June 17, 1952 C. R. KILEY 2,600,545

STRINGED MUSICAL INSTRUMENT

Filed Sept. 1, 1949 2 SHEETS—SHEET 1

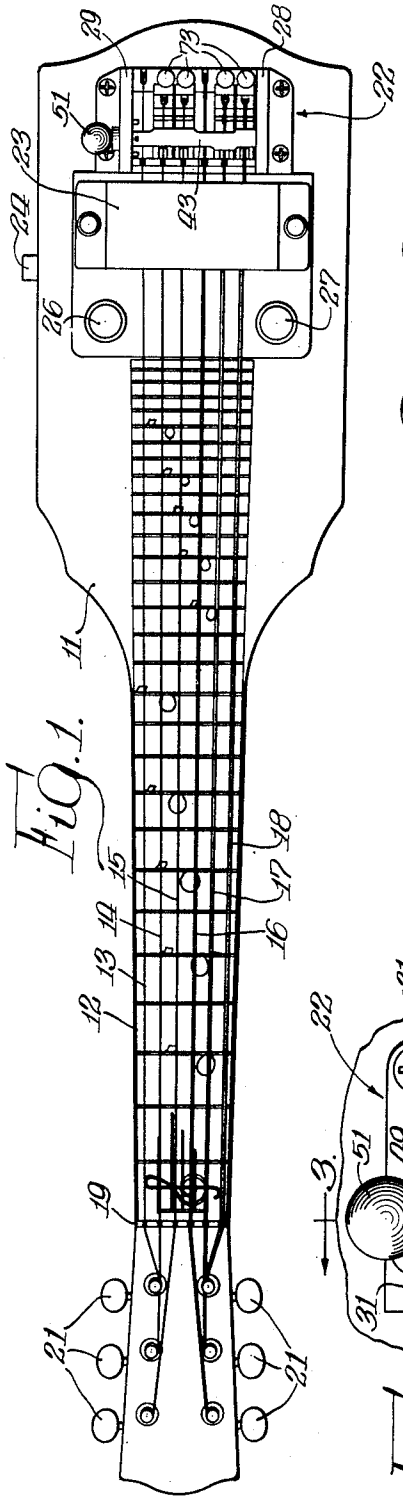

Fig. 1.

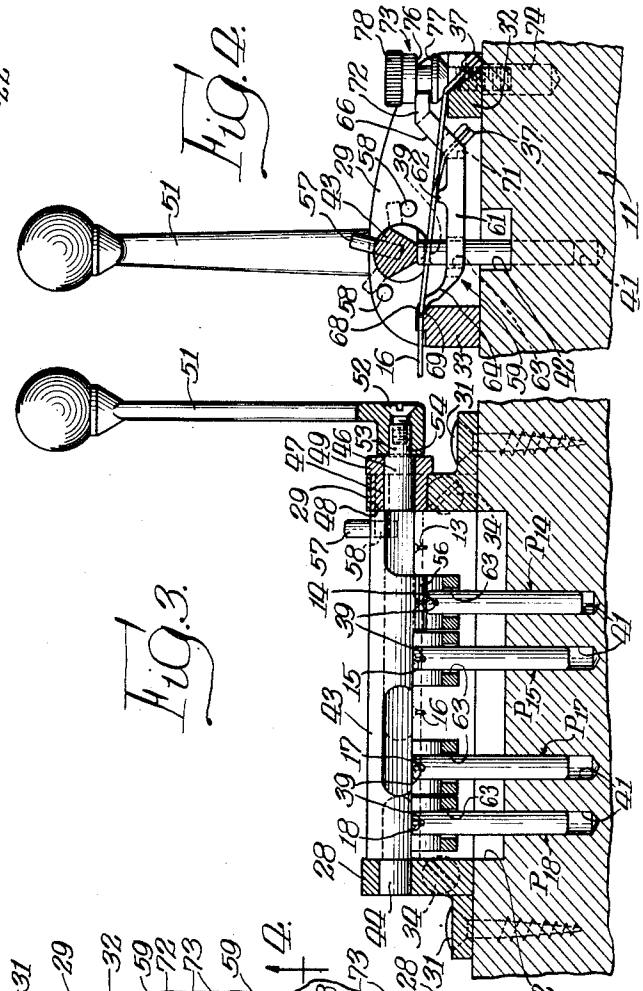

Fig. 3.

Fig. 4.

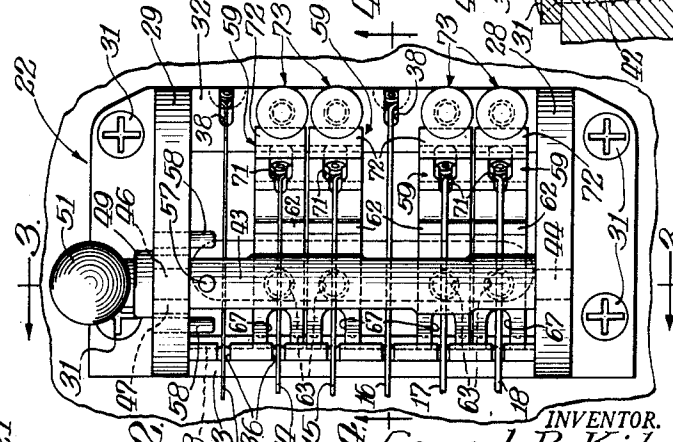

Fig. 2.

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Fig. 5.

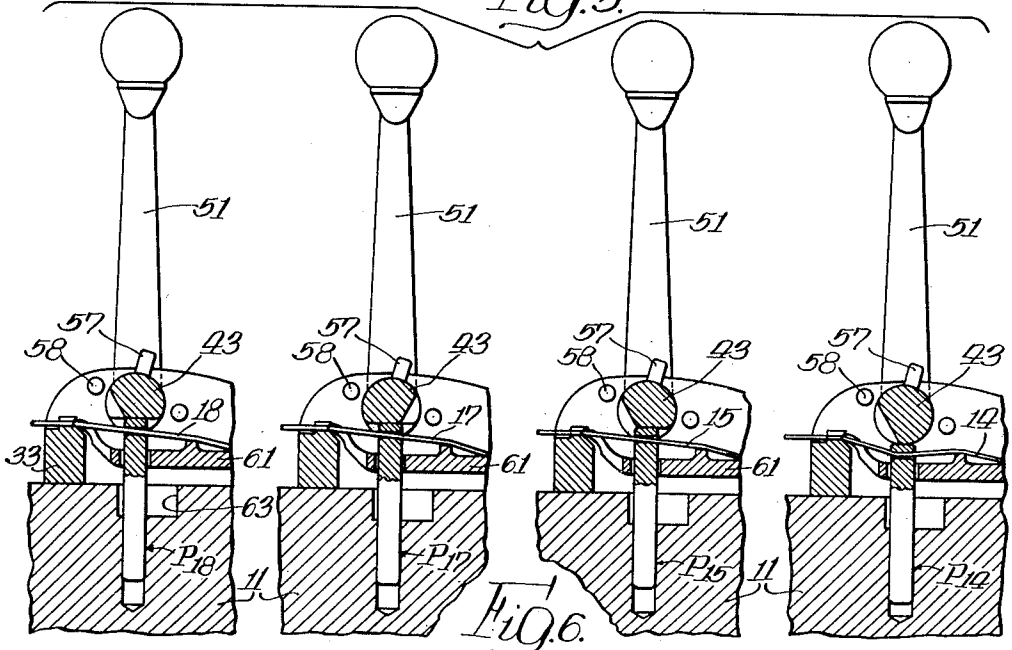


Fig. 6.

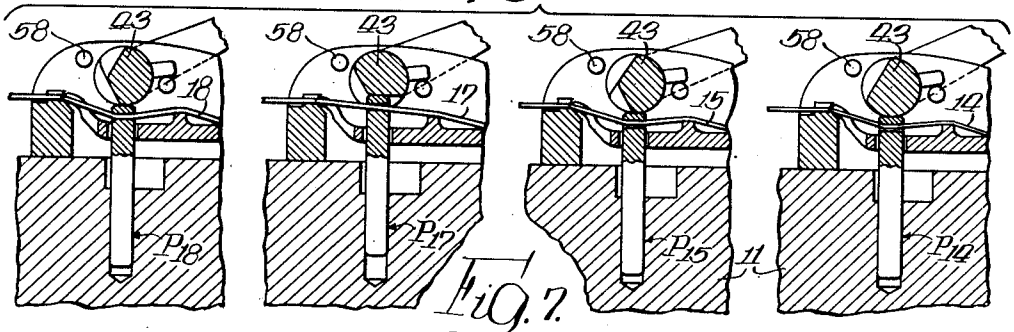


Fig. 7.

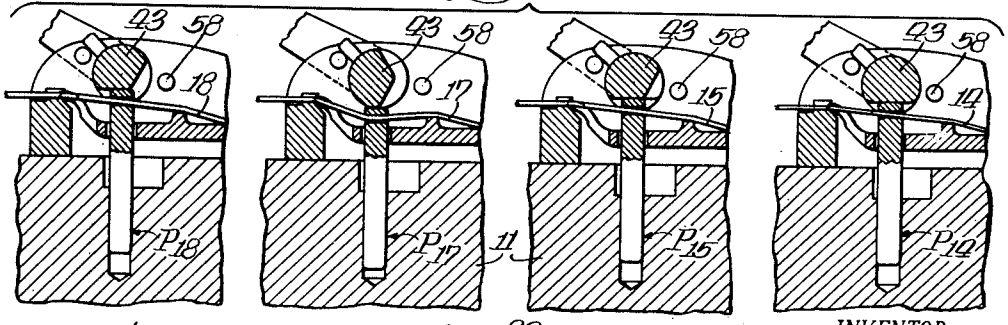
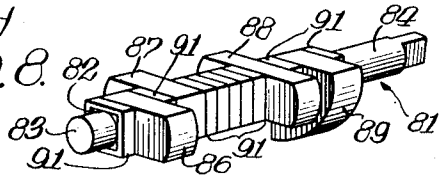


Fig. 8.



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STRINGED MUSICAL INSTRUMENT

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Application September 1, 1949, Serial No. 113,501

8 Claims. (Cl. 84—312)

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This invention relates to stringed musical instruments, especially to instruments of the type of the electric steel guitar, and more particularly to an improved tuning mechanism for such instruments.

The utility of the conventional steel guitar, and other similar stringed instruments used with electrical amplification, is seriously limited by the fact that the strings must be adjusted to a fixed chord tuning which cannot be changed to any appreciable extent while the instrument is being played. Thus, with such an instrument there is no satisfactory means of playing chords or partial chords other than those corresponding to the initial fixed tuning of the strings. Obviously, the resultant lack of flexibiliy and musical range greatly restricts the popularity and adaptability of such instruments, especially for use in orchestras and other musical groups.

Various tuning devices and tuning changers have been suggested for use with instruments of the foregoing character in order to permit relatively rapid changes in the string tuning. However, such of these devices as have been capable of meeting musical and playing requirements have not been altogether satisfactory both for the reason that they have been unduly complicated in structure and operation and also because they are often inaccurate and unreliable in execution of the required changes in tuning. For example, certain of these prior art devices require elaborate and bulky systems of interconnected cranks, levers, and foot pedal arrangements. Furthermore, most of the prior art devices comprise string-tensioning levers or rollers which are attached to the ends of the strings, the opposite ends of the strings being anchored to the instrument, whereby the string tension may be varied by exerting a greater or lesser pull on the strings longitudinally thereof. Such devices are generally unreliable because the levers or rollers which are attached to the ends of the strings tend to wear or become misadjusted with the result that they do not always return to their original positions and thus the initial fixed tuning of the strings is disturbed.

Accordingly, a primary object of my invention is to provide, in a stringed musical instrument of the above-mentioned type, novel means for readily effecting frequent and rapid changes in the tuning of the strings.

A further object of the invention is to provide, in a stringed musical instrument of the type described, a novel tuning mechanism of relatively compact and inexpensive construction which can

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be operated manually to effect rapid changes between a plurality of predetermined tuning patterns.

Another object of the invention is to provide, in a stringed musical instrument of the character described, a novel tuning mechanism for selectively altering the tension of the strings or predetermined groups thereof which is capable of accurate adjustment and which, even with repeated use, does not tend to disturb the original fixed tuning of the strings.

Other objects and advantages of the invention will become apparent upon reference to the subsequent detailed description and the accompanying drawings, in which:

Fig. 1 is a top plan view of an electric steel guitar provided with a tuning changer or string tensioning device comprising one specific embodiment of my invention;

Fig. 2 is an enlarged fragmentary plan view of the tuning changer at the right end of the guitar, as viewed in Fig. 1;

Fig. 3 is a fragmentary sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary sectional view taken along the line 4—4 of Fig. 2;

Figs. 5, 6, and 7 are a series of fragmentary sectional views similar to Fig. 4 and showing the positions of the several parts of the tuning changer corresponding to three different predetermined tuning patterns; and

Fig. 8 is a perspective view of a modified form of an actuating element comprising part of the tuning changer.

Referring now to Figs. 1 to 4 of the drawings, the invention is illustrated by an electric steel guitar comprising a wood or plastic body 11 which is provided on its upper surface with a suitably fretted finger board 12 extending longitudinally thereof in the conventional manner. A plurality of strings, six being shown in the present case as indicated at 13, 14, 15, 16, 17, and 18, are tensioned along the body of the instrument extending over a nut 19 at one end of the finger board 12 and connected to a plurality of conventional tuning keys 21. The strings are anchored at their opposite ends in a tuning changer unit, indicated generally at 22, which is mounted adjacent the opposite end of the body 11. The unit 22 comprises a principal feature of the present invention and will be described hereinafter in greater detail.

The instrument selected for illustration being an electric steel guitar, there is shown in Fig. 1 a hand rest 23 beneath whch is mounted a suitable

pickup device (not shown) of any well known type adapted to transmit the sound vibrations of the strings to an amplifier and loud speaker unit which may be connected to the instrument through an electrical connection **24** at one side of the body **11**. The pickup device is provided with suitable volume and tone control means (not shown) which are inserted in the pickup circuit for modifying the volume and tone of the string vibrations. These controls are adapted to be operated manually by means of a pair of control knobs **26** and **27** which are disposed adjacent the hand rest **23** and are readily accessible to the hand of the player.

Pursuant to the objects of the present invention, tuning changer or string tensioning means of an auxiliary character is provided for selectively varying at will the pitch of predetermined groups or combinations of the strings **13** to **18**. Such variation in pitch is accomplished by means of the string tensioning unit **22** which functions independently of the tuning keys **21** and independently of any other string tensioning mechanism with which an instrument of this type may be equipped.

The tuning changer or string tensioning mechanism **22** comprises a cast one-piece base or frame having a pair of spaced upright sides **28** and **29** rigidly fastened, as by a plurality of screws **31**, to the body **11** of the instrument and having an integral connecting portion or cross member **32** extending transversely between the sides **28** and **29** at the outer edge of the tuning changer **22**. A fixed bridge **33** extending transversely of the strings is detachably secured, as by a pair of screws **34** (Fig. 3), to the inner ends of the sides **28** and **29**. The strings extend across the fixed bridge **33** in contact with a plurality of complementary notched portions **36** provided at the upper edge thereof and thence slope downwardly toward the rear or outer end of the tuning changer unit where they are firmly anchored by means of knotted end portions or suitable enlarged retaining members, such as indicated at **37** (Fig. 4). In the case of certain strings, such as strings **13** and **16**, the retaining members are received and rigidly held in a plurality of slots or recesses **38** (Fig. 2) provided at the outer edge of the cross member **32**. In the case of other strings, such as strings **14**, **15**, **17**, and **18**, the ends of the strings are anchored to adjustable or movable members comprising part of the tuning changer mechanism and hereinafter described in greater detail.

For deflecting the strings in order to vary the tension thereof, a plurality of upright cylindrical members or plungers (each being indicated generally by the letter P and an appropriate subscript) are mounted for reciprocable sliding movement relative to the body **11**, the upper end of each of the plungers having an aperture **39** extending diametrically therethrough and the lower end of each plunger being slidably received in a bore **41** extending downwardly in the body member **11** from the bottom of an elongated transverse recess **42** provided below the tuning changer unit **22**. The instrument shown in the drawings by way of illustration comprises four such plungers designated generally as P_{14}, P_{15}, P_{17}, and P_{18} (Fig. 3) to indicate their association and coaction with strings **14**, **15**, **17**, and **18**, respectively, the end portions of the strings extending through the apertures **39** adjacent the upper ends of the plungers whereby the strings may be deflected transversely for varying the tension thereof upon downward movement or depression of the plungers. In the present embodiment of the invention, plungers are not provided for the strings **13** and **16** and the latter, therefore, retain their original tension as determined by the tuning keys **21**.

For actuating the plungers, a rotatable cam barrel **43** extends transversely between the upright sides **28** and **29** of the tuning changer **22**, one end of the barrel **43** having a shaft portion **44** of reduced diameter journaled in the side member **28** and the opposite end of the barrel **43** having a similar shaft portion **46** of reduced diameter journaled in a bearing sleeve **47** which is frictionally retained in an aperture **48** in the opposite side member **29**. The outer end of the bearing sleeve **47** is formed with an annular flange **49** extending into contact with the side member **29**. An operating handle **51** is secured, as by a screw **52**, to a flattened end portion **53** on the shaft portion **46**, the flattened end **53** being received within a corresponding socket **54** in the handle **51**. The exterior of the cam barrel **43** is formed with a plurality of recesses or cutaway portions and a plurality of integral radially projecting cam surfaces, such as indicated at **56** in Fig. 3, the cam surfaces being selectively distributed over different portions of the barrel **43** for coacting with the upper ends of the plungers P whereby to depress the latter upon rotation of the handle **51** to engage the cam surfaces with the plungers. A radially extending pin **57** is detachably affixed to the cam barrel **43** adjacent the side member **29** for engaging a pair of oppositely disposed stop members in the form of retaining pins **58** extending inwardly from the side wall **29** whereby to limit rotary movement of the barrel **43** as effected by the handle **51**.

It will be seen that the tuning changer mechanism may be readily disassembled by removing the screw **52** to detach the handle **51** from the shaft portion **46**, removing the pin **57** from the barrel **43**, and then withdrawing the bearing sleeve **47** outwardly from the aperture **48**. The cam barrel **43** may then be withdrawn endwise from the tuning changer through the enlarged aperture **48**.

Because the plungers P are mounted for free sliding up-and-down movement within the bores **41**, it will be seen that the plungers are normally retained in their upper or elevated positions, as seen for example at P_{15}, P_{17}, and P_{18}, in Fig. 3, merely by the normal tension of the undeflected strings. However, when the cam barrel **43** is so rotated as to bring one or more of the cam surfaces into coacting engagement with the upper end of one or more cooperating plungers, for example as shown in Fig. 3 where the cam surface **56** is in engagement with the upper end of the plunger P_{14}, the respective plungers are then depressed downwardly thereby deflecting the corresponding strings at their deflectable end portions in order to vary the tension threof. Upon subsequent rotation of the cam barrel **43** to a different rotary position, the cam surface **56** is disengaged from the plunger P_{14} and the plunger is then restored to its normal elevated position by the original fixed tension of the string **14** as determined by its associated tuning key **21**.

For adjusting the normal elevated positions of the plungers relative to the cam barrel **43** and for retaining the ends of the deflectable strings **14**, **15**, **17**, and **18**, an elongated pivoted member or lever, indicated generally at **59**, is provided for each of the plungers P_{14}, P_{15}, P_{17}, and P_{18}. The levers **59** are formed with generally horizontal

central portions 61 (Fig. 4) each having an upstanding projection or bridge portion 62 and an enlarged aperture or opening 63 therein through which the corresponding plunger extends vertically. The ends of the levers 59 are bent upwardly and outwardly on either side of the central portions 61, as indicated at 64 and 66 (Fig. 4), the innermost end 64 of each of the levers 59 being bifurcated, as at 67 (Fig. 2). The extremities of the bifurcated end portions are provided with a pair of pivot points in the form of knife edges 68 (Fig. 4) which are received in a cooperating elongated groove 69 at the upper inner edge of the fixed bridge 33 whereby the levers 59 are mounted for pivotal or rocking movement relative to the bridge 33. The strings 14, 15, 17, and 18 extend across the corresponding notches 36 at the upper edge of the bridge 33, through the bifurcated ends 67 of the levers 59 and through the apertures 39 in the plungers, and thence across the upright bridge portions 62 on the central portions 61 of the levers 59. The retaining members 37 at the ends of the strings are each firmly secured in a keyhole slot 71 provided in the upwardly bent outer ends 66 of the levers 59.

By the above described construction it will be seen that each of the deflectable strings extends through an aperture 39 in a plunger P which upon downward movement is adapted to exert a vertical pull on the string thereby deflecting the same downwardly to increase the string tension. As the plunger P is depressed downwardly in its corresponding bore 41, the associated string is deflected downwardly by engagement with the interior of the aperture 39, the string being retained at opposite sides of the plunger by means of the fixed bridge 33 and the bridge portion 62 on the corresponding pivotally mounted lever 59.

An important feature of my invention is the provision of adjusting means for regulating the extent of movement of the plungers by the rotatable cam means whereby to vary the tuning effected by the cams without altering the original fixed tuning of the strings. To this end, the rear or outer end 66 of each of the levers 59 is provided with a horizontally extending portion 72 for actuating the lever 59 to effect pivotal movement thereof about the groove 69 in the fixed bridge 33. An upright adjusting screw, indicated generally at 73, is provided adjacent the actuating end 72 of each of the levers 59 and is threaded into the cross member 32 for vertical movement relative thereto, the lower end of the screw 73 extending downwardly into an enlarged bore 74 provided in the body member 11 below the cross member 32. The upper portion of each screw 73 is formed with a pair of spaced upper and lower shoulders 76 and 77, respectively, with the actuating end 72 of the lever 59 being received between the shoulders 76 and 77. Above the shoulder 76 is a knurled head or cap 78 for manually moving the screw 73 upwardly or downwardly whereby the shoulders 76 or 77 engage the actuating end 72 of the lever 59 to effect pivotal movement of the latter. By manipulation of the screw 73, it will be seen that the elevation of the outer end of the lever 59 having the corresponding string anchored in the keyhole slot 71 therein can be regulated to move the deflectable portion of the string upwardly or downwardly, as desired, for coaction of the plunger P carried thereon with the actuating cam barrel 43, the enlarged aperture 63 providing sufficient clearance to permit the lever 59 to pivot relative to the plunger P. Inasmuch as both the strings and the levers 59 pivot about substantially the same point on the fixed bridge 33, as will be clear from Fig. 4, it will be apparent that such pivotal adjustment of the levers 59 cannot change or otherwise effect the tension of the strings attached thereto.

Thus, my invention provides for altering the tension of the strings by exerting a localized transverse downward pull on the same intermediate their anchored or rigidly held ends. By avoiding any change in the positions of the fixed ends of the strings during operation of the tuning changer mechanism, there is no tendency for the initial fixed tuning of the strings to be disturbed. When a plunger P is restored to its normal elevated position, the tension of the associated string is uniformly restored to its initial value as determined by the setting of the appropriate tuning key 21.

Dependent upon the particular arrangement of the cam surfaces on the cam barrel 43, the normal elevated positions of the plungers P may be adjusted for coaction with the particular cam surfaces by manipulation of the screws 73 to effect pivotal movement of the levers 59. As hereinbefore described, pivotal movement of the levers 59 will also effect pivotal movement of the end portions of the strings anchored therein without changing the original fixed tension of the strings as determined by the tuning keys 21 because of the common pivot points of the knife edges 68 and the strings on the fixed bridge 33. As the deflectable end portions of the strings are thus pivoted upwardly or downwardly upon adjustment of the screws 73, the plungers P carried on the strings will be moved away from or toward the cam surfaces on the barrel 43 by the tension of the strings. Thus, the extent of movement of the respective plungers by the cams may be adjusted to vary the tuning effected by the cams without altering the original tuning of the strings.

In the form of the invention shown in the drawings, the tuning changer may be operated to obtain any one of three different tuning patterns corresponding to three predetermined positions of the cam barrel 43 and the plungers P actuated thereby.

Referring now to Figs. 5, 6, and 7, a series of fragmentary sectional views are shown to illustrate the positions on each of the plungers P_{14}, P_{15}, P_{17}, and P_{18} in the three different tuning patterns corresponding to the three positions of the handle. Thus, in Fig. 5 with the handle 51 in its upright or center position, it will be seen that plunger P_{14} is depressed by engagement at its upper end with a coacting cam surface on the barrel 43 whereby to deflect and increase the tension of the string 14, the string being retained on one side of the plunger P_{14} by the fixed bridge 33 and on the other side thereof by the upright bridge portion 62 on the lever 59. In this position of the handle 51 the cutaway or recessed portions on the cam barrel 43 are so oriented that each of the plungers P_{15}, P_{17}, and P_{18} remain in their normal undepressed positions. In Fig. 6, the handle 51 is in its rearward or extreme right-hand position and the cam surfaces on the barrel 43 are so positioned as to depress the plungers P_{14}, P_{15}, and P_{18} whereby to increase the tension of the corresponding strings 14, 15, and 18. The plunger P_{17} remains in its normal elevated position with the string 17 retaining its original fixed tension. In Fig. 7 the opposite or forward position of the handle 51 is illustrated and in this case only the plunger P_{17} is depressed

by means of a coacting cam surface on the barrel 43.

It will be understood that numerous variations of the above described tuning patterns may be obtained by means of the tuning changer comprising my invention. For example, by varying the extent, the distribution, and the number of radially projecting cam surfaces on the cam barrel 43, different combinations or predetermined groups of strings may be subjected to increased tension corresponding to certain angular or rotary positions of the barrel 43. Furthermore, the number of plungers P employed in any given instrument may be varied in order to increase or decrease the number of possible changes in the tuning pattern. In addition, it will be evident that the normal elevated positions of the plungers P may be individually adjusted by means of the adjusting screws 73 and the pivotally mounted levers 59 in order to control the extent of the camming action between the cam surfaces and the plungers and thereby regulating the degree of deflection imparted to the strings.

In Fig. 8 there is shown a modified form of the cam barrel comprising a multiple-part construction rather than the integral one-piece construction illustrated at 43 in Figs. 1 to 7. In this form of the cam barrel, a shaft or axle, indicated generally at 81, is provided having a central portion 82 of square cross-section and end portions 83 and 84 of circular cross section for journaling the shaft 81 in the tuning changer mechanism. A plurality of separate cam elements and spacer members having square openings corresponding to the cross-sectional shape of the central portion 82 of the shaft 81 are fitted on the shaft and arranged thereon in any desired distribution. For example, in the arrangement shown in Fig. 8, the shaft 81 is provided with two single throw cam elements 86 and 87 extending in diametrically opposite directions from the shaft 81. In addition, there is provided a double throw cam element 88 adapted to effect camming action in directly opposite rotary positions of the shaft 81. A modified double throw cam element 89 of segmental configuration is also disposed on the shaft 81 for effecting camming action in successive or adjacent rotary positions of the shaft 81. A plurality of square spacer elements 91 are disposed between the several cam elements as required to obtain the desired spacing thereof and to retain the same in assembled position. It will be seen that this modification of the cam barrel construction permits even greater flexibility in the number of available cam actions for effecting different changes of the tuning pattern of the instrument.

The string-tensioning mechanism herein described is a compact device of relatively simple construction which is adapted to be installed on existing stringed instruments as well as in new and specially designed instruments. Because the string-deflecting members or plungers engage the strings transversely intermediate the anchored ends thereof, the disadvantages inherent in certain of the prior art devices are completely avoided. By means of my device the end portions of the strings are retained in fixed position at all times, once the basic or initial tuning of the strings is established and there is, therefore, no tendency for the initial fixed tuning of the strings to be disturbed by use of the tuning changer. Furthermore, all cumbersome foot pedal arrangements and the like have been eliminated in my invention and rapid tuning changes may be executed by means of a simple hand lever located conveniently to the playing area and readily accessible to the hand of the player. The nature of my string-tensioning mechanism is such that innumerable variations in range and flexibility of the device may be achieved dependent upon the design of the cam barrel and also dependent upon the individual adjustments of each of the plungers relative to the actuating portions of the cam barrel.

Although the invention has been described in connection with one particular embodiment thereof, it will be understood that various modifications and equivalent structures may be resorted to without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of said strings comprising a plurality of reciprocable string-deflecting members operatively attached to the strings intermediate the ends thereof, cam means for actuating said members to vary the tension of the strings by transversely deflecting the same in response to movement of said cam means, lever means pivotally mounted adjacent each of said members and having the end portions of the strings anchored thereon, and means for adjusting the pivotal positions of said lever means whereby to move the end portions of the strings and their attached string-deflecting members away from and toward said cam means.

2. In a stringed musical instrument having a plurality of strings tensioned thereon, a fixed bridge having the strings extending across and beyond the bridge, a plurality of members attached to the respective strings beyond the bridge and movable transversely of the strings, the tension of the strings tending to hold said members in a predetermined position, cam means for moving said members away from said position to vary the tension of the strings, and a plurality of levers swingable about said bridge to vary the position of the portions of the strings beyond said bridge and the predetermined positions of said members, the tension of the strings remaining constant during the swinging movement of said levers.

3. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of said strings comprising a fixed bridge having the strings extending thereacross, a plurality of elongated levers extending longitudinally of the strings, each of said levers being pivotally engaged at one end thereof with said fixed bridge and each having a string anchored to the lever at the other end thereof, a plurality of string-deflecting members each being slidably mounted adjacent one of said levers and operably connected to the associated string at a deflectable portion thereof intermediate the ends of the lever, and cam means directly engageable with said string-deflecting members for moving the latter transversely of the strings whereby to alter the string tension, said levers being pivotally adjustable for moving the deflectable portions of the strings and the string-deflecting members connected thereto away from and toward said cam means.

4. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of said strings comprising a fixed bridge having the strings extend-

ing thereacross, a plurality of elongated levers extending longitudinally of the strings and each pivotally engaged at one end thereof on said fixed bridge and having end portions of the strings anchored thereon, a purality of reciprocable upright string-deflecting members each slidably disposed adjacent one of said levers and having operably attached thereto the associated string intermediate the ends thereof, rotatable cam means directly engageable with said string-deflecting members for depressing the latter whereby to alter the tension of the strings, and means for adjusting the pivotal positions of said levers whereby to move the end portions of the strings and their attached string-deflecting members away from and toward said cam means, each of said levers and its associated string pivoting about substantially the same point on said fixed bridge whereby the tension of the string remains unchanged during pivotal adjustment of the levers.

5. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of said strings comprising a fixed bridge having the strings extending thereacross, a plurality of elongated levers extending longitudinally of the strings each being pivotally engaged at one end on said fixed bridge and each having one of said strings anchored thereon beyond said fixed bridge, each of said levers having an enlarged aperture intermediate the ends thereof, a plurality of upright reciprocable string-deflecting members each extending through the aperture in one of said levers and being operably connected adjacent its upper end to the associated string, and rotatable cam means directly engageable with the upper ends of said string-deflecting members for depressing the latter whereby to alter the tension of the strings, the enlarged apertures in said levers permitting pivotal movement of said levers relative to said fixed bridge whereby to move the end portions of the strings and the string-deflecting members connected thereto away from and toward said cam means.

6. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of said strings comprising a plurality of reciprocable upright string-deflecting members operably attached to the strings intermediate the ends of the latter, rotatable cam means directly engageable with said string-deflecting members for depressing the latter whereby to alter the tension of the strings, a plurality of elongated levers each being pivotally mounted adjacent one of said string-deflecting members and having an end portion of one of said strings anchored thereon, said levers each having a rearwardly extending actuating portion for effecting pivotal movement of the lever, and a plurality of adjusting screws in operative engagement with the rearwardly extending portions of said levers for adjusting the pivotal position of the latter.

7. In a stringed musical instrument having a plurality of strings tensioned thereon, means for selectively varying the pitch of the strings comprising a fixed bridge having the strings extending thereacross, a plurality of movable anchor members each having the end portion of a string anchored thereon beyond said bridge, a plurality of string-deflecting members operably connected to the strings intermediate said bridge and said anchor members and movable transversely of the strings, cam means for actuating said string-deflecting members to vary the tension of the strings by transversely deflecting the same, and adjusting means coacting with each of said anchor members for moving the anchored end portions of the strings pivotally about the bridge away from and toward said cam means.

8. The device of claim 7 further characterized in that said cam means comprises a rotatable cam shaft extending across the strings and a plurality of radial cam members detachably mounted on said shaft for engagement with said string-deflecting members.

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