Jan. 3, 1956 R. M. KENNEY 2,729,181

JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

Filed May 9, 1952 6 Sheets-Sheet 1

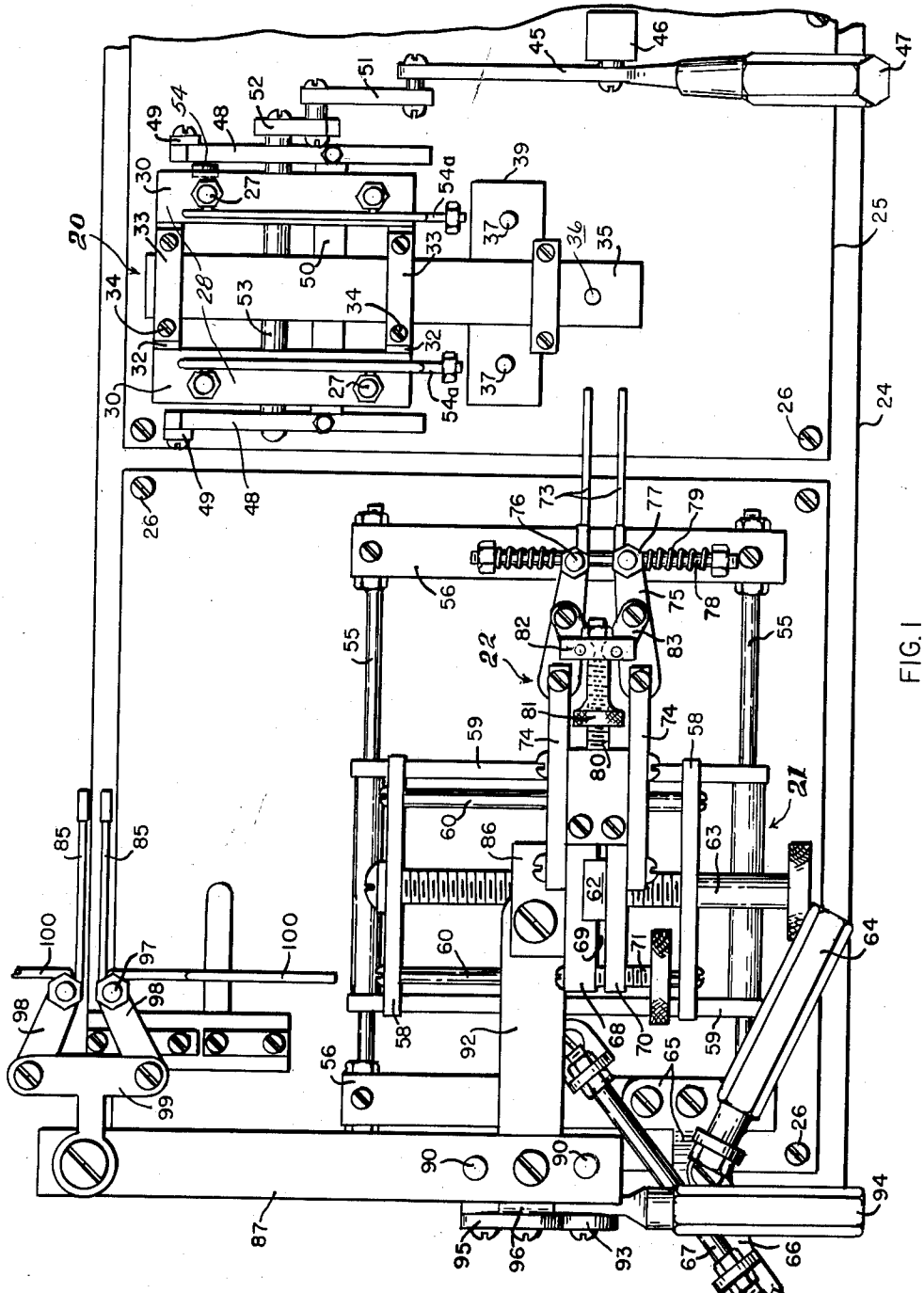


FIG. 1

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6 Sheets-Sheet 2

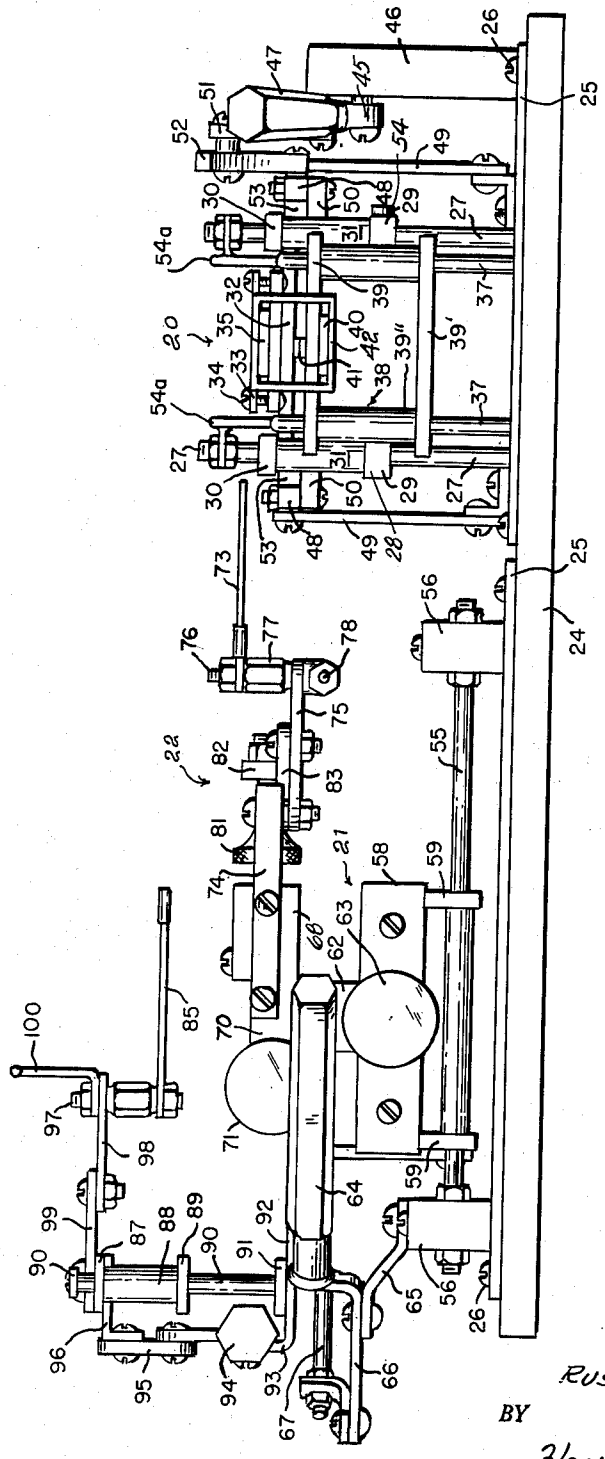


FIG. 2

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JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

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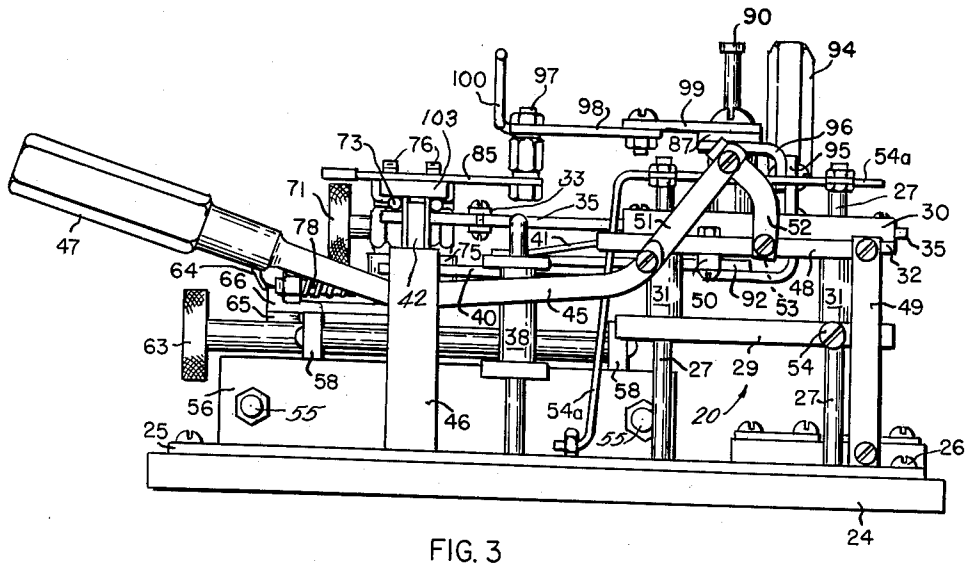


FIG. 3

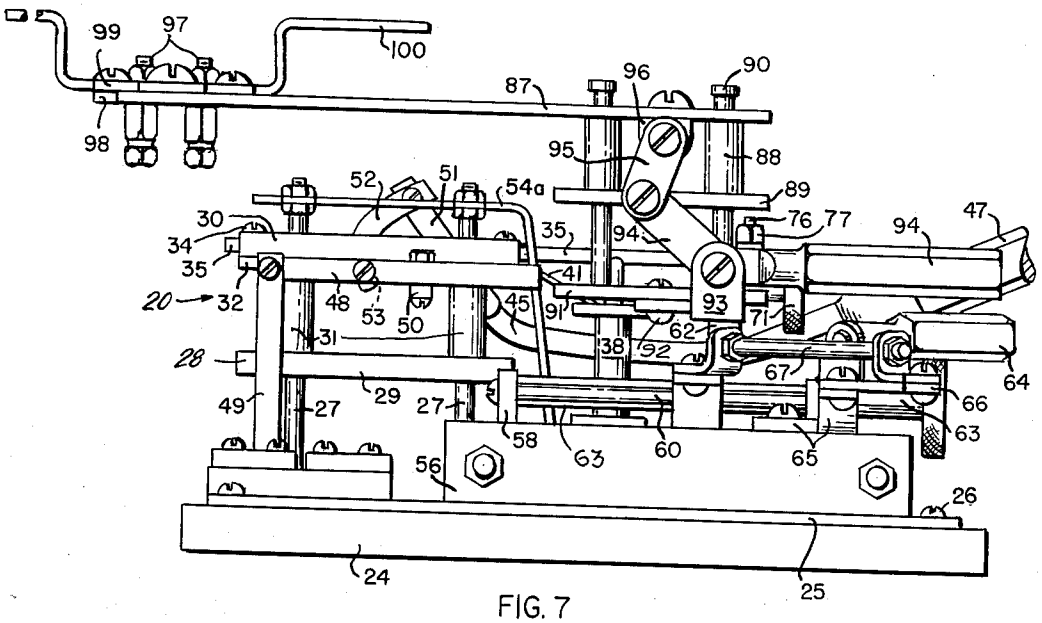


FIG. 7

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JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

Filed May 9, 1952

6 Sheets-Sheet 4

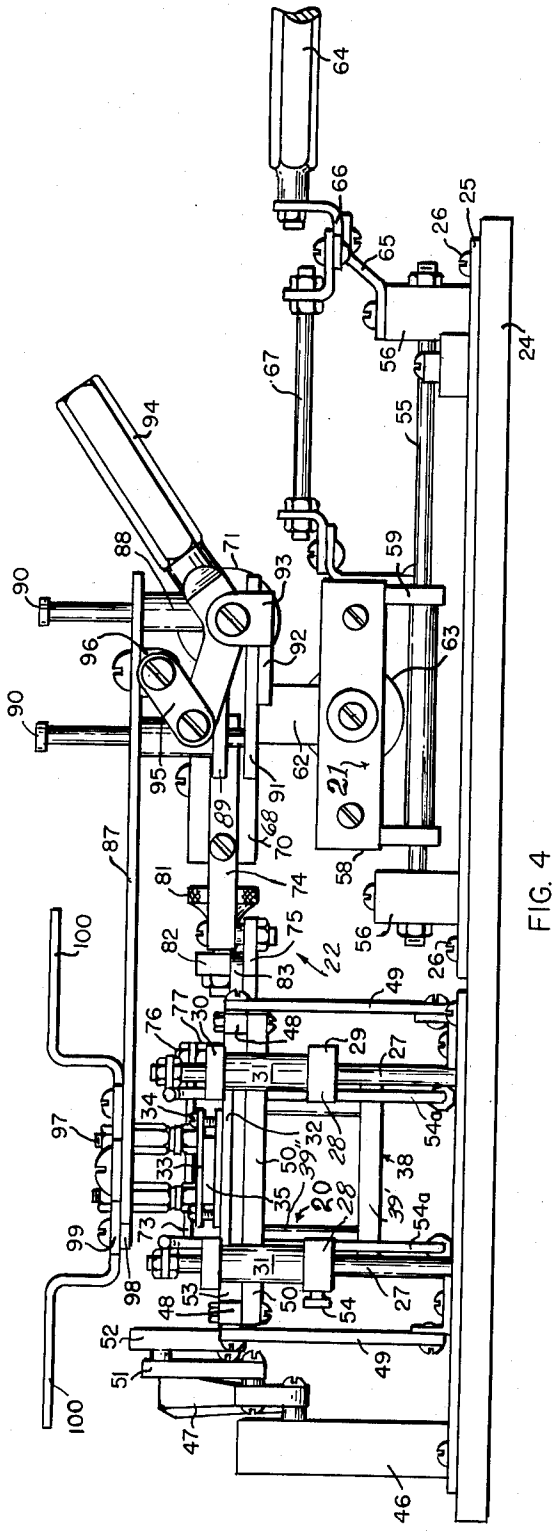


FIG. 4

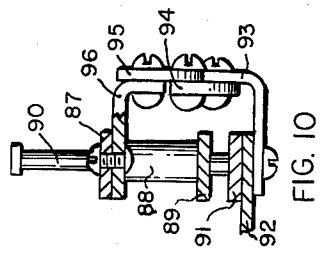


FIG. 10

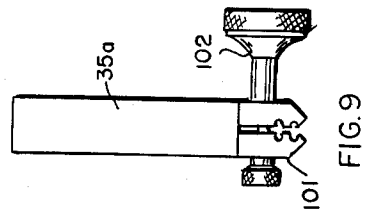


FIG. 9

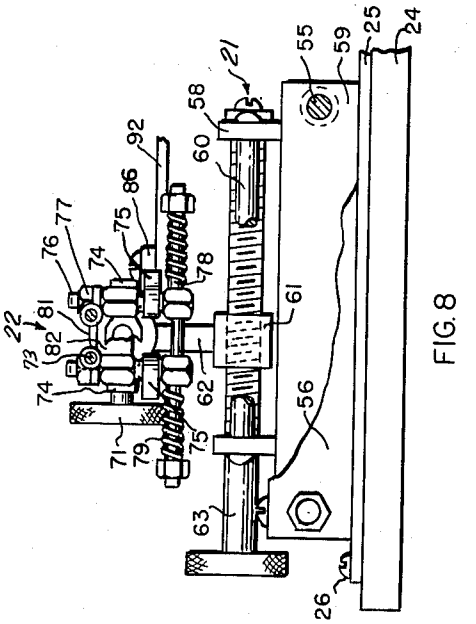


FIG. 8

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JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

Filed May 9, 1952 6 Sheets-Sheet 5

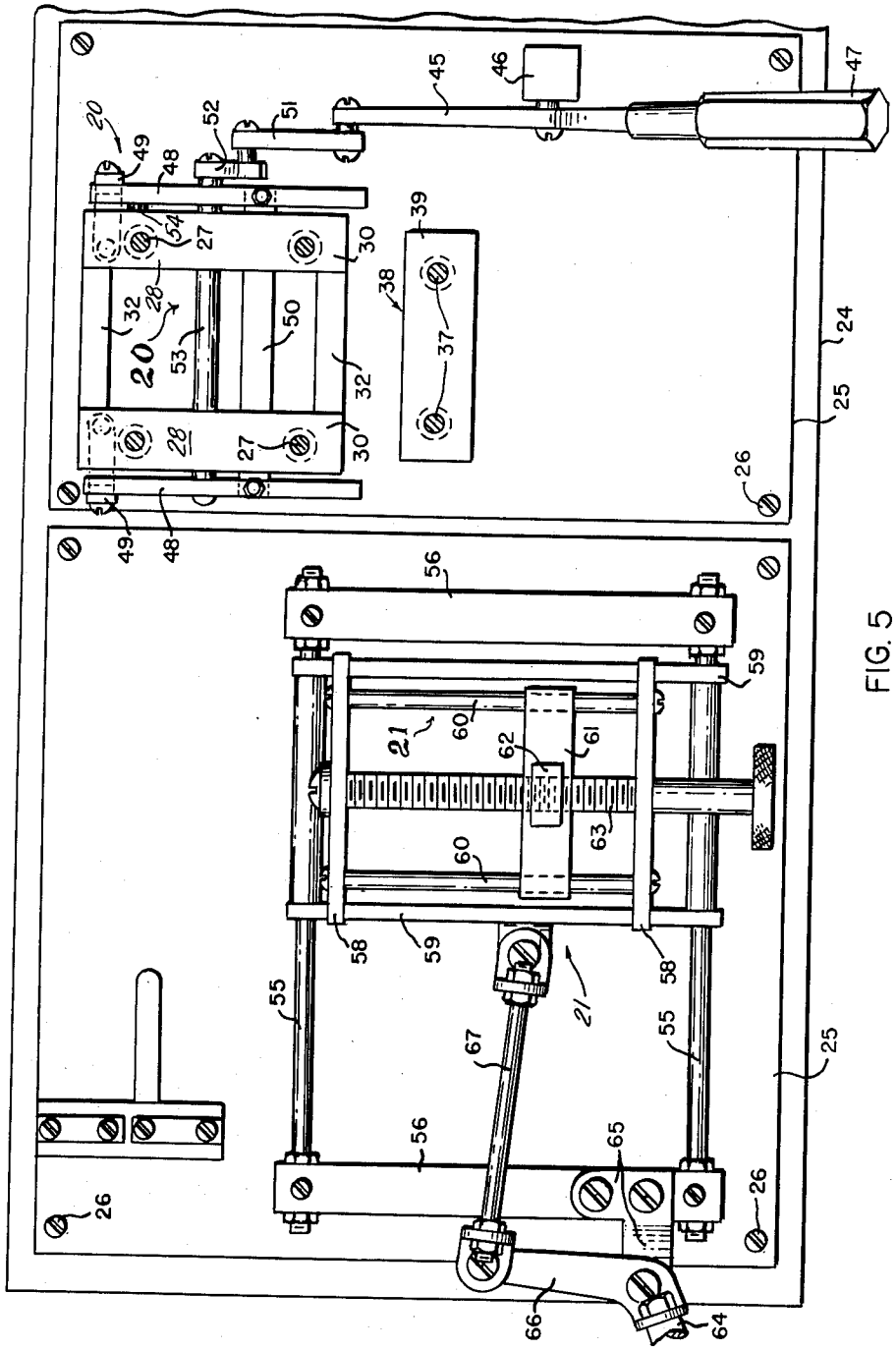


FIG. 5

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JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

Filed May 9, 1952 6 Sheets-Sheet 6

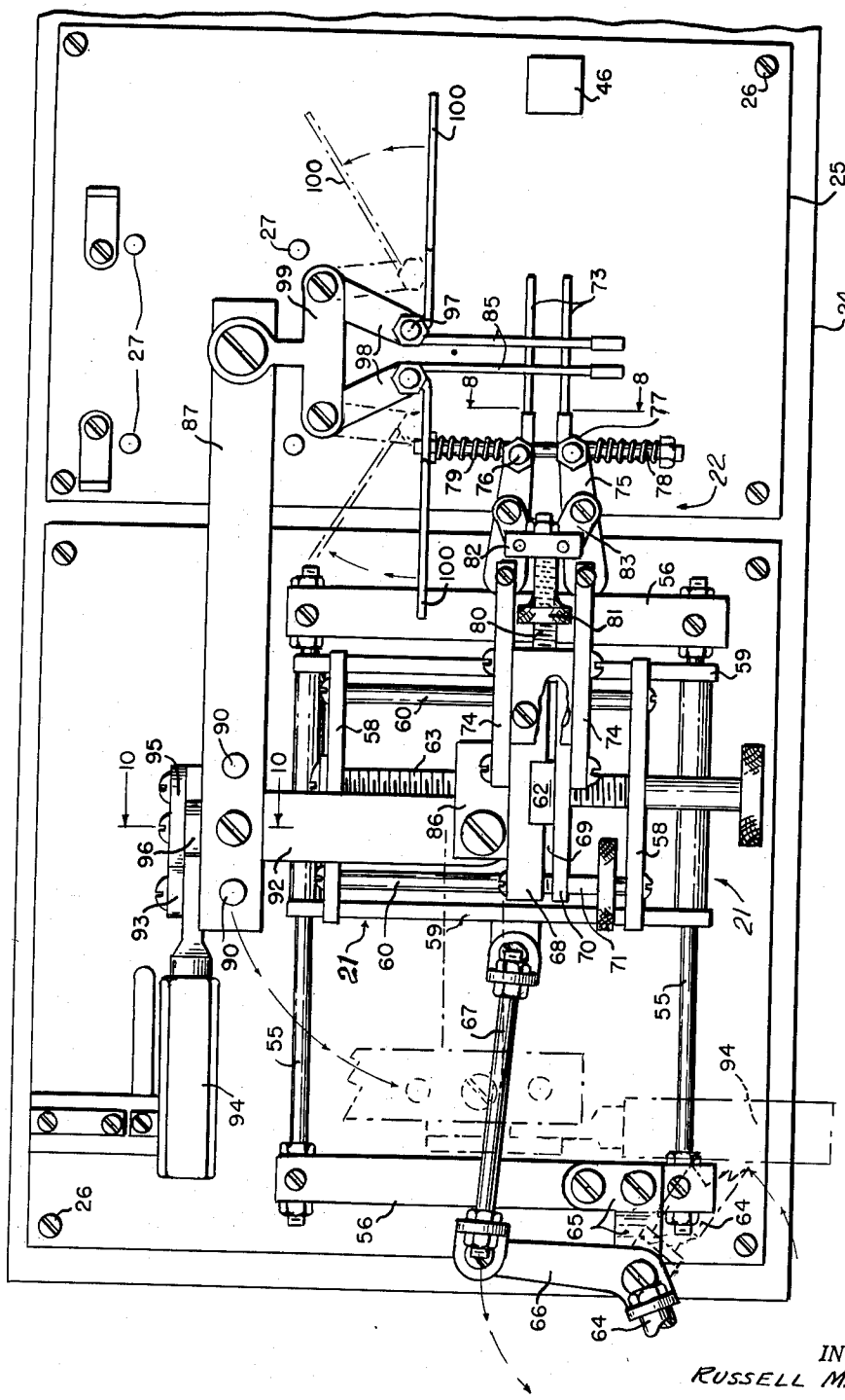


FIG. 6

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United States Patent Office 2,729,181 Patented Jan. 3, 1956

2,729,181

JIG FOR ASSEMBLING INSTRUMENT ROTORS AND HAIRSPRINGS

Russell M. Kenney, Paris, Ky.

Application May 9, 1952, Serial No. 287,024

25 Claims. (Cl. 113—99)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The invention relates to jigs and work holders and particularly and primarily to a mechanism or jig for supporting a rotor in a required convenient position, and also supporting independently and adjustably a hairspring in such position in relation to the rotor that one terminal of the spring may be readily soldered or otherwise attached to the rotor to fix the spring in a required operative relation to the rotor for operation of the latter when assembled on a mechanism. The specific embodiment of the invention here shown and described represents it as constructed heretofore and used in the assembly of hairsprings on coil-pointer assemblies of D'Arsonville galvanometers.

As is well known, manufacturing practices heretofore followed in the production of volt meters, ammeters, bolometers and various other instruments wherein a rotor is held yieldingly at a zero position responsive to slight force tending to rotate it from such zero position, have involved considerable expense for labor occupied in the assembling and securing of the hairsprings on the rotor units.

In the attainment of the primary object above stated, in the present instance it becomes an object also to devise and embody various novel elements contributing to the general end in view, some of these having specific respective features of invention; a number of which are referred to hereinafter in the explanation of features comprised in the invention as units, subassemblies, or devices.

It is particularly an object to present a device for fixing the relation of an inductive coil and hairspring while both are independently supported and the hairspring variously movable, so that the axis of the spring may be located in any of various positions with respect to the pivot axis of the coil, and so that various requirements in such instruments as named, may be met, with great certainty. Thus, in many D'Arsonville galvanometers, the pivot axis is symmetrical with the inductive coil of the rotor, and the hairspring is arranged symmetrically around this axis as nearly as practicable; while in others, the pivot axis is offset from and parallel to the plane of the induction coil, and the spring must still be secured to the coil in symmetrical relation to the offset axis.

A further object is to enable the device to be used with hairspring and coil rotor instruments, and also with vane type instruments wherein a vane or disc is located in a magnetic field, variation of which is to be indicated by the angular displacement of the vane or disc from its zero position.

Additional objects, advantages, and features of invention reside in construction, arrangement, and combination of parts described or involved in the embodiment of the invention, and as may also be understood from the disclosure herein embodied, or apparent from the specific structure, functions and/or uses described, indicated or understandable from the following description and accompanying drawings, wherein:

Fig. 1 is a top view of a machine embodying the invention;

Fig. 2 is a front view of the machine;

Fig. 3 is a right hand side elevation of the machine;

Fig. 4 is a rear view of the machine, with the hairspring holding means in spring-holding position;

Fig. 5 is a plan of the bed plate, carriage and elevator;

Fig. 6 is a plan of the hairspring holding unit, in spring-holding position, the elevator and other rotor support elements being omitted;

Fig. 7 is a left hand side elevation of the machine;

Fig. 8 is a detail of the hairspring holder parts on the carriage, on the line 8—8 of Fig. 6;

Fig. 9 is a detail top view of the vise bar 35–*a*;

Fig. 10 is a fragmentary vertical section on the line 10—10 of Fig. 6.

This invention comprises several principal units and also a number of subassemblies or devices, which are arranged so as to interfit and coact for the purposes of the invention in a novel way; as well as involving novel features of structure by which they are rendered capable of the necessary interaction or cooperation. The principal units comprise a rotor-pointer support or elevator **20**, constructed with means to hold the coil or rotor of a D'Arsonville galvanometer (with its pointer) in the most convenient position for the placement of a hairspring thereon, and means to hold the hairspring during the soldering of the end of the hairspring to the rotor. It is also readily adaptable to support other rotor elements in positions for and while the ends of hairsprings are attached thereto, whether by soldering or otherwise.

Another unit is a carriage **21** and guide rails therefor, by which hairspring holders are moved to and from positions in relation to the elevator **20** as may be required for various types of coil-pointer assemblies, armatures, or other rotors, to enable the support of a hairspring in proper relation to such rotor, for ready securement thereto.

A third unit is the hairspring holder proper, **22**, on the carriage **21**, and includes means for accommodating it to various sizes of hairsprings and to the requirements of access to the spring end, to enable effective soldering and other attaching or fastening methods, as well as enabling the spring-holding device to be accommodated to various positions in horizontal directions, and different levels for convenient work upon various instrument rotor assemblies.

Among novel features in these several units for effecting required functions, adjustments, or adaptations are the specific construction of the elevator for enabling the fixation of a rotor or coil-pointer assembly in a desired position for work thereon. Another feature is a novel device for holding and supporting a hairspring in a fixed position in proper relation to the coil-pointer assembly independently of all other apparatus and/or parts operatively related to the hairspring. A further novel device is a means operable by a single manual lever for moving a hairspring holder horizontally, and/or elevating or lowering this holder for cooperation with another support to properly engage and hold a hairspring and position it for work required to attach it to a rotor assembly mounted in the apparatus.

Another novel feature in the invention is a hairspring holder comprising crossed pairs of flexible supporting fingers, the fingers in each pair being variable in spacing by novel means, and the two pairs being relatively movable by novel means to bring them into positions respectively above and below a hairspring and crossed so as to hold between the pairs the delicate convolutions of a hairspring in proper planiform shape and with the axis of the hairspring on any desired vertical axis within wide horizontal limits.

The elevator

There is illustrated a base block **24**, of suitable size and shape upon which there are mounted right and left rectangular bed plates **25** attached to the block **24** by

usual fastenings 26. Upon the right hand plate 25 there is erected a set of four vertical guide posts 27 defining the corners of a rectangle, and on these there is slidable an elevator proper, having a frame 28 (Figs. 1, 2, 3, 5), comprising two parallel bottom plates 29 (Figs. 2 and 3) extending from front to rear at the left and right sides of the elevator respectively, and two top plates 30 in similar relation and aligned with the bottom plates. These plates receive the posts 27 slidably therethrough and welded or otherwise fixed between the plates are vertical spacer tubes 31 slidably engaged around the respective posts. Front and rear cross bars 32 connect the top plates so that a rigid frame is evolved, vertically reciprocable on the posts. On the cross bars 32 short clamp bars 33 are provided, held releasably by screws 34 at their ends, so that any one of a number of long, flat coil support bars 35, of several widths may be held under the clamp bars 33 and on the bars 32, so as to extend forward a distance from the elevator, and receive thereover the upper bar or arm of a rectangular inductor coil 42 (shown in Fig. 2) such as is used in a D'Arsonville galvanometer. This coil support 35 has a width sufficient to fit as a vise jaw within the inductor coil unit. In case the coil has an inside pivot, the bar 35 may be apertured as at 36 (Fig. 1) to receive the bearing pivot element of the coil. The distal or forward end of this bar may be regarded as the assembly station in the description of the machine.

The assembly station and rotor vise

For cooperation with the jaw bar 35 in maintaining the proper position of a coil on the bar 35, two guide studs 37 are erected a distance in front of the forward guide posts 27, and on these studs 37 there is vertically slidable a clamp frame 38 including a top plate 39 which extends transversely of the bar 35 below the latter, and a bottom plate 39′ parallel to and aligned vertically with the one 39, the two being connected by tubes 39″ welded to these two plates and engaged slidably on the studs 37. On the top plate 39 there is removably fastened in rigid relation to the frame a forwardly projecting short plate or jaw 40 (Fig. 3), of a dimension to align with the extremity of the bar 35 thereabove, and to fit within and against the lower side of the coil which is to be operated on while resting on the bar 35 as described. When a coil 42 is so mounted and lifted by the elevator, the weight of the frame 38 presses the plate 40 against the lower side of the coil hanging on the extremity of the bar 35, and steadies the coil. In addition, a leaf spring 41 is fixed on the lower side of the bar 35 near the elevator, extending forwardly and downwardly, with its extremity over and bearing on the top plate 39 of the frame 38, so as to cause the jaw plate 40 to press firmly downward on the lower side of and within the inductor coil unit and hold it firmly in proper position on the bar 35 while a hairspring is secured to the coil unit.

A pointer, usually fixed on the coil unit of a galvanometer, may be extended over the elevator or oppositely if necessary. It is usual to secure the hairspring to the coil assembly at a point near the pivot on the coil unit and close to the base of the pointer, and consequently—with the coil unit supported at the forward end of the bar 35, the operations in securing the hairspring thereto may be carried out with facility.

The elevator may be provided with other means for supporting rotors or armatures differing from the D'Arsonville type, one other being referred to hereinafter.

As coils, armatures, or other rotors of different instruments will vary in height, and as ready adjusting of a coil unit into assembly relation with an independently positioned spring is essential, it is necessary to raise the elevator so as to support the coil unit conveniently above the bed plate 25. For raising and lowering the elevator, a hand lever 45 of the first order is pivoted on a standard 46 at the extreme right hand end of the bed plate 25, with a handle 47 at its outer forward end, and its rearward arm connected to the elevator by means of a pair of rigidly yoked rocking levers 48, one at each side of the elevator, their rear ends pivoted at the upper ends of upstanding fulcrum links 49, the lower ends of which are pivoted at the rear edge of the bed plate. The levers 48 are connected in mutual rigid relation by a yoke bar 50, and the rear end of the hand lever is connected to the right hand lever 48 by a link 51 pivoted to arm 52 rigidly extended upward from the lever 48. Intermediately of the lengths of the levers 48, a transverse shaft 53 is connected thereto, bearing on the under sides of the top plates 30 of the elevator. Consequently, depression of the handle 47 raises the forward ends of the levers 48, and by the engagement of the pivot shaft 53 with the under sides of the top plates 30, likewise raises the elevator. Two diagonal braces 54–A extend rearward from the bed plate from in front of the elevator to the forward pair of elevator guide posts 27, and rearwardly to the rear posts 27, attached to each adjacent post.

The elevator may be retained at such elevated positions as may be required by means of a clamp screw 54 (Figs. 3 and 4) engaged through one of the bottom plates 29 to impinge on one of the posts 27 when screwed in. Other means for the purpose may be employed, or, the tubes or other parts involved with the elevator may be frictionally fitted so that it will remain yieldingly at any level to which it is adjusted. When the elevator is lowered far enough, the lower side of the coil engages against the base plate 25 and the bar 35 presses downward against the action of the spring 41, freeing the coil for removal or replacement.

Initially, in the positioning of the coil unit on the support or jaw bar 35 of the elevator, the bar is adjusted by raising or lowering the elevator, so that a coil may be set on the bar as described while the lower side of the coil is below the jaw plate 40. The elevator is then elevated sufficiently for the spring 41 to press on the lower plate of the frame 38, thus automatically causing the clamping of the coil in fixed relation to the elevator. The coil may thereafter be further adjusted upwardly or downwardly by appropriate movement of the elevator to accommodate it to a hairspring carried by a support (to be hereinafter described).

Hairspring carrier

For the support of the hairspring, a separate means is provided cooperative with the elevator apparatus described, on the left hand plate 25, having parts of particular functional capabilities and with paths of movement and centers of motion peculiarly coordinated with the elevator mechanism. In this part of the invention, a pair of horizontal parallel guide rails 55 (Fig. 5) are mounted in widely spaced relation close to the bed plate at the left hand part of the apparatus, one rail being near and parallel to the front edge of the bed plate. The rails are fixed in bolsters 56 secured to the bed plate, the rearward rail being near a line through the forward posts 27.

On these rails there is slidable the carriage 21 comprising a carriage base consisting of parallel frame plates 59 transverse to the rails, and through which the rails pass slidably so as to support the carriage for movement in a fixed path toward and from the assembly station. Cross bars 58 connect these two plates permanently, as, by welding. Between the cross bars 58 parallel upper rails 60 are set, upon which the foot beam 61 of a carriage post 62 is slidable forwardly and backwardly in a path transverse to the guide rails 55. Revolubly mounted in the bars 58 there is a fore-and-aft adjusting handscrew 63, having threaded engagement in the beam 61, so that rotation of the screw will move the beam and post 62 forwardly or backwardly on the carriage. The post 62 is rectangular in cross section and receives thereon for vertical movement a hairspring carrier 22 to be described.

For movement of the carriage along the rails 55 from a distal point in the carriage path to a position proximal to the assembly station, a bell-crank hand lever 64 is

pivoted on a lug **65** fixed on top of the left hand bolster **56**, this lever having an arm **66** extended inwardly and connected by a link **67** to the left hand side of the carriage, the link being pivoted to the carriage and lever arm.

The hairspring carrier **23** (Figs. 1, 2, 6, 8) comprises a body block **68** (Figs. 1 and 6) elongated in a direction parallel to the rails **55**, having a rectangular opening vertically therethrough receiving slidably the post **62**. A slit **69** is formed in the block **68** extending from its left hand end in a vertical plane aligned with the front side of the post **62** and extending to the opening in the block and beyond to the right of the post a distance so that a resilient clamping jaw **70** is formed by the material of the block. A hand screw **71** is engaged revolubly through the distal end of this jaw and threaded in the body portion of the block **68**, so that by manipulation of the screw the jaw **70** may be pressed toward the body of the block and clamped against the post **62** to hold the block **68** at adjusted positions on the post.

Carried by the hairspring carrier there is a fork-like pair of resilient moderately flexible metal horizontal and horizontally spaced rectilinear parallel wire-like support fingers **73** projecting toward the right, of suitable length to extend across the coil support bar **35** at the elevator when the carriage is at the right hand limit of its movement, and mutually adjustable in spacing. They are set to remain at a given height by adjustment of the body block **68** on the post **62**. The block **68** has fixed on its front and rear sides rigid horizontal arms **74** projected from the block to the right in parallel relation and having pivoted on their extremities horizontally swinging levers **75** convergent toward their extremity. They have respective vertical short shafts **76** revoluble their extremities, these shafts having threaded tenons at their upper ends on which binding nuts **77** are engaged, holding thereunder eyes formed on the bases of respective parallel fingers **73**. These shafts have commonly and slidably engaged therethrough below the levers **75** a long rectilinear pin **78** headed at each end. Engaged slidably on each end of the pin and confined by the head there is a protractile helical spring **79** which bears against the adjacent lever **75**, so that the ends of the levers are pressed yieldingly toward each other, and consequently tend to bring the fingers **73** close together.

For limiting the movement of the levers **75** by the springs, and for varying the spacing of the support fingers at will, a stud bolt **80** is set in the right hand end of the block **68** and projecting on an axis medially of the two levers **75**. A hollow screw **81** is threaded around the bolt and extended forwardly thereof, carrying a cross bar **82** in which the end of the screw rotates and located intermediately of the lengths of the levers **75**, and from the ends of this cross bar toggle levers or links **83** are extended diagonally to respective levers **75**, so that movement of the screw **81** to the right will press the levers **75** apart, and opposite adjustment of this screw will permit the springs **79** to press the levers and fingers closer together. Throughout such movements of the levers, the fingers **73** will be kept in parallel relation by the pin **78**. The springs **79** serve to keep the pin **78** equally extended without the levers **75** and also to prevent loose movement of the fingers **73** and connected levers.

By this construction, when the size of the coil unit on which the hairspring is to be secured is known, the body block **68** of the hairspring carrier is adjusted to a proper height to present the fingers **73** closely over a coil rotor **42** mounted on the elevator in proper position. The carriage **21** is initially withdrawn to the left, and after the coil rotor **42** is emplaced on the elevator (as in Fig. 2, for instance), the carriage is moved to the right to project the ends of the fingers **73** over the coil, and the hairspring laid on the fingers **73** over the coil. The hairspring is then clamped upon the support fingers by a set of clamp fingers **85** lowered thereover, the fingers **85** extending from the rear at right angles to the support fingers **73**, as may be seen in Figure 6.

The body block **68** of the hairspring carrier has at its rear side a pivot lug **86** on which a horizontal arm **87** (Figs. 1, 2, 4, 6, 7) is pivoted to swing horizontally and rearwardly from an operative position at which its extremity is located over the elevator to initial inoperative position at which the arm **87** is located well to the left of the elevator, and is usually extended rearwardly at the left end of the machine in a direction at right angles to its operative position, as shown in Figure 1. This arm is not pivoted directly on the lug **86**, but is the top member of an elevatable frame **88**, consisting of the arm **87** and a short plate **89** under and aligned with the base end of the arm **87**, and connected to the latter by two guide tubes **88** which are fitted slidably around vertical parallel guide studs **90** set in the ends of a cross plate **91** (Fig. 10) fixed at the extremity of a base lever or clamp mount **92**, extending at right angles to the arm **87**, as viewed from above, the opposite end of the mount or lever **92** is pivoted on the lug **86** and constituting the actual pivotal mounting of the arm **87**. The cross-plate **91** has an upstanting ear **93** upon which there is pivoted a bell crank hand lever **94** the angle of which is pivoted upon the ear and the lateral arm or crank of which is pivoted to a link **95** pivoted in turn to a depending ear **96** on the under side of the arm **87** of the elevatable frame **88**.

By means of the lever **94**, the arm **92** and the relatively elevatable parts thereon may be swung horizontally on the bracket **86** through an arc of substantially ninety degrees from the position shown in Figure 1 to the position shown in Figure 6. At the same time, by depression of the lever handle **94** the crank thrusts the link **95** upward, raising the arm **87**, so that the latter may be elevated prior to such swinging of the arm. After movement of the latter to operative position shown in full lines in Figure 6, the arm may be lowered, carrying the hair spring clamp fingers **85** downward, so as to cooperate with the support fingers **73** and hold a hairspring between the two pairs of fingers with requisite firmness, and at the same time freedom from liability of distortion of the form of the spring. The clamp device thus has a horizontal path fixed relative to the carriage, from an inoperative position to operative position over the support fingers, and may be raised and lowered at will at the extremes of this path.

The clamp fingers **85** (Figs. 1 and 2) are normally parallel or nearly so, and are secured to the lower ends of vertical pintles **97** revolubly mounted through the extremities of a pair of finger support levers **98** pivoted for horizontal movement at the ends of arms of a T-shaped bracket **99** fixed on the extremity of the arm **87**. These fingers normally extend from the arm **87** toward the forward part of the machine when the clamp assembly is in operative position as in Figure 6. The levers **98** are frictionally adjustable on the bracket **99** and the pintles **97** are frictionally held but revolubly adjustable on the levers **98**. The upper ends of the pintles are provided with lateral handle arms **100** by which the fingers **85** may be rotated on the axes of the pintles and also adjusted relatively in spacing, either by mutual or selective movements, or their mutual positions varied translatively in a direction parallel to the arm **87**. The pintles **97** extend some distance below the levers **98**, so that the fingers **85** are located considerably below the arm **87** (Fig. 2), and when the arm **87** is swung to the position shown in full lines in Figure 6, while elevated by the lever **94**, and then lowered by raising the hand lever **94**, the pintles will extend downwardly before the elevator guide structure as far as may be desirable. Thereby, the clamp fingers **85** may rest lightly but firmly upon a hairspring laid on the support fingers **73**.

Modified rotor vise

In Figure 9 there is illustrated a rotor support bar **35**–*a*

adapted to receive and hold a vane type armature for A. C. meters and the like. The forward end of this bar 35–*a* is provided with a split spring steel extension forming vise jaws 101, a clamp screw 102 being engaged with the jaws operative to compress them together upon an interposed vane shaft and the like. The opposed faces of the jaws may be recessed to fit partly around the shaft of the galvanometer armature if desired. This bar 35–*a* is emplacable on the elevator in the same manner as the bars 35, but requires no spring 41 thereon, since the clamp frame is not utilized with this type of meter element, but is removed from its studs 37 and laid aside, the latter being then unused.

Operation of the apparatus

In the use of the invention as thus embodied, the carriage 21 is initially positioned at the left hand limit of its movement on the rails 55, the operating hand lever 64 being then extended forwardly from the machine and somewhat toward the right from its pivot as in Figures 1 and 2. The handle 94 is positioned toward the front so that the arm 87 extends toward the rear as in Figure 1. This handle may be lowered as in Figures 2 and 7 so as to elevate arm 87, or may be raised as in Figure 4 so that the arm 87 is lowered. The elevator 20 is at a lowered or intermediate position and a coil support vise bar 35 is secured thereon extending forwardly of the clamp frame 38, as in Figure 1.

For fitting a hairspring to a D'Arsonville coil, the coil (as at 42, Fig. 2, for instance) of the rotor to be equipped is set upon the jaw extremity of the bar 35 as previously described, the clamp frame 38 being in place on its guide studs 37 and provided with the necessary short presser bar or clamp plate 40. The latter is adjusted within the coil and the elevator then operated so as to allow the spring 41 to depress the frame 38 to bring plate 40 against the lower side of the coil. The pointer on such coil is positioned to extend in a direction to interfere as little as possible with hairspring manipulations and movements of an operator or parts of the device being assembled. The elevator is then secured in, or allowed to remain in, such elevated position while the hairspring is put in position and attached to the coil unit.

The hairspring carrier 22 is now adjusted on its post 62 so that when the carriage is moved to the right to operative position shown in Figures 5 and 6, the hairspring support fingers 73 will be at a level closely adjacent the part on the coil unit to which the hairspring is to be secured, and the handscrew 63 is rotated as may be required to move the hairspring carrier forwardly or rearwardly to align the fingers 73 with the position on the rotor in which the hairspring is to be secured. Also, the screw 81 is manipulated to press the toggle links 83 forward or to allow withdrawal of these links, to attain proper relative positioning of the finger-carrying levers 75 and consequent spacing of the support fingers 73 so that they may properly receive the hairspring thereon, without interference by parts of the coil unit.

The hand lever 64, which is initially extended forwardly from the machine, is now pressed to the left and rearwardly, so that the link 67 presses the carriage toward the right substantially to the position shown in Figures 5 and 6. This brings the hairspring support fingers 73 to position over the coil (in the assembly of most of the devices of this character), and the fingers will usually be spaced equally from the axis of the coil, although in specific exceptional forms the carriage will be adjusted by screw 68 to an unsymmetrical relation to the coil axis. The fingers 73 being properly positioned, the hairspring is simply laid across these fingers with its extremity in the approximate position in which it will be permanently secured to the coil device, and allowed to rest by gravity there until the clamp fingers 75 are brought into place pressing upon the hairspring.

The lever 94 is now operated from its position at the front of the machine where it extends upwardly at an angle of approximately 45 degrees, by depressing the same to a position such as shown in Fig. 2, and then swinging it to the left on its pivot at 86 until the arm 87 (thus moved to the right) extends over the elevator as shown in solid lines in Figure 6. The first mentioned depression of the lever raises the inner or crank arm of the lever so that the link 95 presses the frame 88 and arm 87 toward their upper limit of movement, whereby the arm 87 and parts mounted thereon will clear the elevator structure and the pointer on the coil unit, as well as the hairspring, as the arm moves toward the position required. The clamp fingers 85 may now be adjusted in relation to the hairspring by manipulation of the swing arms 98 and handles 100 so that the fingers 85 will lie at right angles to or generally across the support fingers 73 with proper spacing. The support levers 93 may be moved independently, so that the fingers 85 may be disposed variously with any desired spacing along the fingers 73, symmetrically or eccentrically with respect to the pivot axis of the coil or other unit upon which the hairspring is to be secured. Manipulation of the screw 81 and/or screw 63 will also enable equivalent adjustments of the pair of fingers 73 longitudinally of the fingers 85.

After adjustment of the fingers 85 as desired while in their elevated position, the lever 94 is raised so as to allow the weight of the arm 87 and connected parts to move it downwardly until the fingers 85 rest upon the hairspring formally indicated at 103 in Figure 3. This clamps the hairspring against the support fingers 73 with sufficient firmness to retain the spring in its adjusted position while its end is attached or connected to the coil 42 which is supported by the bar 35. While the hairspring is frictionally held between the two sets of fingers, it may be changed in position and adjusted in various ways to place its extremity in the desired position for securement. It should be noted that in this functioning of the device the hairspring is supported entirely independently of the rotor member, and may be in the clear above the latter in the initial positioning; and its final emplacement with the extremity of the spring resting against the rotor where it is to be soldered, but not materially supporting the spring, may be accomplished by lowering the block 68 on the post 62 sufficiently and securing it by the screw 71. The fingers 73 serve to elevate or support the spring, while the fingers 85 press upon it sufficiently to hold it properly oriented on the fingers 73 after being adjusted angularly around its pivot axis. Solder or other fastening may now be applied in accordance with conventional practice, and the coil assembly with the newly attached spring removed from the machine after raising the clamp fingers 85 by operations of the lever 94 the reverse of those described, and careful withdrawal of the carriage and support fingers 73 by operation of the hand lever 64 to the position shown in Fig. 1. The coil unit is thereafter lifted from the support bar 35 after first lowering the elevator by raising of the handle 47 until the clamp frame 38 with its jaw plate 40 is stopped by the bed plate, against the action of the spring 41, the coil being thus left free for removal from the jaw bar 35 under continued lowering of the elevator, after the lower side of the coil moves below and clear of the jaw plate 40.

If identical coil units and hairsprings are to be assembled in immediate succession, bar 35 may remain as first placed in the elevator, and manipulation of the fingers of the support and the clamp for mutual spacing of the fingers and their lateral positioning relative to the work may be omitted after the first operation of these as described; then, only the placement of the new coil unit on the lowered bar 35 as first described is necessary, followed by traverse of the carriage, placing of the new spring on the spring support, and swinging and lowering of the arm 87, as a preliminary to soldering or other securement of the new spring to the coil unit. These operations can be performed very rapidly and with great certainty in the

location and securement of the hairspring on the coil unit.

Where an A. C. vane armature is to have a hairspring attached thereto, the clamping frame **38** is removed and the bar **35**–*a* put in place and secured on the elevator by the same clamping means which holds the bar **35**. Then the vise **101** is employed to hold the vane in the required position for convenient attachment of the hairspring, and the placement of the latter is effected by utilization of the devices on the carriage **21** in the same manner as previously described.

It should be appreciated that the fingers **73** of the support are of spring material and are yieldable to manual pressure so as to permit depression of the spring if required in its positioning, or for any other reason, and the fingers **85** of the clamp element are also similarly elastic and yieldable to manual pressures. The pairs of fingers are also yieldable to each other to a proper degree, so that when the clamp fingers **85** are lowered upon a hairspring resting on the supporting fingers **73** the spring will be held without objectionable distortion, but firmly enough to assure its retention in an adjusted position while a soldering iron is applied or other securing expedient carried out, depending on the practice involved in a particular case.

Broadly, the vise **101** may be considered one form of clamping means, and the bar **35** and frame **38** may be considered a form of vise. The two pairs of fingers **73** and **85** may also be considered a form of vise in some aspects. The vises or clamping means and supports may be variously modified to permit the holding of other forms of armature or rotor devices and or springs other than those specifically mentioned. Modifications of the structure, arrangement and combination of parts involved in the embodiment of the invention may be made without departing from the spirit of the invention except as limited by the claims hereto appended.

I claim:

1. A work holder and assembling machine for assembling hairsprings on instrument rotor body units, and the like, comprising an assembly station including means to releasably hold a body unit fixedly at a given position, a travelling hairspring carrier, a stationary guide therefor extending generally toward said station, said carrier movable at will on the guide from a position remote from the station to a position adjacent the station, a hairspring support on the carrier constructed to support independently a hairspring in operative assembly relation with said body at said station when the carrier is in said adjacent position, means operable at will to move the carrier on said guide to and from said positions, a clamping device constructed to coengage a hairspring on said support to retain the same oriented on said support in said assembly relation with said body, a clamp mount for the clamping device mounted movably on the carrier for relative movement thereon to translate the clamping device horizontally in a clamp path fixed in plan relative to the carrier the terminal portion of which path overlies the path of said support when the latter is moved with the carrier, said movement of translation being between a position remote from the said support to a proximal one over said support and spaced over a hairspring on the support, and means remote from the clamping device and from the support operable at will to move the clamp mount vertically on the carrier to and from an operative position on a hairspring on said support.

2. A machine as in claim 1 wherein said hairspring support is a pair of horizontal fingers spaced apart at the same level, extended clear of the carrier in the direction of travel of the carrier on said guide and located and positioned so as to project longitudinally in said direction under a hairspring at said station slidable for withdrawal from the hairspring, and said clamping device is also a pair of horizontal fingers lying crosswise of the fingers of the support when said clamp mount is at said proximal position in said clamp path whereby a hairspring may be frictionally held between the support and clamp device in assembled relation to and independently of a body fixed at said station.

3. A machine as in claim 2 wherein said carrier includes a carriage reciprocable on said guide, said support including a carrier body part vertically adjustable on the carriage, and means to fix the body part releasably at its levels of adjustment, said mount for the clamping device being mounted on said body part for movement in said clamp path at all vertical adjustments of the body.

4. A machine as in claim 3 wherein a horizontal guide is constructed on the carriage transverse to the direction of the first named guide, said carrier body part being slidable thereon, and means to move said carrier body part on the second named guide.

5. A machine as in claim 1 wherein said mount for the clamping device includes a base part secured to the carrier for movement at a fixed level with respect to the said carrier body part, and an intermediate part mounted for vertical movement on the base part extended to and carrying the clamping device, and means remote from the clamping device to elevate and lower said intermediate part when the mount is at said proximal position on said clamp path, to clamp and release an assembly component at will when in a given position on said support.

6. The machine of claim 1 wherein said carrier includes a carriage directly on said guide and said clamping device includes a base element horizontally pivoted on the carriage, a vertical guide means on said base element, the clamping member including a body slidable on the vertical guide means, a lever pivoted on said base element for oscillation in a vertical plane only relative to the base element, so that horizontal movement of the lever will move the base element horizontally on its pivot, and a link connected to the lever and said body operable to elevate the said body on movement of the lever in one direction vertically.

7. A machine as in claim 1 wherein said hairspring support comprises elongated approximately horizontal terminal work-engaging surfaces of a resilient furcated spring device shaped to the under side of a hairspring, and said clamping member is a furcated approximately horizontally surfaced resilient spring device arranged at a substantial angle to the hairspring support when the latter and said clamping device are at said station and operative position, the furcations being horizontally spaced in each and yieldable to each other and to the hairspring.

8. The structure of claim 1 wherein said hairspring support comprises a pair of thin horizontal wire-like elongated spring fingers on the hairspring carrier extended generally longitudinally of said guide device toward said station and stopping short thereof when the carrier is at said position remote from the station, but projecting over said station when the carrier is in its said position adjacent the station.

9. A machine as in claim 1 wherein said guide consists of a rectilinear horizontal guide device located laterally of said station and in line therewith, a carriage reciprocable on the guide device, said hairspring support including a post device mounted on the carriage, means to secure the support vertically adjustable on the post, and means on the carriage to adjust the post across the carriage transversely of said guide device.

10. The structure of claim 9 wherein a bell crank hand lever is pivoted on the guide device and one arm thereof linked to said carriage so that horizontal oscillation of the lever will reciprocate the carriage.

11. A machine as in claim 9 wherein said means to releasably hold a body unit comprises a vertically reciprocable elevator, and means remote from the elevator operable at will to raise and lower the same adjustably in a vertical range of movement including the levels of adjustment of the hairspring support on said post, for assembly of said body unit to a hairspring, clamped between the hairspring support and clamping device.

12. The invention of claim 11 wherein the elevator and means to hold a body unit comprise a stationary vertical guide means spaced from said given position, an elevator proper slidable thereon, a bar member on the elevator proper projected a distance therefrom toward said station constructed to engage and support a body unit at said given position, a vise member spaced vertically from and movable relative to said bar to coengage said body unit in opposition to said bar and hold the body unit upon the bar, and yielding means connected between the bar and vise member to move the vise member to engage the body unit in opposition to said bar.

13. The structure of claim 12 in which said elevator includes releasable means to hold said bar fixedly on the elevator proper, for replacement by bars of special forms for respective different body unit.

14. The invention as in claim 12 wherein the vise member comprises a vertical guide device spaced from said vertical guide means in the direction of projection of said bar, said bar having a jaw constructed to engage under and against the upper part of a coil set therearound, a holding member slidable on said guide device having a jaw to engage within and against the lower side of a coil set on the first jaw, and resilient means confined between the bar and said holding member to cause the said jaws to press in opposite directions against the sides of the coil.

15. An assembling and repair jig for an article to be assembled at an assembly station comprising means to hold an article component fixedly at said station, a horizontal guide extended generally toward said station, a carriage reciprocable at will thereon from a remote position to a position near said station, a post element mounted on the carriage for movement on and relatively to the carriage transversely to said guide, means to adjust the post in its transverse movement on the carriage, a vertically adjustable body on the post, means to secure the body releasably at its adjusted heights on the carriage, a pair of horizontal second article component-supporting spring fingers projected from said body toward said station in the direction of movement of the carriage on said guide, movable clamp means to frictionally engage upon said second article component when carried by said fingers, a mount for said clamp means including means to guide the clamp means in a clamp path directionally fixed in relation to said body from a remote position clear of the said first named fingers to a position over said first named fingers and into clamping relation upon said second article component on the said fingers, and means to operate said mount to move the clamp means in said path to and from said positions on said clamp path.

16. The structure of claim 15 in which said fingers are mounted for relative lateral movement with respect to each other, and means to fix the fingers in adjusted relative positions in said movement.

17. The structure of claim 16 in which the fingers are fixed on vertical pins revoluble in the extremities of horizontally movable links pivoted on the said body, a transverse pin engaged slidably on the vertical pins, and means to adjust the links relatively to each other.

18. The structure of claim 17 wherein spring devices are engaged with the links tending to press them toward one limit of their relative movement, and manually adjustable means to limit the movements of the links toward said limit.

19. The structure of claim 17 wherein respective helical compression springs are confined between the extremities of the transverse pin and the adjacent links, a slidable means mounted on said body constructed to limit inward movement of the links in degree according to the longitudinal position of the sliding means, and a screw member on the body in bearing with the slidable means tending to press the latter outwardly and operable for movement of said slidable means relative to the links.

20. The structure of claim 19 wherein said links are convergent from their bases, a stud bolt set in the forward part of said body on an axis bisecting the angle of the links to each other, said screw member being a hollow screw engaged on the stud and a cross member on the screw between the links, and connected to the latter to bear them apart on movement of the screw in one direction and to space the links closer on opposite movement of the screw.

21. The structure of claim 20 wherein the last named connection comprises toggle links connected between the links and said cross member.

22. A work assembling jig for an article in course of assembly, including a stationary elevator guide, an elevator movable thereon, a vise bar releasably fixed on the elevator projected a distance from the elevator toward a predetermined assembly location for the article, vise means at the distal part of the bar constructed to hold a work piece in said location, a carriage distant from the bar, guide means for the carriage to guide the carriage in a fixed carriage path extending generally from a distal point remote from said location to a position proximal to said location, a work component support vertically adjustable on the carriage and projecting from the carriage toward said station a distance sufficient to reach said location when the carriage is at said proximal position near but spaced from said location and positioned to support a work component in assembled relation to said work piece at said location, means to operate the elevator for raising and lowering said vise means, and means operable at will to move said carriage on said guide means to said distal point to clear said location for emplacement of said work piece, and to move the carriage to said proximal position whereby said support is extended to the work piece and will hold said component in assembled relation to the work piece.

23. The structure of claim 22 wherein a clamp device is mounted on said carriage movable for coaction with a work component on said support, a mounting for said clamp device to guide it in a clamp path fixed relative to the carriage above the level of a work component on said support from a point in said clamp path remote from the said support to a position over a work component on said support, and means to move the clamp device in said clamp path, and to lower the clamp device into engagement with a work component on said support when the carriage is at said proximal position.

24. The structure of claim 22, wherein the vise means includes a jaw part on the extremity of said bar, a vertically movable second vise jaw below the first one, a separate support therefor constructed for vertical movement of the second vise jaw relative to said bar and to limit movement thereof in at least one direction, and a spring member on the bar positioned to engage the lower jaw member within a given part at least of the relative movement of the two under operation of said elevator, and press it against a part of an article when supported at said position in opposition to the first named jaw, under operation of the elevator upwardly beyond a given limit in relation to the lower jaw, by pressure of said spring device.

25. The structure of claim 24, wherein said elevator has one limit of movement in released relation to one said jaw, whereby on movement of the elevator near to such limit, one jaw element will be stopped while the other is moved to released relation thereto to free an engaged article, against stress of said spring.

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