small porous washer constructed of steel fibers, for example.

At this point, it is significant to note that the present vacuum pencil **10** is adapted to be held in and operated by one hand. The pencil is, therefore, convenient to use. It should also be noted that the small size of the pencil and the taper of its tip section **18** uniquely adapts the pencil for use on miniature and micro-miniature electronic assemblies. The pencil may be provided with a pocket clip **68**.

Reference is now made to FIGURES 5 through 9, illustrating a more highly refined embodiment of the present vacuum pencil, which possesses certain advantages over the vacuum pencil described earlier, notably greater simplicity of construction and economy of manufacture. The modified vacuum pencil **100** is generally similar to the earlier vacuum pencil and comprises two separable sections, to wit, a rear cylinder section **104** and a front tip section **106**. The front end of the rear cylinder section **104** is internally threaded at **108** at receveice a rear, reduced threaded extremity **110** on the tip **106**. Preferably, the threads **108** comprise modified acme threads of relatively large pitch and having flat tips disposed flush with the inner surface of the rear cylinder section **104**. Threads of large pitch are preferably employed to permit the tip **106** to be quickly removed from and reassembled on the rear cylinder section.

Slideably fitted within the rear cylinder section **104**, is a plunger **112**. Plunger **112** comprises a sleeve, the rear end of which is closed by a plug **114**. Plug **114** has an intermediate cylindrical portion **116** and front and rear cylindrical ends **118** and **120**, respectively, of reduced diameter relative to the central portion **116**. The juncture of the central portion **116** and the front end **118** of the plug **114** defines an annular, forwardly presented shoulder **122** on the plug. The juncture of the central portion **116** and the rear end **120** of the plug defines an annular, rearwardly presented shoulder **124** on the plug. The central portion **116** of the plug is dimensioned to have a light press fit within the plunger **112**. When assembling the plug **114** to the plunger **112**, the plug is driven into the plunger in a position wherein the rear plug shoulder **124** is located a small distance inwardly or forwardly of the rear end of the plunger. The rear end of the plunger is then turned inwardly to form an internal shoulder **126** on the plunger, which seats axially against the plug shoulder **124** and radially against the rear plug end **120**. The front end of the plunger **112** is open. Formed in the external surface of the plunger, adjacent its front end, is an annular groove **128**. This groove defines an annular, rearwardly presented shoulder **130** at the front end of the plunger.

Plunger **112** is exposed through a slot or opening **132** and the rear end of the rear cylinder section **104**. This opening extends laterally through the side wall and axially to the rear end of the cylinder section. The angular extent of the opening **132**, measured circumferentially of the cylinder section **104**, is somewhat less than 180 degrees. The axial length of the opening is somewhat less than the length of the plunger **112**. Accordingly, the plunger, while exposed through the opening **132**, is slideably confined by the cylinder section. The rear end of the cylinder section is turned inwardly to form a shoulder **134**, which limits rearward movement of the plunger in a cylinder section.

Concentrically disposed within the front end of the rear cylinder section **104** is a generally conical spring **136** which tapers to a smaller diameter toward the rear end of the section. Spring **136** is wound in the proper direction and properly dimensioned, to mate at its front, large diameter end, with the internal threads **108** in the front end of the cylinder section. Accordingly, the spring may be threaded into the front end of the cylinder section. The spring is thus inserted into the cylinder section to a position wherein the front end of the spring seats within a relief groove **137** at the rear end of the cylinder threads **108**. Preferably, the front end of the spring is secured to the cylinder section in any convenient way, as by adhesively bonding the spring to the section. Several adjacent coils at the rear, small diameter end of the spring **136** have substantially the same diameter and together define an effective bearing bore **138** centered on the axis of the cylinder.

Extending centrally through the cylinder **104** and the plunger **112** is a coil spring **140**. One end of the coil spring **140** seats against the outer surface of the conical spring **136** at a position intermediate the ends of the latter spring. The rear end of the spring **140** encircles the front end **118** of the plunger plug **114** and seats against the forwardly presented plug shoulder **122**. Spring **140** is axially dimensioned to urge the plunger **112** to its rear limiting position of FIGURE 5, wherein the plunger seats against the rear shoulder **134** on the cylinder **104**.

In the event that the vacuum pencil **100** is to be employed to remove excess solder from electronic assemblies, and the like, the tip **106** is preferably constructed of high temperature resistant material to which the solder will not adhere, such as Teflon. Extending axially through the tip is a stepped bore **142**. This bore decreases in diameter toward the front end of the tip and terminates, at its forward end, in a relatively small diameter orifice **144**. The rear end of the bore **142** opens to the interior of the cylinder **104**. Preferably, the tip **106** is externally tapered, like the tip of the vacuum pencil described earlier.

Plunger **112** is movable forwardly in the cylinder **104** to its forward extended position of FIGURE 8, wherein the front end of the plunger is telescoped over the rear

end of the conical spring **136** and is located adjacent the rear end of the tip **106**. Latch means **146** are provided for releasably latching the plunger in this extended position. Latch means **146** comprises a latch member **148** which is pivotally mounted intermediate at its ends on the cylinder **104** for pivotal movement between its latching position of FIGURES 6 and 8, wherein the front end of the member projects into the central opening or bore in the cylinder, and a retracted position, wherein the front end of the member is substantially flush the wall of the cylinder bore. As will appear from the following description, the latch member is resiliently biased to its latching position. Latch member **148** may be pivotally mounted on the cylinder **104** in various ways. According to the preferred practice of the invention, however, the latch member is integrally formed with the cylinder by routing or otherwise cutting a pair of overlapping, generally U shaped slots **150** and **152** in the wall of the cylinder in such a way as to define a latch member of generally T shape and a pair of resiliently flexible connecting portions **154** extending rearwardly from and integrally joining the outboard ends of the forward cross arm of the T to the wall of the cylinder proper. The connecting portions **154** are located intermediate the front and rear ends of the latch member **148** and pivotally mount the latch member on the cylinder for pivotal movement about an effective pivot axis extending transversely of the cylinder. After cutting the slots **150, 152** the front ends of the resiliently flexible connecting portions **154** are bent inwardly slightly to resiliently retain the latch member **148** in its latching position in FIGURES 6 and 8.

When the plunger **112** is pushed forwardly in the cylinder **104** to its extended position in FIGURE 8, the front shoulder **130** on the plunger initially engages the inwardly projecting front end of the latch member **148** and urges this end of the member outwardly against the spring action of the resiliently flexible connecting portions **154** of the latch. The latch member thereby exerts a lateral thrust on the front end of the plunger which urges the latter into frictional engagement with the opposite inner wall of the cylinder **104**. The plunger spring **140** may be selected to have a spring rate, such that this frictional engagement of the plunger with the cylinder is effective to retain the plunger in its extended position. If desired, however, the plunger may be positively latched in its extended position by pushing the plunger forwardly in the cylinder until the front, inwardly projecting end of the latch member **148** snaps behind the plunger shoulder **130**, as illustrated in FIGURE 8. In either case, the plunger is released for return to its rear limiting or retracted position of FIGURE 5, under the action of the plunger spring **140**, by pressing on the rear end of the latch member **148**. Thus, pressure on the rear end of the latch member causes flexing of the resiliently flexible portions **154** in such a way that the latch member pivots on its effective axis in a direction to retract the front end of the member out of latching engagement with the plunger. The plunger is then returned to its retracted position of FIGURE 5, by the action of the plunger spring **140**. In order to avoid excessive local wear of the plunger shoulder **130** by repeated engagement of the shoulder with the latch member **148**, it is desirable to periodically rotate the plunger in the cylinder **104**, thereby to periodically present a new portion of the shoulder to the latch member.

The vacuum pencil **100** is used in the same way as the vacuum pencil described earlier. Thus, the plunger **112** of the vacuum pencil **100** is latched in its extended position and the front end of the orifice **144** in the tip **106** is placed in close proximity to the object or material to be picked up. The rear end of the latch member **148** is then depressed to release the plunger for retraction in the cylinder **104** under the action of the plunger spring **140**. During this retraction of the plunger, air is drawn into the pencil through the orifice **144**, thereby aspirating the object or material into the pencil through the orifice.

It is apparent, of course, that efficient operation of the pencil requires sealing of the cylinder slots **150** and **152** against air flow therethrough during retraction of the plunger. To this end, the portion of the cylinder **104** containing the latch means **146** is enclosed in a sealing sleeve **156**, which is sealed to the wall of the cylinder forwardly and rearwardly of the latch means. Sleeve **156** is constructed of a flexible material which permits depression of the rear end of the latch member **148**, to release the plunger **112**, by the application of pressure to the sleeve **156** over the rear end of the latch end. Preferably, the sleeve is marked, as by a small colored dot **158** and the illustrated word "Press," to indicate the position at which pressure should be applied to the sleeve to release the latch member **148**. The sealing sleeve **156** may be constructed in various ways. For example, the sleeve may comprise a length of pressure sensitive plastic tape, or the like, which is wrapped around the cylinder **104**. According to the preferred practice of the invention, however, the sealing sleeve comprises a length of so called "shrink tubing," which is shrunk onto the cylinder **104** about the latch means **146**. A sealing sleeve of this type is preferred for the reason that it is more durable than pressure sensitive tape, for example, and cannot be removed to expose the latch means **146** without destruction of the sleeve.

It is significant to note that when, in its forward extended position of FIGURE 8, the plunger **112** limits inward deflection of the rear end of the latch member **148**. Accordingly, the plunger when extended, is effective to prevent excessive inward deflection of the latch member which would cause stressing of the resiliently flexible connecting portions **154** beyond their elastic limit and thereby, permanent deformation of the portions. It is possible, however, that a person using the vacuum pencil **100** may inadvertently exert pressure on the rear end of the latch member **148** while the plunger **112** is retracted. In this case, there is a possibility that the latch member may be depressed to such an extent that the connecting portions **154** of the latch member, are permanently deformed sufficiently to destroy the proper latching action of the member. For this reason, the illustrated vacuum pencil **100** is equipped with spring means **160** for preventing excessive inward deflection of the rear end of the latch member. The illustrated spring means **160** comprises a band of resiliently flexible material, such as Milar, which encircles the cylinder **104** in underlying relation to the rear end of the latch member. Accordingly, inward pressure on the rear end of the latch member effects engagement of the member with the band **160**, which thereby limits inward deflection of the rear end of the member. Other types of spring means, other than the illustrated band **160**, may be employed for this purpose, such as a spring ring, or the like.

Extending axially through the barrel **102** is an ejector rod **162**. The rear end of this rod is fixed within a central bore in the plunger plug **114**. The forward end of the rod extends slideably through the effective bearing bore **138** defined by the conical spring **136**. Rod **162** is dimensioned to fit slideably within the orifice **144** in the tip **106**. When the plunger **112** is retracted, the front end of the ejector rod is located within the rear end of the conical spring **136**. During forward movement of plunger in the cylinder **104**, to its extended position of FIGURE 8, the front end of the rod enters the orifice **144** to eject therefrom any objects or material, such as solidified solder, present in the orifice.

It is now evident that the operation of the modified vacuum pencil **100** is essentially the same as the operation of the vacuum pencil described earlier. Accordingly, it is unnecessary to repeat, in detail, the operation of the modified vacuum pencil. It is significant to note, however, that the conical spring **136** serves a two-fold pur-

pose. First, this spring provides a bearing which slideably supports the ejector rod **162** during axial movement of the rod in the barrel **102** with the plunger **112**. Secondly, the spring serves as a filter which permits air flow between the cylinder **104** and the tip **106** during extension and retraction of the plunger **112**, but blocks the entrance into the cylinder of the various objects and materials which are aspirated into the pencil during operation thereof. In this regard, it is significant to note that during retraction of the plunger in the cylinder **104** under the action of the plunger spring **140**, a pressure differential is created across the conical spring **136** which tends to extend the latter and thereby separate the adjacent spring coils to permit free flow of air through the spring. However, the spring coils do not separate sufficiently to permit passage therebetween of the objects and materials aspirated into the pencil. If desired, a conically tapered brush, or the like, may be furnished with the vacuum pencil **100** for the purpose of cleaning the interior surfaces of the tip **106** and the conical spring **136**.

One highly important advantage of the present vacuum pencil resides in the fact that the pencil is small in size and light in weight and thus may be used for extended periods of time without causing fatigue of the operator. A typical vacuum pencil, according to the invention, for example, weighs on the order of 1 oz. Another advantage of the vacuum pencil is that after retrieving a small fork part, such as a micro-miniature circuit component, by aspirating the part into the pencil, the pencil tip may be immediately pointed upwardly and the plunger may be latched in its extended position wherein the ejector rod closes the pencil orifice, thereby to trap the part in the forward pencil chamber until the part is deliberately removed by releasing the plunger, pointing the tip downwardly, and shaking the pencil or removing the tip.

While the invention has herein been shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having described the invention, what is claimed as new in support of Letters Patent is:

1. A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, comprising:

a relatively small, slender, pencil-like barrel adapted to be held in one hand, said barrel having front and rear ends and an orifice opening through said front ends;

a plunger movable in said barrel;

a spring acting between said barrel and plunger for urging said plunger rearwardly in said barrel, the rear end of said plunger being exposed at the rear end of said barrel for forward movement of said plunger to a forward extended position in said barrel against the action of said spring by finger pressure on the exposed rear end of said plunger;

latch means operable externally of said barrel for latching said plunger in said forward extended position;

an ejector rod operatively connected to said plunger and movable forwardly in said barrel with said plunger to a position wherein the forward end of said rod extends into said orifice when said plunger occupies said forward extended position thereof;

and a screening element disposed within said barrel in surrounding relation to said ejector rod between said orifice and plunger, said screening element being pervious to air but impervious to articles and fluids aspirated into said pencil.

2. A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, comprising:

a relatively small, slender, pencil-like barrel adapted to be held in one hand and including a rear cylinder section and a front hollow tip section removably secured to the front end of said cylinder section;

a plunger slidable in said cylinder section;

a spring acting between said cylinder section and plunger for urging the latter rearwardly in said cylinder section;

means on said cylinder section for limiting rearward movement of said plunger in said cylinder section, said cylinder section having a rear opening extending laterally through the side wall and axially through the rear end of said cylinder section and exposing the rear end of said plunger for forward movement of said plunger to a forward extended position in said cylinder section by finger pressure on the rear exposed end of said plunger;

externally operable latch means in said cylinder section for releasably latching said plunger in said forward extended position thereof;

an ejector rod operatively connected to said plunger and movable forwardly in said barrel with said plunger to a position wherein the forward end of said rod extends into said orifice when said plunger occupies said forward extended position thereof;

and a screening element disposed within the forward end of said cylinder section in surrounding relation to said ejector rod, said screening element being pervious to air but impervious to articles and fluids aspirated into said pencil.

3. A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, comprising:

a relatively small, slender, pencil-like barrel adapted to be held in one hand, said barrel having front and rear ends and an orifice opening through said front end;

a plunger movable in said barrel;

a spring acting between said barrel and plunger for urging said plunger rearwardly in said barrel, the rear end of said plunger being exposed at the rear end of said barrel for forward movement of said plunger to a forward extended position in said barrel against the action of said spring by finger pressure on the exposed read end of said plunger;

latch means operable externally of said barrel for latching said plunger in said forward extended position thereof;

a screening element disposed within said barrel between said orifice and plunger, said screening element comprising a coil spring with normally contacting coils which is pervious to air but impervious to articles and fluids aspirated into said pencil;

said screening spring comprising a conical spring the diameter of which decreases toward the rear end of said barrel and which terminates at its rear end in a number of coils of substantially equal diameter defining an effective bearing bore on the axis of said barrel;

an injector rod operatively connected to said plunger and movable forwardly in said barrel with said plunger to a position wherein the forward end of said rod extends into said orifice when said plunger occupies the forward extended position thereof;

said rod extending slidably through said bearing bore whereby said conical spring slidably supports said ejector rod during axial movement of the rod with said plunger.

4. A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, comprising:

a relatively small, slender, pencil-like barrel having front and rear ends and adapted to be held in one hand, said barrel including a rear cylinder section, an intermediate coupling section, and a front tip sec-

tion, said coupling section having a rear extremity threaded in the forward end of said cylinder section and a forward extremity threaded in the rear end of said tip section, said tip section having an internal chamber and a forward orifice opening through the front end of said tip section and communicating with said chamber, said coupling section having a central opening communicating said chamber to the interior of said cylinder section, a plunger movable in said cylinder section comprising a sleeve having an open forward end and a closed rear end, a spring acting between said coupling section and said plunger for urging said plunger rearwardly in said cylinder section, said cylinder section having a rear opening extending laterally through the side wall and axially through the end of said cylinder section for exposing the rear end of said plunger for forward movement of said plunger to a forward extended position in said barrel against the action of said spring by finger pressure on the rear exposed end of said plunger, said cylinder section having a rear shoulder for limiting rearward movement of said plunger in said cylinder section, an ejector rod extending axially through said barrel and having a rear enlarged head engaging between two adjacent turns of said spring, whereby said rod undergoes axial movement in said barrel with said plunger, said rod being movable forwardly in said barrel with said plunger to a position wherein the front end of said rod extends into said orifice when said plunger occupies said forward extended position thereof, a screening element disposed within said coupling section in surrounding relation to said ejector rod, said screening element being pervious to air but impervious to articles and fluids aspirated into said pencil, said plunger having a forward internal, rearwardly presented latch shoulder, a latch member mounted within the forward end of said cylinder section for latching engagement with said shoulder when said plunger occupies forward extended position thereof, said latch member being movable inwardly out of latching engagement with said shoulder, thereby to release said plunger for rearward movement in said barrel, and a latch actuating member operatively engaging said latch member and projecting externally of said barrel through an opening in said cylinder section to receive finger pressure for moving said latch member inwardly out of latching engagement with said plunger.

5. A unitary, completely self-contained vacuum pencil for aspirating articles and fluids from confined spaces, comprising:

a relatively small, slender, pencil-like barrel having front and rear ends and adapted to be held in one hand, said barrel including a rear cylinder section and a front tip section threaded in the forward end of said cylinder section, said tip section having an internal chamber opening to said cylinder section and an orifice extending axially thru the front end of said tip section and communicating to said chamber, a conical spring disposed within the forward end of said cylinder section and having normally contacting coils, the forward end of said spring seating in an internal relief groove within the forward end of said cylinder section at the rear end of the threads in said cylinder section, said spring decreasing in diameter toward the rear end of said cylinder section and terminating at its rear end in a number of coils of substantially equal diameter defining an effective bearing bore on the axis of said barrel, a cylindrical coil spring seating at one end against the outer surface of said conical spring and at the other end against the closed rear end of said plunger for urging said plunger rearwardly in said barrel, said cylinder section having a rear opening extending laterally through the side wall and axially through the rear end of said cylinder section for exposing the rear end of said plunger for forward movement of said plunger to a forward extended position in said barrel by finger pressure on the rear exposed end of said plunger, a shoulder on the rear end of said cylinder section for limiting rearward movement of said plunger in said barrel, an ejector rod secured to the rear end of said plunger and extending axially through said barrel for axial movement in said barrel with said plunger, said ejector rod being movable forwardly in said barrel to a position wherein the forward end of said rod extends into said orifice when said plunger occupies said forward extended position thereof, said ejector rod extending through and being slidably supported in said effective bearing bore, the wall of said cylinder section having overlapping generally "U" shaped slots defining a generally "T" shape latch member and resiliently flexible connecting portions joining said latch member to the wall of said cylinder section, said connecting portions pivotally mounting said latch member on said cylinder section for rocking movement between a latching position wherein the front end of the latch member is disposed within said cylinder section for latching engagement with the front end of said plunger when said plunger occupies said forward extended position thereof, and a retracted position wherein the front end of said latch member is disposed to release said plunger for rearward movement in said barrel, said connecting portions being stressed to yieldably urge said latch member to said latching position and the rear end of said latch member being disposed to receive finger pressure for rocking said latch member to said retracted position thereof, a yieldable sealing sleeve surrounding said cylinder section in the region of said slots and latch member and sealed to said cylinder section at opposite ends of said latch member, and said latch member being pivotally movable to said retracted position thereof by application of finger pressure to said sealing sleeve over the rear end of said latch member.

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