

Oct. 22, 1946.

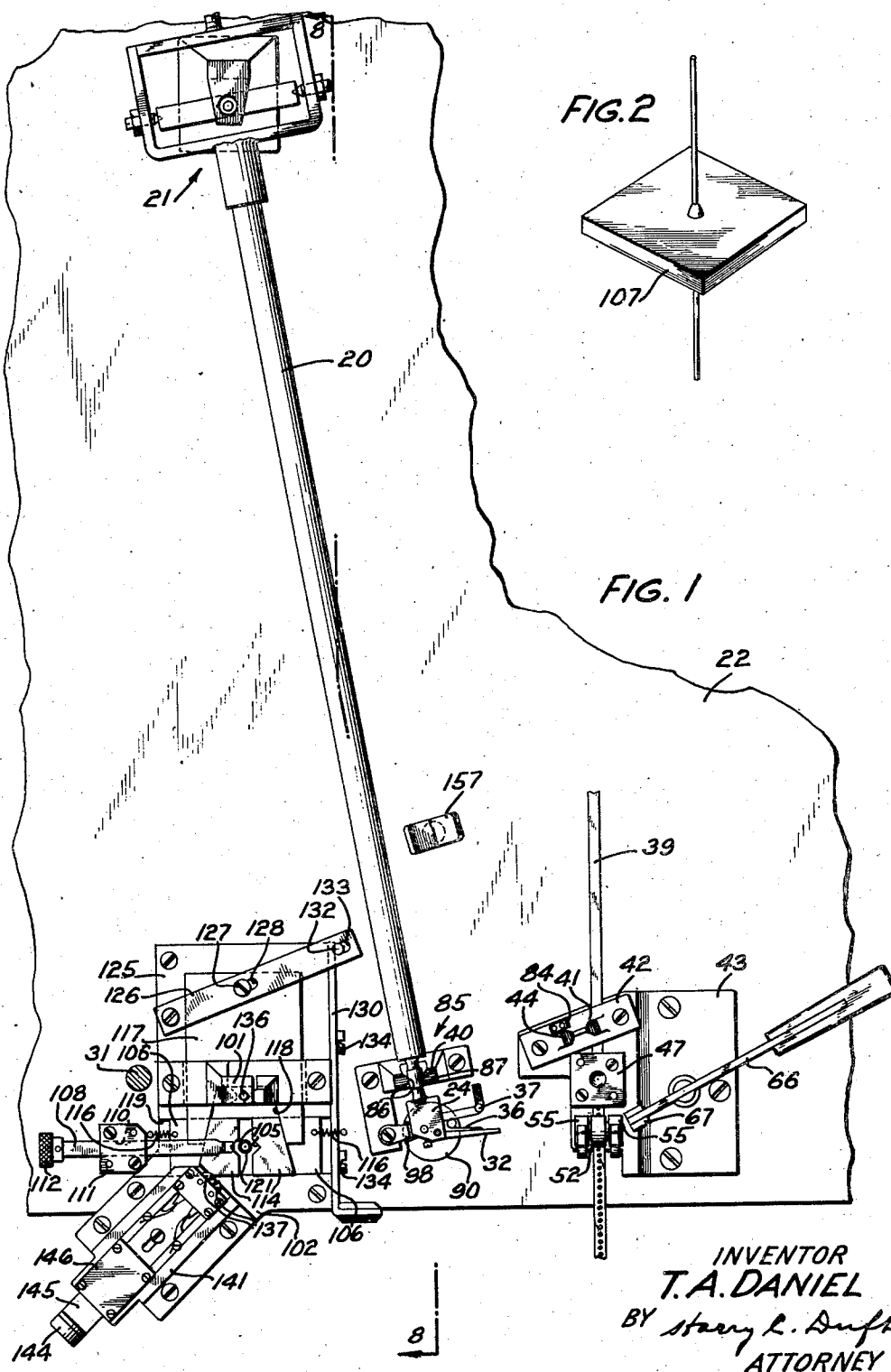
T. A. DANIEL

2,409,615

METHOD OF AND APPARATUS FOR SOLDERING

Filed Sept. 16, 1943

5 Sheets-Sheet 1



Oct. 22, 1946.

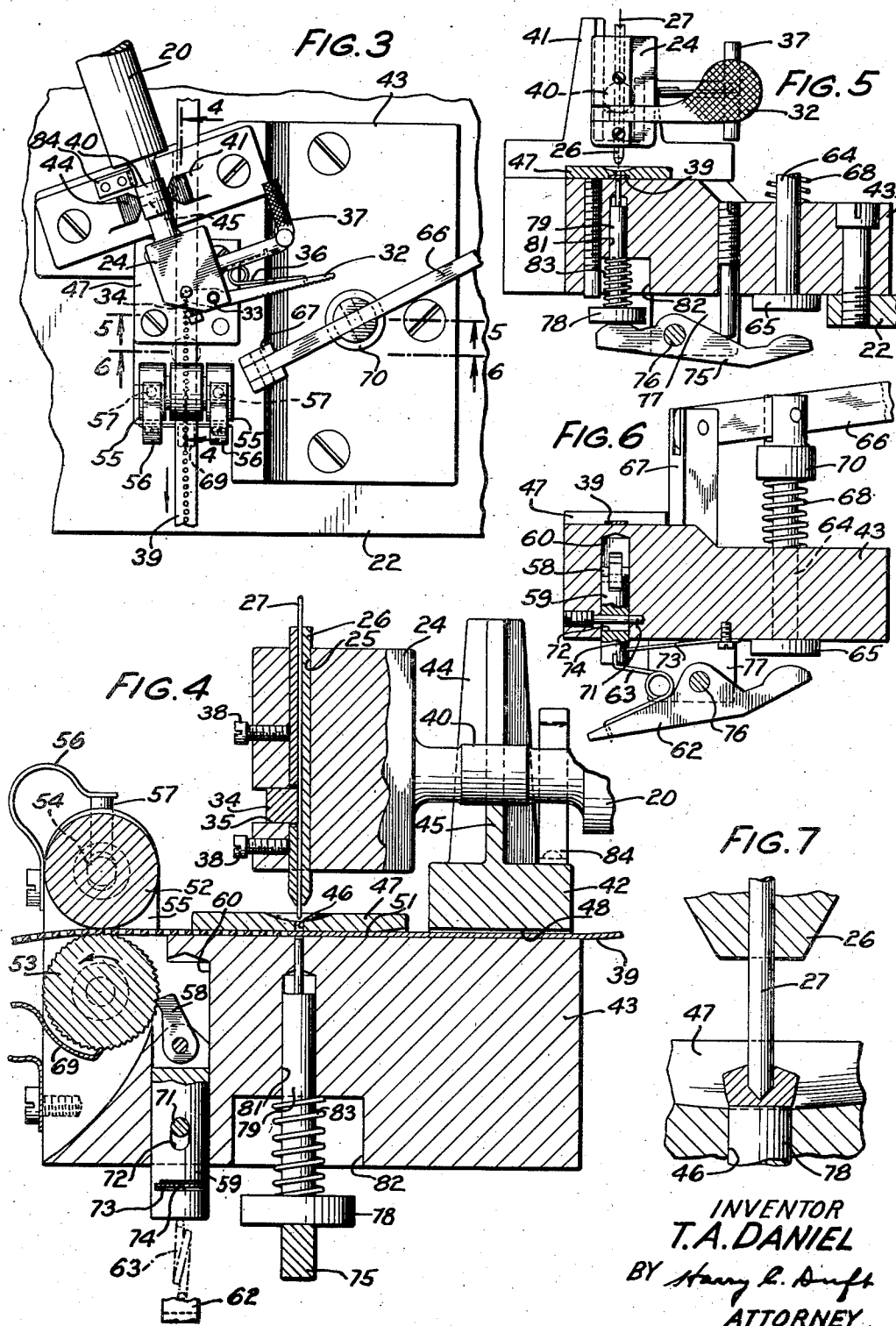
T. A. DANIEL

2,409,615

METHOD OF AND APPARATUS FOR SOLDERING

Filed Sept. 16, 1943

5 Sheets-Sheet 2



Oct. 22, 1946.

T. A. DANIEL

2,409,615

METHOD OF AND APPARATUS FOR SOLDERING

Filed Sept. 16, 1943

5 Sheets-Sheet 3

FIG. 8

This figure shows the overall side profile of the machine. The main frame 20 supports a vertical assembly. At the top, there is a motor or actuator 23 connected to a shaft 21. This shaft passes through a series of bearings and gears, including a large gear 24 and a smaller gear 37. A long drive shaft 31 extends from the gear train down to a pulley 30. The vertical support 91 holds a horizontal bar 94, which is part of a larger mechanism involving components 92, 93, 94, 95, 96, 97, and 98. Various other parts are labeled with numbers like 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 25, 26, 27, 28, 29, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144.

INVENTOR
T. A. DANIEL
BY Harry L. Sufst
ATTORNEY

Oct. 22, 1946.

T. A. DANIEL

2,409,615

METHOD OF AND APPARATUS FOR SOLDERING

Filed Sept. 16, 1943

5 Sheets-Sheet 4

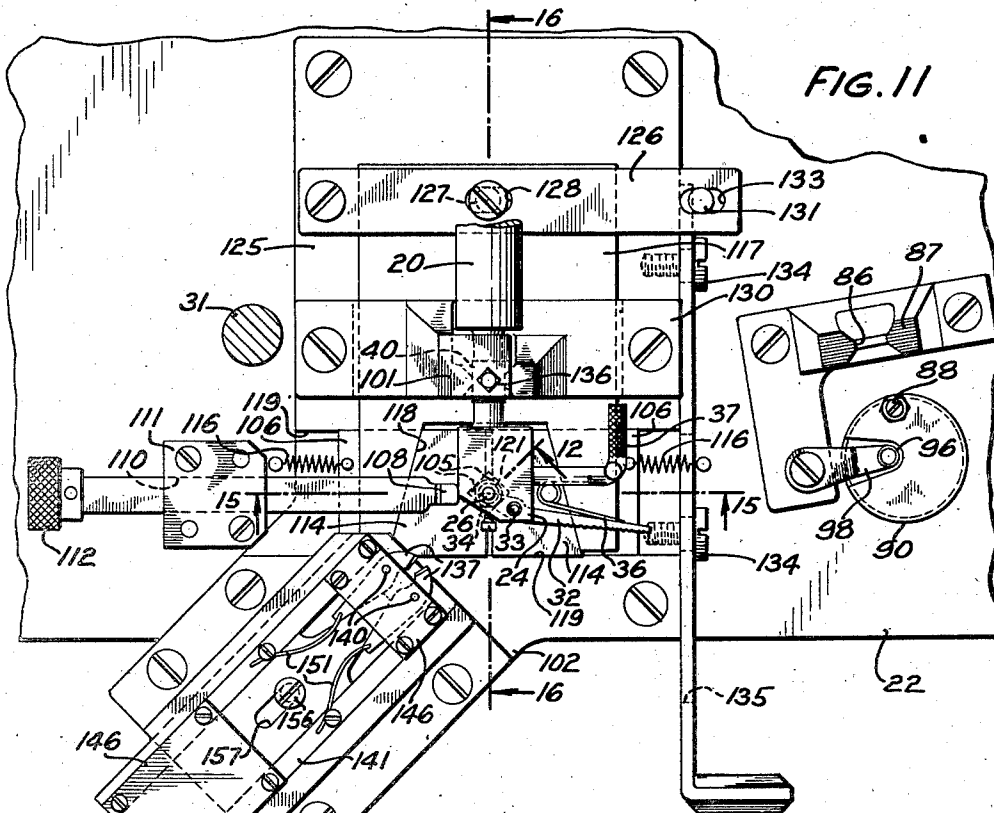


FIG. 11

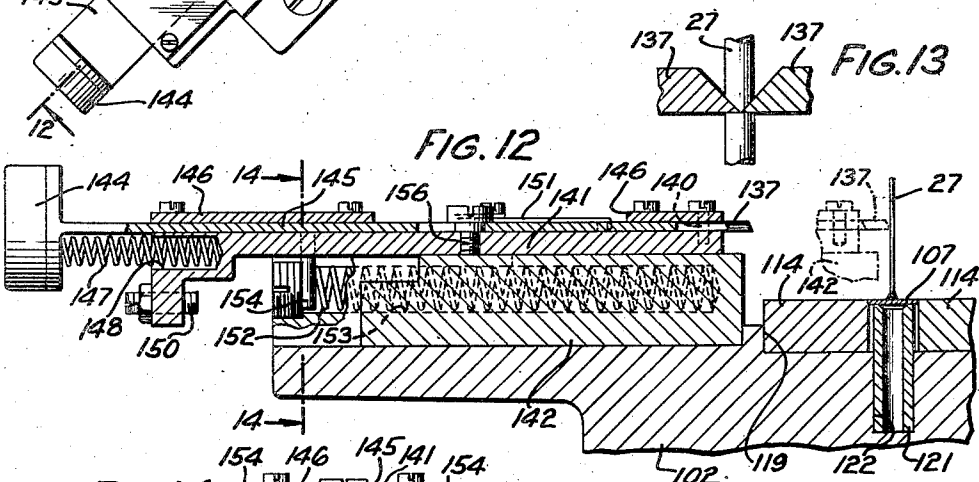


FIG. 12

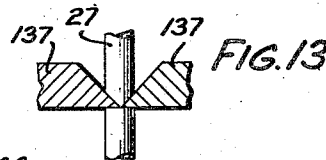


FIG. 13

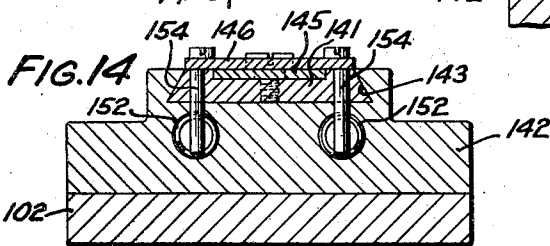


FIG. 14

INVENTOR
T. A. DANIEL
BY *Harry E. Drift*
ATTORNEY

Oct. 22, 1946.

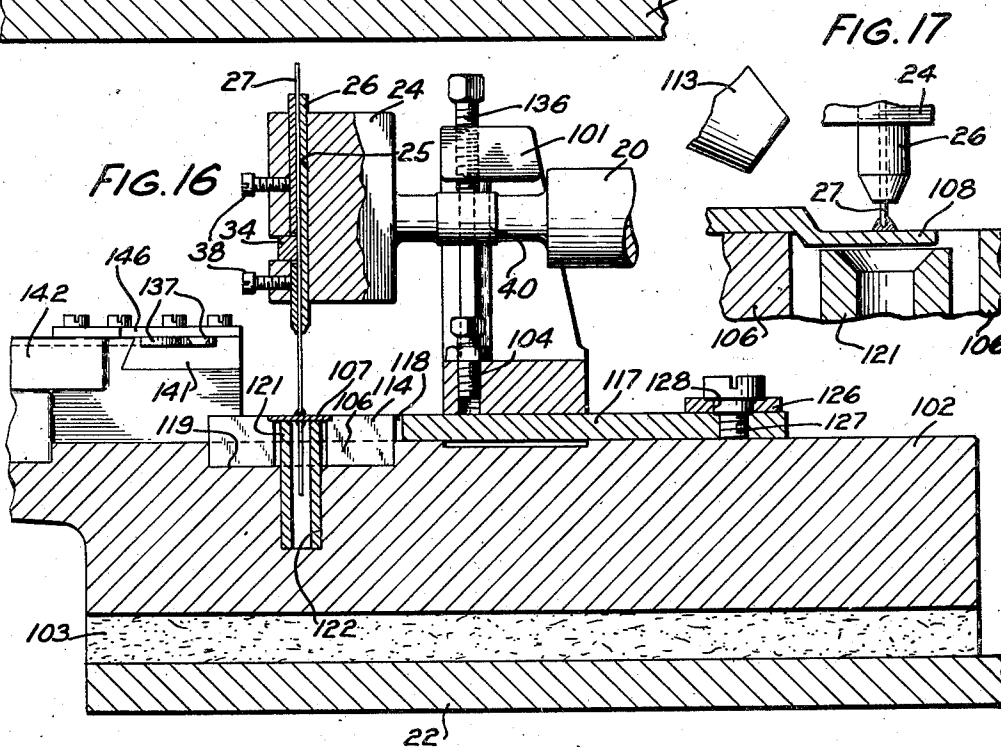
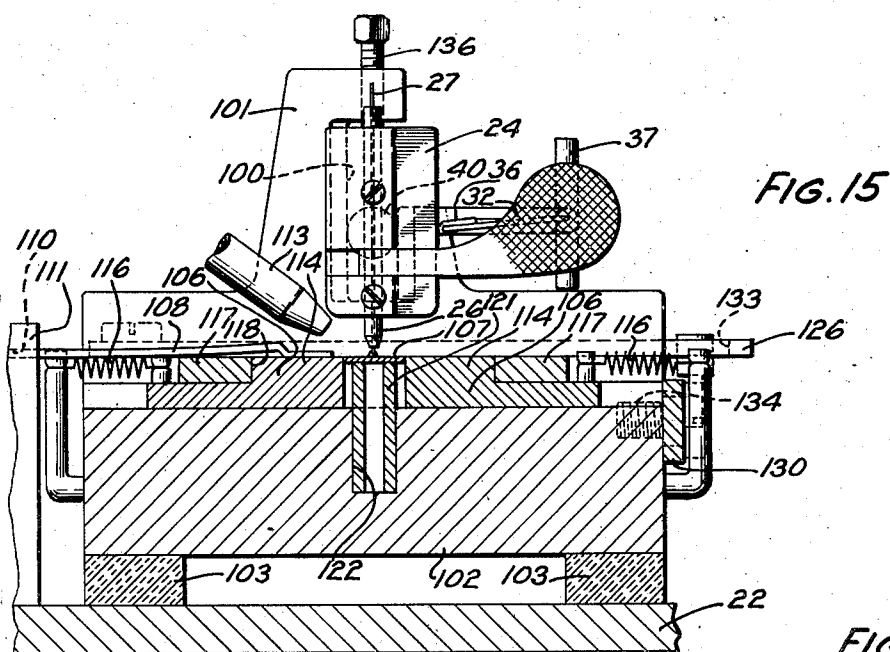
T. A. DANIEL

2,409,615

METHOD OF AND APPARATUS FOR SOLDERING

Filed Sept. 16, 1943

5 Sheets-Sheet 5



INVENTOR
T. A. DANIEL
BY *Harry R. Swift*
ATTORNEY

UNITED STATES PATENT OFFICE

2,409,615

METHOD OF AND APPARATUS FOR
SOLDERING

Thomas A. Daniel, Downers Grove, Ill., assignor
to Western Electric Company, Incorporated,
New York, N. Y., a corporation of New York

Application September 16, 1943, Serial No. 502,628

10 Claims. (Cl. 29—33)

1

This invention relates to a method of and an apparatus for soldering and more particularly to a method of and an apparatus for soldering lead wires to quartz crystals.

In the manufacture of electronic communication equipment, it is sometimes desirable to employ piezoelectric crystals as frequency control devices. Where it is necessary to establish direct contact with these crystals, the sides of the crystals may be provided with a thin plating of a metallic compound and conducting wires may then be attached to either side of the crystals. In some types of crystal assemblies, these lead wires serve also as supports for the crystals and because the crystals may be subjected to considerable rough usage and consequent mechanical shocks in use, the supporting wires must be securely attached to the crystals. Also, the wires must be attached to the crystals at a definite point on each side in order to permit the crystals to operate efficiently.

An object of the present invention is to provide an efficient and effective method of and apparatus for soldering lead wires to quartz crystals.

In accordance with one embodiment of this invention, a soldering apparatus may be provided in which a pellet of solder is punched from a tape and impaled on a sharpened end of a lead wire, the sharpening of the end of the wire being performed at a soldering station where the end of the lead wire is cut off after the wire has been soldered to the crystal. A fluxing station is provided intermediate the punching and soldering station.

Other objects and advantages of the present invention will be apparent from the following detailed description taken in conjunction with the drawings, wherein

Fig. 1 is a plan view of a soldering apparatus constructed in accordance with this invention;

Fig. 2 is a perspective view of a completed crystal;

Fig. 3 is a fragmentary plan view of the punch mechanism;

Fig. 4 is a sectional view along the line 4—4 of Fig. 3;

Fig. 5 is a sectional view along the line 5—5 of Fig. 3;

Fig. 6 is an irregular sectional view taken substantially along the line 6—6 of Fig. 3;

Fig. 7 is a detail sectional view showing the punch as it impales a pellet on the end of the lead wire;

Fig. 8 is a side elevation, partly in section, along the line 8—8 of Fig. 1, showing the lead wire arm in position over the fluxing station;

Fig. 9 is an enlarged sectional view along the line 9—9 of Fig. 8;

Fig. 10 is a sectional view similar to Fig. 9, ex-

2

cept that it shows the position of the flux cup in normal position when the lead wire arm is not positioned at that station;

Fig. 11 is an enlarged plan view showing particularly the soldering station;

Fig. 12 is an enlarged sectional view along the line 12—12 of Fig. 11;

Fig. 13 is a detail view showing the wire cutting blades as they engage the lead wire;

Fig. 14 is a sectional view along the line 14—14 of Fig. 12;

Fig. 15 is a sectional view along the line 15—15 of Fig. 11;

Fig. 16 is a sectional view along the line 16—16 of Fig. 11; and

Fig. 17 is an enlarged fragmentary detail view, along the line 15—15 of Fig. 11, showing the solder pellet forming plate in advanced position.

Referring now to the drawings and particularly to Fig. 1, wherein the entire apparatus is illustrated in plan view, and to Fig. 8, wherein a sectional view is shown of the apparatus, it will be seen that this apparatus includes a long arm 20, of rod-like appearance, which is secured at one end, and pivotally supported by a universally pivotable supporting assembly, designated generally as 21, mounted on a table 22. The arm 20 extends beyond the supporting assembly 21 to the right, as viewed in Fig. 8, and the extended portion, which is threaded, is provided with a weight 23, which threadedly engages this threaded portion of the arm and which is selected to be sufficient to counterbalance the arm so that the left end of the arm may be easily moved and is adjustable to provide the required pressure at the left end, as will be explained hereinafter.

As may be seen in Figs. 4, 15 and 16, a head 24 is fixed to the left end of the arm 20 and is provided with a vertically extending aperture 25, in which is positioned a quill 26, which serves as a guide for a wire 27. As may be seen in Fig. 8, this wire is supplied from a spool 30 rotatably mounted on the upper end of a vertical arm 31, which is mounted on the table 22. A thumb actuated lever 32 is pivotally mounted on a stud shaft 33 positioned in the forward portion of the block 24 and is provided with an inwardly bent portion 34, which is movable in a recess 35 formed in the left side of the block, as viewed in Fig. 4, so as to bear against the wire positioned in the quill, which is also suitably recessed at this point. A spring 36, mounted on a small handle 37, which extends a short distance from the right of the block 20, as viewed in Fig. 11, bears against the thumb actuated lever 32 and urges the portion 34 thereof against the wire. A pair of set screws 38 threaded in the block 24 holds the quill 26 in place.

The first station to which the arm is pivoted is the station where the solder pellet is punched

3

from a tape 39 and impaled on the end of the wire 27. This portion of the apparatus is illustrated particularly in Figs. 3 through 7. A portion 40 of the arm 20 immediately adjacent the head 24 is somewhat reduced, as may be seen in Fig. 4, and is carefully machined to obtain a definite and precise dimension in this area. When the arm 20 is pivoted into position over the punching station, this reduced portion engages a vertically extending guide post 41, which is mounted on a plate 42, which is, in turn, bolted to a base 43 of the punching apparatus. A second post 44, somewhat lower in height than the post 41, is also mounted on the plate 42 and spaced a distance therefrom equivalent to the width of the reduced portion 40 of the arm 20. Thus, as this reduced portion of the arm 20 engages the post 41 and is moved downward by the operator, the opposite side of this reduced portion will be engaged by the post 44 and these posts then cooperate to position the arm with respect to the punching apparatus and in a definite relation thereto. A stop member 45 is integrally formed with the plate 42 and positioned between the posts 41 and 44 and limits the downward movement of the arm 20. While this stop member is shown as integrally formed, it will be apparent that an adjustable member could be substituted therefor, such as a threaded post.

When the arm 20 is in position in the guide assembly comprising the posts 41 and 44 and the stop member 45, the end of the wire 27 in the quill 26 is positioned immediately above a die aperture 46 formed in a die plate 47, which is mounted on the punching assembly base 43. The solder tape 39, which is supplied in strip form from any suitable source, is moved through a rectangular aperture 48 of relatively wider cross section than the tape and is formed in the lower side of the plate 42. The tape then passes through an aperture 51 formed in the die plate 47 of slightly greater cross sectional size than the tape and then between a pair of rollers 52 and 53, which engage, respectively, the upper and lower sides of the tape.

The upper roller 52 is provided with a smooth periphery and serves primarily to urge the tape against the lower roller 53, the periphery of which is serrated, since this roller acts as the driving roller. A shaft 54, which supports the upper roller, is mounted in a vertically slotted housing 55 to permit vertical movement of the roll, while springs 56, having members 57 attached to the ends thereof, which bear against the ends of the shaft 54, urge the roller 52 against the roller 53.

The drive roller 53 is actuated by a pawl 58, which is pivotally mounted on the upper end of a plunger 59, and engages the serrated periphery of the roller 53. Both the plunger and pawl assembly are positioned in an aperture 60 formed in the lower side of the base block 43, as shown in Figs. 4 and 6. The plunger is actuated by a pivotally mounted lever arm 62, against the upper surface of which bears one end of a spring 63, as shown in Figs. 4 and 6. The other end of the spring 63 bears against the lower side of the plunger 59. The lever arm 62 is actuated by a piston 64, which has a disc 65 fixed to the lower end thereof. The piston is moved up or down by a lever arm 66 pivotally mounted on a post 67 fixed to the upper side of the base 43 and is connected to the piston 64 a short distance from the post 67. A helically coiled spring 68 is positioned about the piston 64 and the upper end of

4

the spring engages a collar member 70 integrally formed with the upper end of the piston 68. Thus, the piston 68 is normally urged upward, but may be moved downward by moving the lever arm 66 downward and, when so moved, moves the disc 65 against the right end of the lever arm 52, as viewed in Fig. 6, thereby pivoting the other end thereof upward and moving the plunger 59 and pawl upward, which rotates the roller 53 in a counterclockwise direction, as viewed in Fig. 4. A spring detent 69 prevents reverse rotation of this roller.

The vertical movement of the plunger 59 is limited by a pin 71, which is threaded into the left side of the block 43, as viewed in Fig. 6, and, extending across the aperture 60, extends through an elongated slot 72 formed in the lower portion of the plunger 59. This pin also serves to prevent axial rotation of the plunger and thus maintains correct axial position of the pawl 58 with respect to the drive roller 53. When the plunger 59 has been raised to maximum height, continued downward movement of the piston 64 merely compresses the spring 63. A flat spring 73, mounted in the lower side of the block 43, extends into a small recess 74 formed in the lower side of the plunger 59 and serves to return the plunger when the lever arm 66 is raised.

A second lever arm 75, which is pivotally mounted on a stud shaft 76 positioned between a pair of downwardly extending plates 77, is mounted on the lower side of the base 43. This shaft 76, it will be noted, serves also as a pivotal support for the lever arm 62, which is positioned adjacent the arm 75 so that both are operated by the same piston 64. Downward movement of the piston 64 causes the left end of the lever arm 75 to engage a disc 78 fixed to the lower end of a punch 79, the upper end of which is reduced sufficiently so as to fit in the aperture 46 formed in the die plate 47 when the punch is raised. The punch is slidably movable in a suitably shaped aperture 81 formed in the base block 43, which is also provided with a somewhat larger recess 82 to receive a helically coiled spring 83, the lower end of which bears against the upper side of the disc 77, while the upper end of the spring bears against the upper side of the recess 82. When the lever arm 66 is raised at the completion of the punching operation, this spring returns the punch to the starting position.

It will be apparent, from the foregoing, that as the lever arm 66 is moved downwardly, the strip 39 of solder is first advanced and then as the plunger 59 becomes stationary because of the operation of the pin 71, continued downward movement of the lever arm 66 moves the punch 79 upward and punches a pellet of solder from the strip. The punch carries this pellet of solder into engagement with the lower end of the wire 27, which extends a predetermined distance from the lower end of the quill 26, the wire being held motionless by the spring-pressed inwardly bent portion 34 of the thumb operated lever 32. A flat spring member 84 is positioned adjacent the guide assembly, comprising the posts 41 and 44, to increase the frictional engagement between the reduced portion 40 of the arm 20 and these posts so as to prevent the head 24, carrying the wire 27, from moving upwardly when the pellet of solder is pressed against the end of the wire. The counterbalance weight 23 is also adjusted to increase the downward pressure of the block 24 as necessary to prevent the wire 75 from moving.

5

In effect, as shown in Fig. 7, the pellet is impaled on the end of the wire, which is sharpened into a point. This sharpening operation is performed at the soldering station when the portion of the wire which is to be the lead wire of the crystal and which has been soldered to the crystal, is severed from the wire supply. This operation will be described in greater detail hereinafter.

In the next operation, a flux is applied to the lower end of the wire and to the solder pellet attached thereto. The arm 20 is lifted out of the guide assembly, including the posts 41 and 44, and moved to the left, as viewed in Fig. 1, to position the wire over a fluxing assembly designated generally as 85 and shown in detail in Figs. 8, 9 and 10. The reduced portion 40 of the arm 20 is then positioned in a rectangular notch 86 formed in the upper portion of a guide plate 87, which is mounted on the table 22. As the head 24 which contains the quill 26 and wire 27 is moved downwardly into the notch 86, the lower end of the head 24 engages a projecting pin 88, which is mounted on the upper side of a small tank 90. This tank, which contains fluxing fluid, is mounted on the upper end of a vertically disposed movable post 91, being attached thereto by a set screw 92, threaded in a block 93 which is fixed to the lower side of the tank 90. This post 91 is movable vertically in an aperture 94 formed in the table 22 and is supported on the upper side of the left end of a flat spring 95, the other end of which is fixed to the underside of the table 22, as shown in Fig. 8. Thus, as the arm 20 moves down and the head 24 presses against the pin 88, the tank 90 is also moved downwardly. As the end of the wire 27 moves downwardly, it is immersed in fluxing fluid contained in a small cup 96 which is normally positioned beneath the surface of the fluid in the tank but which, being mounted on an upright stationary member 97 positioned adjacent the tank by a bracket arm 98, does not move downwardly as the tank moves downward. The depth of the notch 86 in the guide plate 87 is selected with reference to the position of the cup 96 so that when the arm 20 has been moved downwardly as far as possible, the desired amount of the wire 27, with a pellet of solder attached, projecting from the quill 26, will be immersed in the cup 96, the tank 90 then being substantially beneath the cup 96, as shown in Fig. 9. In this way, the level of the fluxing fluid, as applied to the end of the wire, is maintained uniform, the cup being refilled as soon as the arm 20 is removed from the fluxing station and the amount of flux applied may be precisely controlled.

After the lower end of the wire has been provided with the necessary fluxing medium, the arm 20 is again pivoted to the left and the wire is positioned over a soldering station designated generally at 99 and shown in Figs. 1 and 11 to 17. As the arm moves to the left and is positioned over the soldering station, the reduced portion 40 of the arm 20 enters a C-shaped aperture 100 formed in a guide plate 101, which is mounted on a base block 102 supported on the table 22, being separated therefrom by strips of insulating material 103. The C-shaped aperture 100 is so formed that when the reduced portion of the arm 20 enters the lower portion thereof and rests on the upper portion of a vertically movable threaded stop member 104, it will be positioned so as to accurately align the end of the wire 27 with respect to a pair of right-angled notches

6

105 formed in a pair of slidably mounted clamping plates 106 which engage a crystal 107 during the soldering operation. The end of the wire 27 projecting from the quill 26 is then just above the surface of the crystal so that the end of the lead wire, when soldered to the crystal, does not actually touch the crystal.

However, prior to assembling a crystal between the clamping plates, in some instances it is desirable to heat and form the pellet of solder to cause it to flow a short distance up the wire and to fuse to the wire, and also to flatten the base of the pellet, forming, in effect, a cone at the end of the wire. This may be done by inserting the end of a flat elongated spring member 108 in the position normally occupied by the crystal prior to lowering the wire guide block 24. Then, as the block 24 is lowered, the pellet of solder and the wire rest on the upper surface of the end of the member 108. This member, which is resilient so that it may be readily moved into and out of position, is mounted in a slotted aperture 110 extending through the upper portion of a block 111 positioned at the left of the soldering station, as shown in Fig. 11, and is provided with a knob 112 by which it may be slid into position. With the solder pellet in position on the spring 108, heat is applied to the solder from a jet 113 from which heated air may be projected to melt the solder. It has been found that the air may be sufficiently heated to cause the solder to fuse in a very few seconds by passing the air through the jet at low pressure, the jet being provided with heating coils (not shown). The member 108 is provided with a surface such as stainless steel, to which solder does not adhere, and, thus, when the warm air supply is shut off, the end of the wire with the solder fused thereto in the form of a cone, may be easily removed therefrom. The member 108 is then withdrawn.

A crystal 107 is then positioned between the notches 105 in the clamping plates 106 and the plates are moved together. As may be seen in Figs. 11 and 15, the plates 106 are provided with raised upper portions 114, or shoulders, in the areas adjacent the notches or jaws 105. The sides of these raised portions are bevelled inwardly from left to right, as viewed in Fig. 11, so that cooperatively they form a truncated wedge. Normally, the plates 106 are pulled apart by springs 116, which are mounted on opposite sides of the soldering assembly base and are attached to the rear of the plates. However, when it is desired to clamp a crystal between the plates, a large plate 117, having a recess 118 formed therein, as shown in Fig. 11, is moved to the left, as viewed in Fig. 16. The sides of the recess 118 are bevelled outwardly and engage the inwardly bevelled edges of the raised portions 114 of the plates 106, and urge them together as the plate 117 is moved to the left. The plates 106 are slidable in rectangular channels 119 formed in the upper surface of the block 102, as shown in Figs. 15 and 16. Since the plates move along a common axis, centering of the crystal is insured regardless of the size of the crystal, the apexes of the notches 105 being directly opposite each other.

When the crystal is positioned between the jaws 105, which serve primarily to align the crystal with respect to the end of the wire 27, it is also supported on a tubular member 121, which is positioned in a recess 122 formed in the block 102. The purpose of using this tubular type of support is to permit a lead wire to be attached to both sides of the crystal. It will be apparent that in

this way, after a lead wire has been attached to one side of the crystal, it may be merely turned over and the lead wire positioned so as to extend along the inside of the tubular member 121 while the crystal is then supported on the upper edges of the tubular member without interference.

The large recessed plate 117, which, as hereinafore stated, is slidably mounted, is positioned in a rectangular frame 125, the two opposite sides of which serve as a guide therefor. An arm 126, which is pivotally attached to one side of the frame 125, is connected to the upper surface of the plate 117 by a bolt 127 mounted in the plate 117 and which extends through an elongated slot 128 formed in the arm 126. A link arm 130 is connected to the right end of the arm 126, as viewed in Fig. 11, by a pin 131, which extends into an elongated slot 133, the link arm 130 being slidably movable along the side of the block 103 and supported thereon by a pair of bolts 134, which extend through elongated slots 135 formed in the link arm 130 and extending longitudinally therealong. Moving the link arm 130 to the left, as viewed in Fig. 8, moves the recessed plate 117 to the left and, consequently, clamps the plates 106 against the crystal 107 positioned between the notches 105 formed therein. Heat is then applied from the jet 113 to fuse the solder to the crystal, the surface of which may be previously prepared, as by spotting, to provide a surface to which the solder will readily adhere. The heat is then shut off and the solder permitted to cool for a moment and then the operator presses the thumb actuated lever 32 to release the inwardly bent portion 34 of this lever from the wire 27 to permit the lead wire to move freely through the quill 26, and operator lifts the block 24 vertically until the upper surface of the block 24 engages the lower end of a threaded post 136. The wire remains stationary since its end is soldered to the crystal, which is held stationary. This post 136 is threaded through the upper horizontal portion of the plate 101 and is made vertically adjustable so that the lead wire length may be selected as desired.

While the block 24 is held against this adjustable member 136, a pair of cutting jaws 137 are moved into engagement with the lead wire to sever the lead wire from the wire supply. The jaws 137 are positioned with respect to the position of the end of the quill 26 and block 24 so as to sever the wire a predetermined distance from the lower end of the quill. The cutting surfaces of the jaws are selected also to form, as shown in Fig. 13, a point at the end of the wire as they sever the lead wire therefrom. This prepares the end of the wire to receive the solder pellet, as hereinbefore explained. These jaws 137 are mounted on pivots 140 set in the forward end of a plate 141, which is slidably mounted on a supporting block 142, the jaws extending a short distance beyond the plate 141. As may be seen in Fig. 14, the plate 141 is trapezoidal in cross section and fits into a suitably formed recess 143, which extends longitudinally along the upper surface of the block 142, the sides of the recess thus serving as guides for the slidable plate 141.

In operating the cutting jaws to sever the wire 27, the operator presses a button shaped end 144 of a plate 145, which is slidably positioned on the upper surface of the plate 141, to move this plate 145 forward. As may be seen in Figs. 11, 12 and 14, the plate 145 is retained on the plate 141 by a pair of cross plates 146, which extend transversely across the plate 145 and which are bolted

at their ends to the plate 141. The forward end of the plate 145 is wedge-shaped and fits between the rear arms of the jaws 137, as may be seen in Fig. 11. Thus, by moving the plate 145, the jaws may be pivoted and closed. However, during the first part of the forward movement of the plate 145, the plate 141, which carries the jaws 137, is also slid forward, being urged forward by a helically coiled spring 147 positioned between the inner side of the button 144 and the rear end of the plate 141. A recess 148 is provided in the rear end of the plate 141 to receive a portion of the spring 147, the rear end of the plate 141 being provided with a downwardly extending shoulder 149. An adjustable stop member 150 is mounted on the lower side of the shoulder 149 at the rear end of the plate 141 and is engageable with the rear of the fixed block 142 to limit the forward movement of the plate 141. After the block 142 is contacted by the stop member 150, however, the plate 145 may be moved forward a short distance to close the jaws and thereby to sever the lead wire, the stop member 150 being adjusted to properly position the jaws with respect to the lead wire. By slightly changing the adjustment of the stop member 150, a new portion of the jaws 137 may be used in cutting the wire, thus extending the useful life of these jaws.

A pair of springs 151 are mounted on the upper side of the plate 141 and attached to the rear of the jaws 137, thus urging the jaws open. Two helically coiled springs 152 are positioned in cylindrical recesses 153 formed in the block 142 and two pins 154, mounted on the lower side of the plate 141 and extending downwardly therefrom through elongated slots 155 in the block 142, are engaged by the rear ends of these springs 152, as may be seen in Figs. 12 and 14. These springs return the plate 141 and associated parts after the operator releases the button 144. A pin 156, mounted in the upper surface of the plate 141 extends into an elongated slot 157 and retains the plate 145 on the plate 141 while permitting the necessary relative movement therebetween to operate the jaws 137.

After a lead wire has been soldered to one side of the crystal, the crystal is turned over, as shown in Figs. 16 and 17, and a second lead wire soldered to the opposite side thereof. This completes the soldering operation. The arm 20 may then be pivoted to the right, as viewed in Fig. 1, and rested on a Y-shaped support 157, which is mounted on the table 22 and is positioned substantially midway between the soldering and fluxing stations. The operator then removes the completed crystal.

While but one embodiment of this invention has been shown and described, it will be understood that many modifications may be made therein without departing from the spirit or scope of the present invention, which is limited only by the appended claims.

What is claimed is:

1. An apparatus for soldering a lead wire to a crystal comprising a head for guiding and supplying a wire, means for carrying said head in a predetermined path, a punch and die assembly located in said path for punching a pellet of solder from a strip, means for positioning said head and lead wire in the path of the pellet being punched for impaling the solder on the end of said wire held in said head, a fluxing means located in said path for applying a predetermined amount of flux to the end of said wire extending from said head, means movable into said path for forming

the pellet impaled on the end of said wire and for causing it to fuse to said wire, and means for heating said solder while in contact with said crystal in said predetermined path to fuse said wire and to attach the wire to said crystal.

2. An apparatus for soldering a lead wire to a crystal comprising a head for guiding and supplying a wire, means for carrying said head in a predetermined path, a punch and die assembly located in said path for punching a pellet of solder from a strip, means for positioning said head and lead wire in the path of the pellet being punched for impaling the solder on the end of said wire held in said head, a fluxing means located in said path for applying a predetermined amount of flux to the end of said wire extending from said head, means movable into said path for forming the pellet impaled on the end of said wire and for causing it to fuse to said wire, means for heating said solder while in contact with said crystal in said predetermined path to fuse said wire and to attach the wire to said crystal, and means for severing said wire a predetermined distance from said head to form a point on the severed end of said wire remaining in said head, said last mentioned means being slidably mounted for movement into said path to operate on the wire held in the head.

3. In an apparatus for attaching a lead wire to a crystal, means movable through a fixed path for supporting the lead wire, means positioned in said path for applying a quantity of solder to the end of the wire, means in alignment with said path for supporting a crystal, means for heating said solder, means for forming said solder to a predetermined shape on the end of a wire supported by said supporting means prior to fusing said solder to said crystal including a solder forming element to which the solder will not adhere, means for positioning said forming element in position to be engaged by the solder applied on the end of the wire, means for heating the solder while in engagement with said forming element, and means for severing said lead wire a predetermined distance from said crystal.

4. The method of attaching a lead wire to a crystal comprising punching a pellet of solder from a strip, impaling said pellet on the end of said wire, applying a flux to said solder pellet and the end of said wire, heating and forming said solder to cause said solder to assume a substantially cone shape, and then heating said solder in contact with a crystal to attach said lead wire to said crystal.

5. The method of attaching a lead wire to a crystal comprising punching a pellet of solder from a strip, impaling said pellet on the end of said wire, applying a flux to said solder pellet and the end of said wire, heating and forming said solder to cause said solder to assume a substantially cone shape, heating said solder in contact with a crystal to attach said lead wire to said crystal, and then severing the lead wire a predetermined distance from said crystal, said severing operation being performed so as to form a point at the severed end of said lead wire.

6. In an apparatus for attaching a lead wire to a crystal, a head movable through a predetermined path for supporting a wire during the preparation thereof and attachment thereto of a crystal, means in alignment with said path for punching a pellet of solder from a strip and operable as an incident to the punching operation for impaling said solder pellet on the end of said wire, means in said path for applying flux at the

end of said wire comprising a movable tank, a stationary cup positioned within said tank, said tank being movable relatively to said head, means actuated by said head for moving said tank relatively to said cup, the end of said wire then being immersed in said cup, and means positioned along said path and operable on the wire moving in said path for heating said solder while in contact with the crystal to attach said wire to said crystal.

7. An apparatus for soldering lead wires to crystals comprising a head movable through a predetermined path for guiding and supplying a wire, a punch and die assembly for punching a pellet of solder from a strip and impaling the solder on the end of said wire while the wire is held by the head at a predetermined point in said path, means for aligning said head with said assembly, means associated with said assembly for advancing said strip in timed relation to the punching operation, fluxing means lying in said path for applying a quantity of flux to the end of said wire during its movement by the head in moving through said path, means movable into alignment with said wire carried by the head for forming the pellet impaled on the end of said wire for causing it to fuse to said wire, means adjacent said path for directing heat into said path for heating said solder while in contact with a crystal to fuse said solder and to attach the wire to a crystal, and means movable into said path for severing said wire a predetermined distance from said head to form a point on the severed end of said wire remaining in said head.

8. An apparatus for attaching a solder pellet to a wire comprising means for supporting a wire in a predetermined position, means for advancing a strip of solder, means for punching a pellet from said strip and impaling on said wire, and common means for actuating said advancing and punching means comprising a common actuator, a punch actuating lever positioned to be actuated by said common actuator, a pawl and ratchet for actuating said advancing means, a plunger for actuating the pawl, and a lever positioned to be actuated by said common actuator and to operate said plunger.

9. In an apparatus for soldering a lead wire to a crystal, a head for guiding and supplying a wire, means for carrying said head in a predetermined path, and means in said path for impaling a pellet of solder on said wire comprising a reciprocatory punch, means for positioning said head to align the wire carried by it in alignment with said punch, a die for cooperating with said punch, means for feeding a strip of solder between the punch and die, and means for actuating said punch to punch a pellet of solder from the strip and force it through the die and onto the wire.

10. In an apparatus for attaching a lead wire to a crystal, means for supporting a wire in a predetermined position to receive a pellet of solder, means for applying said pellet of solder to the end of said wire including a punch and die assembly operable in a single stroke to punch said pellet of solder from a strip thereof and to impale it on said wire, said punch being movable coaxially of the wire in said predetermined position to carry the pellet through the die to the wire, a lever arm for moving said punch relative to said die, a pair of rollers for advancing said strip to position between the punch and die, and common means for operating said lever arm and actuating said rollers.

THOMAS A. DANIEL.