United States Patent

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[33] **Japan**
[31] **Nos. 42/102999 and 43/79254**

[54] **KEY ASSEMBLY**
6 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **84/433,**
84/434
[51] **Int. Cl.** **G10c 3/12**
[50] **Field of Search** 84/433-
—435, 439—440

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ABSTRACT: A key assembly involves a plurality of key members arranged on a transverse support member. The arm of each of said key members has a specific cross-sectional form which comprises a pair of vertical sidewalls and horizontal web bridging said vertical sidewalls. Said web has a through aperture, both side edges of which are set in line with said sidewalls.

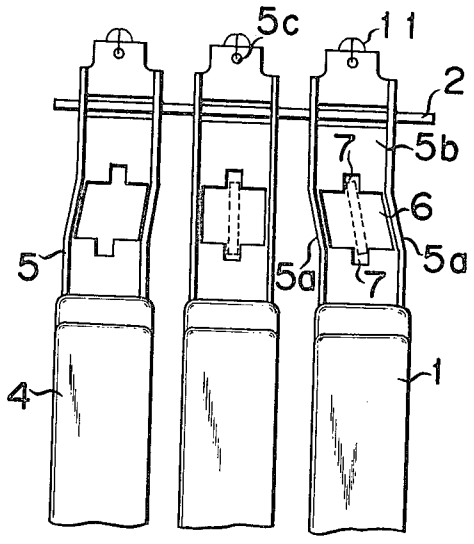


FIG. 1

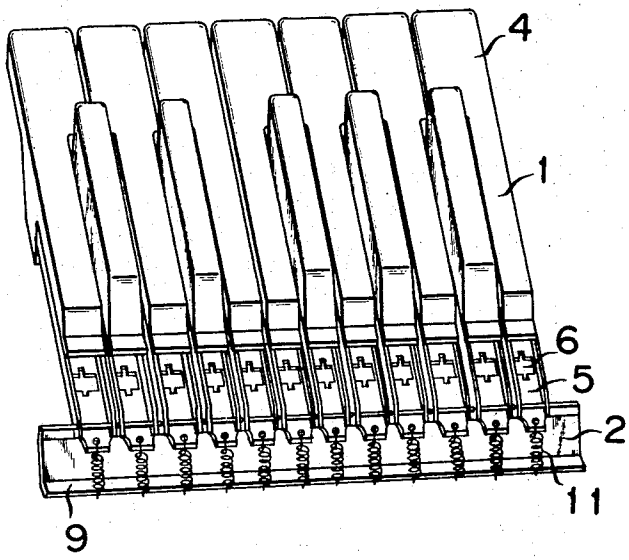
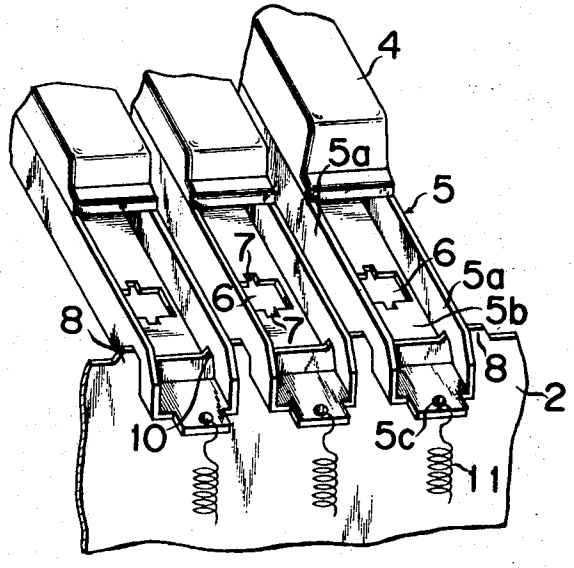


FIG. 2



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FIG. 3

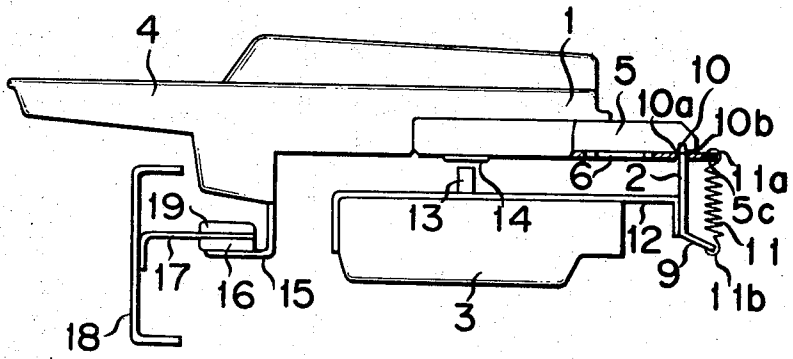


FIG. 4

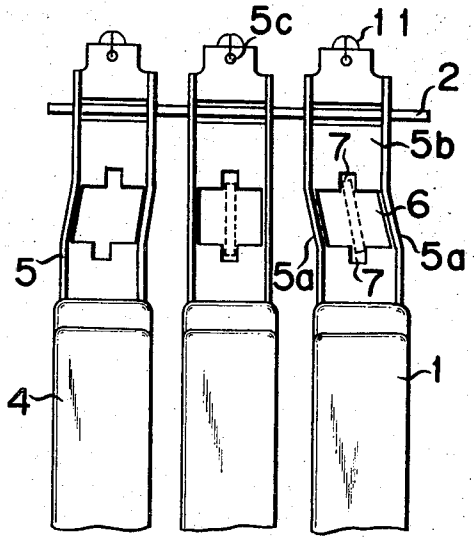
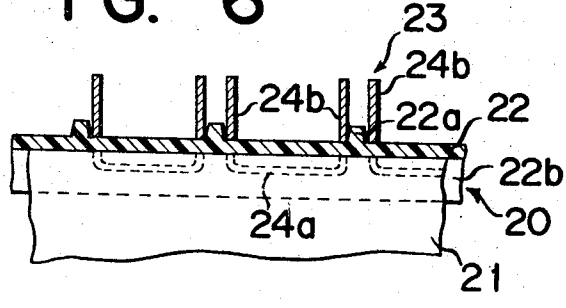


FIG. 6

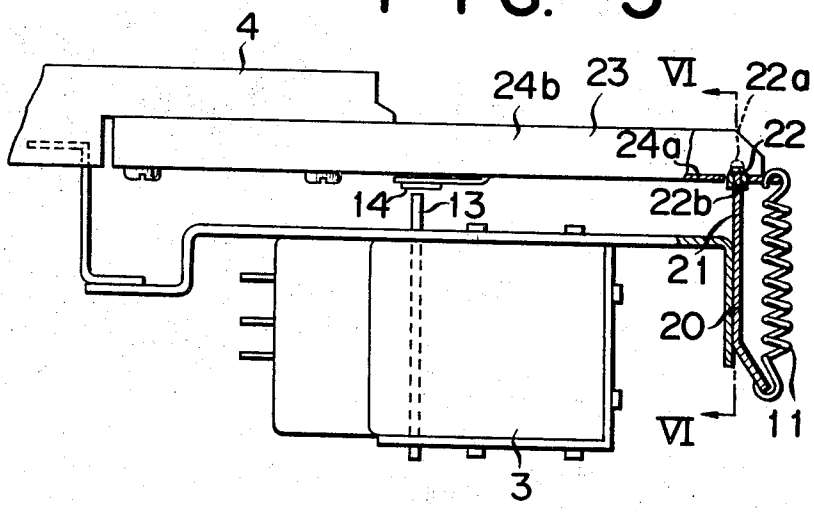


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FIG. 5



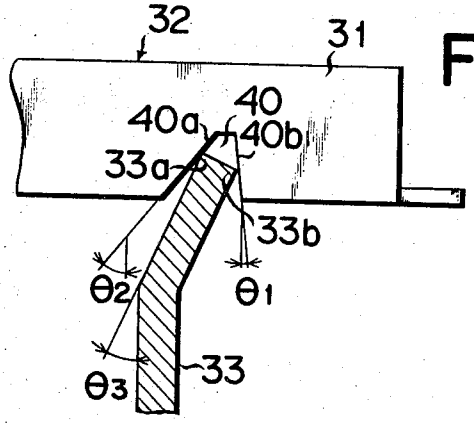


FIG. 7

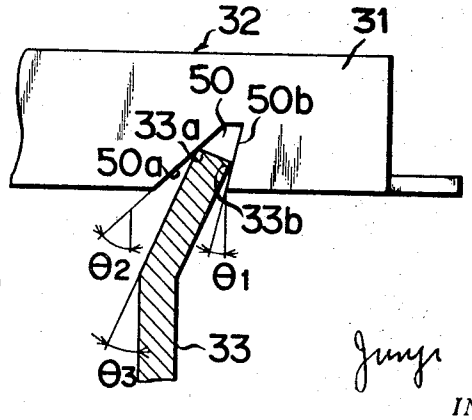


FIG. 8

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FIG. 9

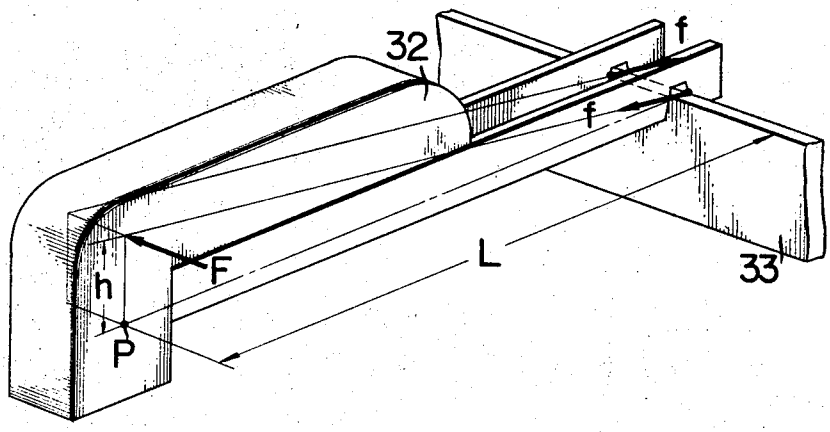


FIG. 10

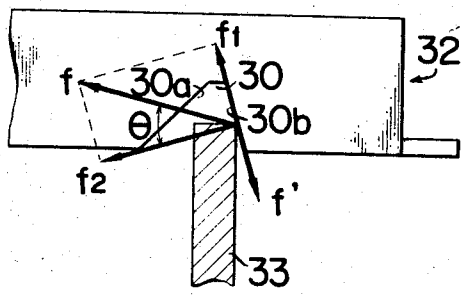
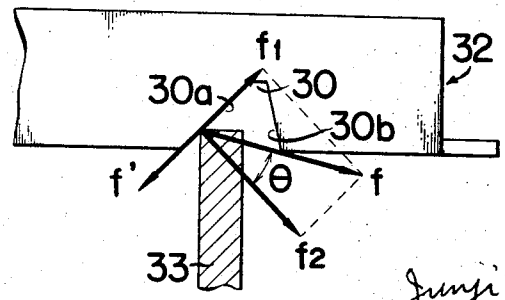


FIG. 11



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KEY ASSEMBLY

This invention relates to a key assembly mainly used in an electronic musical instrument, and more particularly to a key assembly improved so as to cause the gap between the adjacent key members to be easily adjusted.

The prior art key assemblies were provided with a plurality of key pins positioned on a key frame floatingly to support the key members.

Such construction unavoidably required much time in adjusting the gap between said adjacent key members by slightly bending said key pins. This was because the gap between said key members had to be inspected each time the key members were set on the previously adjusted key pins.

Furthermore, when music was performed by glissando, key members having their arms disposed on a transverse support member were subjected to a torsional stress generated by the sliding of the fingers, with the result that the stability of the key members on the transverse support member was reduced or lost.

An object of this invention is to provide a key assembly improved so as to cause the gap between the adjacent key members to be easily adjusted in the assembling step.

Therefore, the key assembly of this invention involves a plurality of key members, a transverse support member on which the arms of said key members are supported, said arms having a specific cross-sectional form which comprises a pair of vertical sidewalls and a horizontal web bridging said vertical sidewalls, and a through aperture formed in said web, both side edges of said aperture being set in line with said sidewalls.

Another object of this invention is to provide a key assembly improved so as to cause the gap between the adjacent key members to be easily adjusted in the assembling step and also the stability of the key members on the transverse support member to be desirably maintained even in the case music is performed by glissando.

In the drawings:

FIG. 1 is a perspective view of a key assembly embodying this invention;

FIG. 2 is a perspective back-side view of a part of the key assembly of FIG. 1;

FIG. 3 is a side view of the key assembly of FIG. 1;

FIG. 4 is a plan view of a part of the key assembly of FIG. 1, wherein the sidewise bent arms of the key members are indicated in enlargement;

FIG. 5 is a side view of the rear part of a key assembly modified from that of FIG. 1;

FIG. 6 is a cross-sectional view of line VI–VI of FIG. 5;

FIG. 7 is an enlarged side view of the rear part of a key member and the upper part of a transverse support member specifically involved in a key assembly further embodying this invention;

FIG. 8 is an enlarged side view of the rear part of a key member and the upper part of a transverse support member modified from those of FIG. 7;

FIG. 9 is a perspective view of a vector diagram indicating analyzed vectors applied to the support member when music is performed by glissando;

FIG. 10 is a vector diagram in an elevation of the right side of the key member; and

FIG. 11 is a vector diagram in an elevation of the left side of the key member.

FIGS. 1 to 4 indicate a key assembly embodying the present invention. Said key assembly involves a plurality of key members 1, a transverse support member or plate 2 for supporting the rear portions of the key members 1, a plurality of key switches 3 disposed under said key members 1 in a manner to be coupled one by one with said key members, and means for depressing said key members 1 to the upper edge of the support member 2. Each of the key members 1 consists of a key head 4 made of synthetic resin, and an arm 5 made of metal which has a specific cross-sectional form comprising a pair of vertical sidewalls 5*a* and a horizontal web 5*b* bridging said vertical sidewalls. Said web 5*b* has a through aperture, for example, a substantially rectangular through aperture 6, both side edges of which are set in line with the sidewalls 5*a*. web 5*b* further has a pair of lengthwise extending cavities 7 into which each side of a driver is inserted thereby to flexure the web by twisting said driver. Said cavities 7 respectively communicate with said aperture 6 at the front and rear sides thereof. In this embodiment, said key arm 5 has a channel-shaped cross section as shown in the aforementioned FIGS. but may have an H-shaped cross section (not shown).

Said transverse support member 2 has a plurality of protrusions 8 formed on the upper edge thereof at an equal space or predetermined different spaces, and a rearwise extending flange 9 formed on the lower portion thereof. A trapezoidal notch 10 is cut out starting with the lower side edge of the key arm 5. Said notch 10 has a front face 10*a* contacting the upper front edge of the support member 2, and a rear face 10*b* contacting the upper rear edge thereof.

Said depressing means involves a plurality of coil tension springs 11 each of which is stretched between the rear end of the key member 1 and the lower end of the flange 9 by being hooked to them. Namely, said engagement is made by hooking the upper portion 11*a* of the spring 11 through a bore 5*c* drilled in the web 5*b* to the rear end of the key arm 5, and the lower portion 11*b* of the spring 11 to the lower edge of the flange 9.

A supporting frame 12 for mounting said key switches 3 thereon is attached to the front side of said support member 2. An actuator 13 of each of the key switches 3 upwardly projects from the housing thereof. Attached to the lower surface of the key arm 5 is a contact piece 14 for actuating said actuator 13.

An L-shaped member 15 is secured to the lower portion of the key member 1.

A flat pad 16 made of felt or foamed resin is adhesively bonded to the underside of another member 17 which backwardly extends from a key slip member 18. Said pad 16 normally contacts the upper portion of the member 15 by swinging the key member 1 at the upper end of the support member 2 by spring action so as to define the key level. Another flat pad 19 opposed to said flat pad 16 is attached to the upper portion of the member 17 so as to limit the depth to which the key is depressed.

In this embodiment, the key arm 5 is arranged on the support member 2 so that the trapezoidal notch 10 may be positioned at an intervening space between the adjacent protrusions 8.

However, said support member 2 may, if necessary, be without protrusions.

In the assembling step, the driver blade (as shown at a dotted line in FIG. 4) is so inserted into the aperture as to bridge the cavities formed on both sides thereof thereby to flexure the web and sidewalls of the key member near the sides of the aperture as illustrated in FIG. 4 by twisting said driver to adjust the gap between the adjacent key members.

Namely, the aperture 6 is deformed from a rectangle to a parallelogram so that the forward portion of the key arm on the front side of the aperture, i.e., the key head, may be shifted in parallel relationship to the adjacent key head without being inclined thereto. This is one of the main advantages of this invention.

Adjustment of the gap while it is observed by the naked eye offers great advantage in saving time.

The rear end portion of the web 5*b* including the bore 5*c* may backwardly project from the position at which the sidewalls 5*a* are terminated. In this case, the bias of the coil spring 11 is minutely adjusted by bending said rear end portion of the web 5*b* in an upper or lower direction.

FIGS. 5 and 6 jointly indicate a key assembly modified from that of FIGS. 1 to 4. Said key assembly is the same type as that of the first-mentioned embodiment excepting that said assembly has a transverse support member 20. Said support member 20 is prepared from a strip member 21 having its upper edge flattened, and an attachment member 22 made of

elastic resin. Said attachment member **22** has a plurality of mutually spaced protrusions **22***a* as the support member of the first-mentioned embodiment of FIGS. **1** to **4**, and a channel-shaped groove **22***b* formed at the lower portion thereof, into which the upper portion of the strip member **21** is rigidly inserted. Said key assembly is provided with a key member **23**, the arm of which has a web **24***a* whose rear end portion backwardly projects from the position at which the sidewalls **24***b* of said arm are terminated.

FIGS. **7** and **8** jointly indicate another embodiment of the key assembly of this invention. Said key assembly is the same type as that of the first-mentioned embodiment excepting that said assembly has a notch **30** specifically formed in a key arm **31**. Therefore, only said specific notch **30** will be detailed hereinafter for avoiding the duplicated and complicated explanation of the key assembly.

When music is performed by glissando, the key member **32** exhibits a vector relationship as indicated in FIGS. **9** to **11**. In other words, where the finger force F is applied to the sidewall of the key member **32**, couple forces *f* are derived (as shown in FIG. **9**) at points, one of which is defined at the right side edge of the notch **30** (See FIG. **10**) by contacting the rear face **30***b* of said notch **30** with the upper rear edge **33***b* of a transverse support member **33**, and the other at the left side edge of the notch **30** (See FIG. **11**) by contacting the front face **30***a* of said notch **30** with the upper front edge **33***a* thereof.

The function line of said couple forces *f* is directed toward a point to which the finger force F is applied. One of the couple forces *f* defined at the right side edge of the notch **30** is separated into two component forces f_1 and f_2, said component force f_1 lifting the key arm, and said component force f_2 depressing the key arm to the support member.

With character *f'* representing a friction force produced on the rear face **30***b* (See FIG. **10**) or the front face **30***a* (See FIG. **11**) by said component force f_2, then there will be established formula:

$f' = \mu \cdot f_2$ . . . (wherein μ is a coefficient of friction)

Since, however, $f_2 = f$ ** $\cos\theta$.... (wherein θ is an angle between the function line of said component force f_2 and that of said couple forces *f*), then there will result formula:

$$f' = \mu \cdot f \cdot \cos\theta \qquad (1)$$

Consequently, if the friction force *f'* equal to or greater than that of the component force f_1, the key member is prevented from floating up from the upper edge of the transverse support member thereby to keep the key members on the support member desirably stable.

Since the vectors of said forces F, *f*, f_1, f_2 and *f'* are predetermined, the angle θ can be set at a specified value in designing the key assembly.

In this case, with the component force f_1 constituting a couple-force *f* ** $\sin\theta$, the other will be established formula:

$$f' \geqq f_1 = f \cdot \sin\theta \qquad (2)$$

From formulas 1 and 2, there will be derived formula:

$$\mu \cdot f \cdot \cos\theta \geqq f \cdot \sin\theta$$

which will lead to μ**$\tan\theta$ and finally

$$\theta \leqq \tan^{-1} \cdot \mu \qquad (3)$$

Namely, the notch must be so formed as to have a face wherein the angle θ defined by the function line of couple forces with the plane vertical to said face is equal to or smaller than the friction angle which is the arc-tangential value of the coefficient of friction between said key arm and support member.

The key arm and transverse support member together are really made of cold rolled steel. In this case, since the friction coefficiency is estimated at $\mu = 0.2$, the angle can be set at θ**11.3.

A notch **40** formed in a white key member as shown in FIG. **7** has a front face **40***a* and rear face **40***b* designed under the conditions as specified above. A notch **50** formed in a black key member as shown in FIG. **8** has a front face **50***a* and rear face **50***b* similarly designed to that of FIG. **7**. Namely, in order to prevent the key member from floating up from the upper edge of the transverse support member, the angle θ_1 defined by the rear face **40***b* or **50***b* with the vertical plane normal to the length of the key arm (θ_1 is assumed to have a positive value with respect to the anticlockwise direction.) should be limited as expressed by formula:

$$\theta_1 \leqq \theta - \tan^{-1}\frac{h}{L} \qquad (4)$$

wherein L refers to a horizontal distance between the fulcrum defined by the contact of the support member with the notch **40** or **50** and the point P, which is positioned on a horizontal line extending from said fulcrum and beneath the function point of the finger force F, and *h* represents the vertical distance between said point P and the function point.

Similarly, the angle θ_2 defined by the front face **40***a* or **50***a* with the vertical plane (θ_2 is assumed to have a positive value with respect to the clockwise direction.) should be limited as indicated by formula:

$$\theta_2 \leqq \theta + \tan^{-1}\frac{h}{L} \qquad (5)$$

With concrete values applied to said formulas, the vertical and horizontal distances are set at L = 100 mm., h = 26 mm. when the black key is designed, and at L = 140 mm., h = 15 mm. when the white key is designed.

In the former case,

$$\theta_1 \leqq 11.3° - 14.6° = -3.3°$$
$$\theta_2 \leqq 11.3° + 14.6° = 25.9°$$

In the latter case,

$$\theta_1 \leqq 11.3° - 6.1° = 5.2°$$
$$\theta_2 \leqq 11.3° + 6.1° = 17.4°$$

It is important that the angle θ_1 in the former case be of a negative value. Namely, the rear face **40***b* or **50***b* is not inclined in the rear direction as is the case with that of the conventional notch, but in the forward direction. Where the white key, as well as the black key, is designed so that the finger force F may be applied at a higher point than in the above-mentioned embodiment, the angle θ_1 of the key will have a negative value, namely, the rear face of the notch formed on the key member will be inclined in the forward direction. The angles θ_1, θ_2 and θ_3 of FIG. **8** respectively represent −5°, 25° and 8°. In this case, consideration is given so that the key arm is swingably positioned within the range defined by said front and rear faces. To this end, the angles θ_1, θ_2 and θ_3 of FIG. **7** are set at 4°, 16° and 8°. In a modified design, the inclined upper edge of the transverse support member as mentioned above may be replaced by a cylindrical head. Furthermore, in this embodiment, where the angles θ_1 and θ_2 are set at −4° and 17° respectively, the same key arm members can be commonly used for the white and black keys.

In the embodiments of this invention, the rearwise extending flange (as shown at **9** in FIGS. **1** to **4**) may be formed in a state inclining from a vertical plane at half the right angle. Furthermore, the white key member may be supported at a point which is removed 5 to 7 millimeters from the engaging point of the bias spring and 160 millimeters from the forward end thereof. On the other hand, the black key member may be supported at a point which is removed 5 to 7 millimeters from the engaging point of the bias spring and 110 millimeters from the forward end thereof. In this case, the former bias spring may apply a load of 1.5 kg. on the white key member, and the

latter bias spring may apply a load of 1.2 kg. on the black key member in order to secure the key arms tightly on to support member.

I claim:

1. A key assembly including a transverse support member with a supporting point; a plurality of key members supported by said support member, each of said key members having a head and an arm, said arms having a specific cross-sectional form which comprises a pair of vertical sidewalls and a horizontal web bridging said vertical sidewalls, a through aperture formed in said web between said head and said supporting point, both side edges of said aperture being set in line with said sidewalls and means for depressing the key members on the transverse support member.

2. A key assembly claimed in claim 1 in which said through aperture is formed into a substantial rectangle, and there are further provided a pair of cavities for the driver bridged by said aperture.

3. A key assembly claimed in claim 1 in which each of the arms of said key members has a notch having a front face and a rear face, said faces contacting the upper edge of the support member so as to support the key members on said support member wherein the angle θ defined by the function line of couple-forces with the plane vertical to said face is equal to or smaller than the arc-tangential value of the coefficient of friction between said key arm and support member.

4. A key assembly claimed in claim 3 in which said support member has a flange rearwise extending in a state inclining from a vertical plane at half the right angle.

5. A key assembly claimed in claim 3 in which said notch is slightly spaced from the engaging point of the bias spring.

6. A key assembly claimed in claim 1 in which said depressing means involves a plurality of coil tension springs each of which is stretched between the rear end of the web and the lower end of the support member, said rear end of the web backwardly projecting from the position at which the sidewalls are terminated.