(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 294 742 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88108998.1**

(51) Int. Cl.⁴: **G10F 3/00**

(22) Date of filing: **06.06.88**

The title of the invention has been amended (Guidelines for Examination in the EPO, A-III, 7.3).

(30) Priority: **07.06.87 CN 87104074**

(43) Date of publication of application: **14.12.88 Bulletin 88/50**

(84) Designated Contracting States: **DE FR GB**

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(54) Interactive programme-controlled musical apparatus.

(57) With the development of society, people are becoming more and more musically-minded.But the accelerating rhythm of life has deprived most people of the time people should spend practising if they want to acquire the accomplishment to play the piano; as a result, most pianos have to fritter away their time in loneliness. But on the contrary, the "rush for pianos and electronic instruments" causes the pianos and electronic instruments which are in great demand now in China to be most expensive decorations.

Where is the way to overcome the difficulty in the performance of the piano? The man-machine musical programme-controlling apparatus will help you realize easily the dream of playing the "high-brow", elegant music by yourself, thus making your piano or electronic instrument your dearest companion to express your musical emotions.

The man-machine musical programme-controlling apparatus has applied the musical information. data-processing technique, which enables people to acquire the programme-controlling ability in sight-playing and performance. The player can play, without touching the keyboard, any music which can express his emotions by applying necessary force, rhythm and speed; so, those who lack the conditions for musical training and long-time-hard-practice can acquire in no time the ability to perform any difficult and complicated music.

From what we mentioned above, this invention, in a word, has solved the technical problem which people have wished to solve for ages.

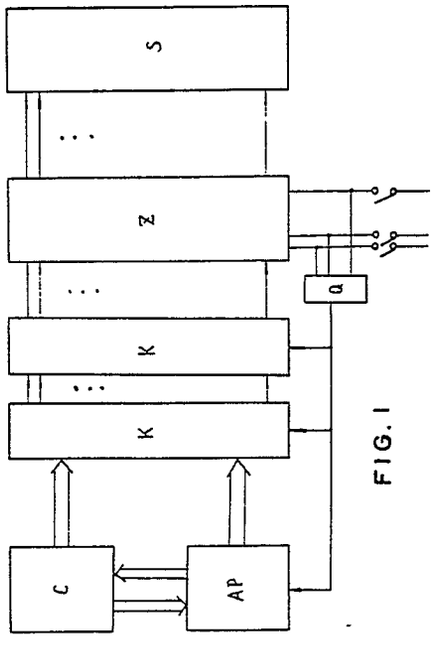


FIG. 1

EP 0 294 742 A2

A Man-Machine Co-operative Musical Program-Controlled Apparatus and Its Special Score Instruction

Controlled Apparatus and Its Special Score Instruction

The present invention relates to the data processing, storage,reproduction and associated devices of music score information.Particularly,the invention relates to a specific score instruction and a man-machine co-operative musical program-controlled apparatus capable of performing in accordance with this score instruction.

Now,the attempt of trial-manufacture of music performing robot is being explained.The expensive capital cost,works against its production,and,moreover,its automatic performance can not be fully expressive of a human player's emotions as he does freely,nor can it help the less musically-trained people and those with less suitable circumstances for long years of laborious practice to acquire in a short time the capability of performing elaborate music.

The invention is aimed at helping those mentioned above to gain the performing capability in a short time.

The above stated intention is to be realized through the method for coding the score instruction and the man-manchine co-operative program-controlling apparatus,thus to enable them to obtain the program-controlled capability in score performing at sight and performance fingering, and as a result to fully express his(or her) musical emotions freely in rhythmic beat and dynamics.

The method for coding the score instruction according to the invention is:corresponding to the number M of keys of the performing instrument (for example,piano,electronic synthesizer,etc.),a binary number of M bits is generated by the data processing of a computer with respect to the notes to be played simultaneously or not to be played at the same time in accordance with the naturally continuous procession of the score information fermata,renewal, overlapping, and rest,to form the primary bits of the score instruction,and appending other control information that doesn't participate in transposition to the primary bits to form the secondary bits of the score instruction. The rest may be deduced by analogy.Applying data processing to the notes to be played or not to be played in the successive score information to form the primary bits of the score instruction and the appending the secondary bits of the score instruction to it respectively.All score instruction (including primary bits and secondary bits) are transmitted into the storage device sequentially via the computer to produce various kinds of score instruction firmwares of ROM,EPROM,magnetic tape,floppy or hard disc,cartridge store,optical disc,digital record,and etc., for use and sale.

In the score instruction coded with the method,a set of score instructions comprises primary bits and secondary bits.Transposition processing can be applied by means of shifting,multiplication,division and etc. to the primary bits of the score instruction without altering the internal interval relations;each bit of the primary bits of the score instruction and each of the keys of the piano,correspond to each other and control the keys together with the control keys.The number of bits of the uncompressed primary bits is equal to or greater than the total number of control keys;the secondary bits of the score instruction and the non-key controlled units correspond to each other;the number of bits of the uncompressed secondary bits is equal to or greater than the total number of non-key controlled units.

The man-machine co-operative program-controlled apparatus is formed from computer unit,storage unit,control circuit,executing unit,and request signal generator.

The computer unit can be a micro-computer or any other with similar function,which is to input into the storage device the score instruction produced by the method stated above;or to fetch the score instruction kept in the storage device and transmit it to the control circuit in response to the request signal.

The storage can be composed of magnetic tape driver,floppy disc driver,hard disc driver,cartridge recorder,optical disc,digital record,various kinds of ROM and EPROM.Its function is to store the compiled score instructions.At the time when performance sets in,once a score instruction floppy disc prepared in advance is inserted into the storage device,and the computer is initiated,the first set of score instruction in the floppy disc is fetched from the storage device and transmitted to the control circuit.

The control circuit mainly comprises electronic units of latches and the like.It falls into two part:the input and the output.The function of the output part is to output the preceding set of binary score instruction as the operating instruction of the controlled unit(key).The function of the input part is to accept the succeeding set of score instruction fetched from the storage.

The executing facility can be electronic executing facility,mechanical executing facility, or electromechanical executing facility.One of its functions is to transmit a request signal to the computer through the trigger of the switch of a signal gener-

ator by the motion of its control key,and the other is to control the motion of the controlled unit(key) along with the operating instruction output from the control circuit.Herein,mechanical executing facility is used to drive the keys of a mechanical piano or those keyboard musical instruments,while electronic executing facility is used to control the toggles of the keys of an electronic synthesizer or electronic piano,and the electro-mechanical executing facility can be used in electronic synthesizer and mechanical piano.Each of these three executing facilities is provided with 1-99 control keys, the popularized type with 1-10 control keys.

The request signal generator is made from a monopulse generating unit.Its input comes from a request signal switch adjacent to the control keys.When the control key operates, it triggers the request signal switch,thus delivers an instruction signal to the request signal generator.The output terminal of the request signal generator is connected to the control circuit and the computer.

No matter what kinds of executing facilities they are, their internal structure are all designed and constructed in accordance with the logical expressions or their negative logical expressions as follows:

(1) Qmn = Km• Dn

(2) Yn = Qmn = Km•Dn

(3) Yn = Q1n + Q2n + ... + Qmn

Where,Km stands for the logical status of the control key of a certain serial number;

Dn for the logical status of the bit of a certain serial number in the binary operating instruction;

Qmn for the result of the logical "AND" operation of the logical status of the control key of a certain serial number and the logical status of the bit of a certain serial number in the operating instruction;and

Yn for the logical status of the controlled unit-(key).

The executing facility designed and constructed according to the above logical expressions has the following features:from logical expression(2),we can see that the status of the controlled unit changes only as the output data and the control key act concurrently,that is,the musical instrument won't sound if the control key does not operate, through with instrument given.The instrument won't sound either as the key does operate,but with not instruction whatever given.The musical instrument does sound only when the control key operates and an instruction is supplied.But whichever of the keys is to be played is not determined by the control key but by the instruction.This feature enables the performer to obtain super capability in performing at sight score and fingering skill of performance.

We can see from logical expression(3),that the consecutively output instructions can be added together. That is,if a key is pressed without loosening,the instruction performs a chord,if other keys are pressed,then the chords and melodies performed by those keys can be overlapped with the first chord.This feature is extremely necessary to musical performance.

In view of the entire apparatus,press the control keys one after another,and the computer will transmit the instructions stored in the storage device to the control circuit in succession,which outputs the instructions in succession simultaneously,and drives the controlled unit in co-operation with the control keys;then the instrument will perform well in succession.The performers are able to play only by pressing the control keys a variety of prefabricated pieces of music of various difficulties unrestrainedly with tone,rhythm,and metre.

The man-machine cooperative musical program-controlled apparatus enables performers to obtain program controlled capability of the technique in sight-performin score and performance fingering by using the date processing technique of musical information.Instead of the keys of the musical instrument,the performers need only to press the control keys,they can perform the pieces of music in any required dynamics,rhythm,and pace to express the emotion of the performers,thus enables those lacking special musical training and constant hard exercises to perform elaborate and complicated musical pieces.

As a result of invention,not only the expressive function of the controlled keyboard instrument is unproved,but the merits of the keyboard instrument are also reserved, such as the function of consecutively overlapping the notes, providing a very pleasing crescendo effect,and it is impossible for ordinary electronic synthesizers to insitate such performing method,which significantly improves the performing function of the electronic synthesizers.When the invention is applied to the piano,the features of its tone control,volume control,and dynamics control can all be reserved and developed.

The expressive power of the invention is embodied in fingering.This solves the problem that the expressive power of the electronic synthesizer is limited to the expression pedal(repenter pedal)-,which has long been tackled since its emergence,a great leap forward to the needs of performance.

There is also the function of flexible transposition, which can be realized merely by pressing the key.

The present invention extends the area of creative music work.As has always been the case,creative music work is limited by the skill of performance as one can not play the chord of eleven notes with ten fingers.However,the present invention allows the composer's imagination full

play to create his music work ,88 notes can be performed simultaneously as easily as turning one's hand over. Therefore,it is not necessary at all for the composer to confine his work to fingering skill and to worry about the difficulties in performance.

To sum up,the invention has solved the technical problem,which has long been tackled but remains unsolved yet.

The following is a brief description of an embodiment of the invention in the light of the figures:

Fig.1 illustrates the block diagram of the principle of the man-machine cooperative musical program-controlled apparatus according to the present invention.

Fig.2 illustrates the principles of an embodiment of the electronic executing facility of the man-machine cooperative musical program-controlled apparatus according to the present invention.

Fig.3 illustrates the side cutaway view of an embodiment of the machanical executing facility of the apparatus according to present invention.

Fig.4 illustrates the contour of the machanical executing facility.

Fig.1 is the principle diagram of the man-machine cooperative musical program-controlled apparatus according to the present invention,herein-(c)denoting the storage device,(AP) the computer unit,(K)the control circuit,(Z) the executing facility,-(S) the controlled devices (for example electronic synthesizer or machanical piano),and (Q)the request signal generator.

Fig.2 illustrates an embodiment of the man-machiene cooperative musical program-controlled apparatus according to the present invention with the electronic executing facility therein.The notations in the figure are the same as in fig.1.

In Fig.2,the embodiment of the control circuit designed constructed according to the above stated logical expressions (1),(2),and (3), is mainly composed of electric elements such as latches and the like.The latch of the input part of the control circuit has output control gate named B, and the latch of the output control part has allowing input gate named C.Their logical relations with request signal A are:B = A,C = A.When there is no request signal,B causes the input part towards the output part parallelly,determining a binary score signal of the status of the controlled units as executing instruction,and C causes the latch of the output part to received parallelly the above stated binary executing instruction.When a request signal is being applied,B causes the latch of the input part to close off the output gate, and receive a new binary score instruction,output from the computer and storage device.C causes the output part to refuse the new instruction from the input part,and continue parallelly outputting the latched original instruction,until the request signal A changes.

The latches filled in the input and output parts of the control circuit respectively are latches (8D)-74LS373, which is a kind of transparent latch of type D.When the allowing terminal (pin11 of LS373)is high-level,output (pin 2,5,6,9,12,15,and 16) will follow the data input (pin 3,4,7,8,13,14,17,and 18).When the allowing terminal is low-level,the output terminal will be latched on the created data level.The present embodiment connects all the output control pin 1 and the allowing terminal pin 11 of 74LS373 used in the control circuit to the request signal A via inverters,as shown in the figure,to be made to corres pond to the logical expression $B = A, C = \overline{A}$.

In the present embodiment,the operating instruction output by the control circuit can be displayed on each of the keys with LED.

The electronic elements used in the electronic executing facility of the present embodiment are mainly 8 D74 LS373. They form 88 gate circuits in one-one connection with the 88 keys respectively.The connections will be made to correspond to the logical expressions $Qmn = Km \bullet Dn, Yn = Qmn = Km \bullet Dn$ and $Yn = Q1n + Q2n + ... + Qmn$.

In the executing facility,switches and repeaters are used to construct control keys,control keys can be constructed together with repeaters(electronic elements able to modulate electric current and voltage),so as to control the volume of notes.Every control key,capable of controllign the total volume of the instrument performance,is to regulate the electronic synthesizer to perform in accordance with the required volume,dynamics,and rhythm.

The operation of the whole man-machine cooperative musical program-controlled apparatus is as follows:

Insert the pre-fabricated score instruction floppy disc into the driver,initiate the computer,and the first set of score instructions stored in the floppy disc is transmitted to the corresponding 74 LS373's of the executing facility via the input and output parts of the control circuit.

When pressing a certain control key,the allowing terminals (pin11) and output control terminals (pin1) of all 74 LS373's connected to this key change from high-level to low-level immediately,making these 74 LS373's stop receiving new score instructions,and outputting the first set of score instructions parallelly to the corresponding switches of the keys of the electronic synthesizer,and these keys sound accordingly.

At the same time the control key is being pressed, the request signal circuit is caused to delever signal making all the allowing terminals-(pin11) of 74LS373's in the output part of the control circuit change from high-level to low-lev-

el,and causing all the output terminals(pin1) of 74LS373's in the control circuit to change from low-level to high-level temp orarily,so as to temporarily make the output part of the control circuit stop receiving score instructions from the input part.

At the same time when the control key is being pressed, the request signal circuit is made to deliver signal causing the computer to output the second set of score instructions and transmit it to every 74 LS373 in the input part of the control circuit.

Several milliseconds after the transmission, the request signal circuit causes the input part of the control circuit to transmit score instructions to the output part again,and the score instructions are all 74 LS373's in the executing facility connected to the unpressed control keys.

When the control key is pressed the second time,the instrument will play new notes according to the second set of score instructions,and reserve the sounded notes if the pressed key at the first time is not released yet.

When the control key is pressed at the second time, the instrument will play the notes only according to the new score instruction,if the previouly pressed key has been realeased.

Press the control keys in their order of time value, rhythm, and dynamics of the score instruction,and the program-controlled instrument,or synthesizer,or piano will perform musically in harmony with the performer's emotions.

The mechanical executing facility works in the same manner as the electronic executing facility,and uses the same logical expressions.

Referring to Fig.3 and 4 ,the following is the description of an embodiment fo the mechanical executing facility designed and constructed according to the above-stated logical expression(1),(2),and (3).

The notation 1 in Fig.3 represents keys of a mechanical piano,notation 2 represents the ocntrol keys of the man-machine co-operative musical program-controlled apparatus. The control key is a Z from long bar as shown in the figure, notation 3 represents the striking string mechanism that makes the piano sound;notation 4 represents the coil of the electro-magnet;notation 5 represents the bar arm of force;notation 12 represents a swing rod able to move forwards and backwards,upwards and downwards, the upper towing band 6 of the swing rod is suspended on the upper panel of the piano,the towing bands 6 at the lower ends of the swing rods 12 are connected to the keys of the piano,on the swing rod there is a small protruding suspending block;notation 7 repreents the transmission rod, the upper end of which is connected to a thin strip11, known as the transmission bridge, and at its lower end there is a hook crooked toward the swing rod,which is used in cooperation with the protruding block on the swing rod 12 to pull the rod upward and downward;notation 9 represents a principal support fixed on the frame 10 of the piano; a group of 1-99 levers 14 is stretched parallelly from the principal support;attached to the other end of the lever 14 is an supporting axle 8,the length of which approximately equals the width of the piano keys;on the bottom surface of the lever 14,a request signal switch 13 is fixed;the transmission bridge 11 is fixed on the control key 2,and attached to the supporting axle 8 from below,and rotating round the supporting axle.

The said electro-magnet coil 4 is fitted on plate 15, which is fixed on the upper panel of the piano,and on which 88 small holes are drilled,facilitating the rods of the arm of force to apply a force to the swing bar through the holes;

The operation of the mechanical executing facility is as follows:

After the executing facility has received the previous executing instruction from the control circuit,the electric current passes or no current passed through the 88 electro-magnetic coils 4 or Fig.3 in accordance with the 88-bit binary executing instruction.For the electro-magnet through which current passed,a magnetic force is generated,which causes the head of the rod of arm of force to apply a force to the swing rod 12 through the small holes on the plate15. The swing rod moves to the left under the action of the force,which causes the small protruding block higher than the position of hook on the lower end of the transmission rod 7,positioning the swing rod 12 in a state towable by transmission rod 7.

At the same time the piano performer presses the control keys,the transmission bridge 11 is towed upwards,the movement of the transmission bridge pulls the transmission rod 7 to move upwards.When the transmission rod moves,the hook at its lower end pulls the swing rod 12 already in movable state to move upwards.The upward motion of the swing rod 12 pulls the towing band 6 at the lower end of the swing rod 12,and causes the rear part of key 1 to move upwards accordingly,this motion of the key 1 equals the motion on playing the piano,so as to make the piano sound by striking string mechanism 3.

When the piano performer presses the control key,the transmission bridge 11 is made to move upwards,thus triggering the request signal switch,and inputting a signal to the request signal generator, which in turn delivers a request signal to the computer and the control circuit.In response to this request signal,the computer fetches the next set of score instruction from the storage device,and transmits it to the control circuit,thereby making the preparations for performing the next set of score

instruction.

Referring to fig.5,the following is the description of another embodiment of the mechanical executing facility designed and constructed in accordance with the said logical expressions (1),(2),and (3).

Notation 1 in Fig.5 represents the keys of a keyboard instrument,notation 2 represents the control keys of the man-machine co-operative musical program-controlled apparatus;the control key is T-shaped as shown in the figure.the vertical part of the control key can swing round the intersection axle.Notation 4 represents the electro-magnet coil, notation 105 represents an arm rod of force,notation 112 represents a swing rod rotating round the axle centre, the upper end of an up and down movable transmission rod 107b is fixed on the bearing of the swing rod 112,the width of 88 transmission rods 107b standing on the corresponding keys approximately equals and is less than the width of the keys,the transmission rod is a flake rod,there is a locating gap 115 on the transmission rod for restricting the position of the rod,notation 107a requests a transmission rod parallel to the keyboard and approximately as long as the keyboard,the side view of the transmission rod looks like a cross;the rod may also be shaped like a square, or other ortho-polygons.Both ends of the transmission rod 107a are fixed on the bearings of 108a.A thin strip 111 known as the transmission briege is touched to the underside of the transmission rod 107a,the length of the transmission bridge 111 equals that of the transmission rod 107a,the thin strip on the transmission bridge is a little wider than the transmission rod, one side of the thin strip is close to the transmission rod 107b and swing rod 112,the other side of the thin strip and the supporting rods stretched from the two ends of the thin strip are fixed on thebearings 108b,the transmission rod 107a and spring 116 push the transmission bridge 111 to move up and down round the bearing 108b.A request signal switch 13 is fitted under the transmission bridge 111,every mevement of the transmission bridge 111 can trigger the request signal switch 13.A step motor 116 is connected to transmission bridge 111.

The said electro-magnet coil 4 is fitted on the principal support 109,the side view of the entire support looks like a reduced upright piano,and the aerial view of it is like "⌐ ",and like a table tennis net clips clipping both sides of the keyboard.An arm rod 112 of force is suspended from the electro-magnet coil 4,when the rod 112 is driven by electro-magnet coil,it can apply a force to the swing rod112.

Under the control key and parallel to the keyboard, a pause swing needle towing rope 114b is fitted,the control key works,pressing down the towing rope 114b,and the towing rope tows a needle line comprising 88 elastic steel wires, known as the pause swing needle 114a,to swing toward the locating gaps 115 on the 88 transmission rod 107b. Each swing needle corresponds to one and only one transmission rod 107b.A electro-magnet coil 117 is connected to the pause swing needle 114a.

The operation of the present embodiment of the mechanical executing facility is as follows:

After the executing facility has received the preceding executing instruction from the control circuit,current flow through certain electro-magnet coils 4 of figure 5,in accordance with the 88 bit binary operation instruction.

The electro-magnet coil 4 with current flowing through can produce a magnetic force to cause the lower end of the arm rod of force 5 to move and aply a force to the swing rod 112. Swing rod 112 swings under the action of the force,and its upper end stretcher to the undersids of transmission bridge 111, and makes the transmission bridge and transmission rod 107b connected like the function of a clutch.

On pressing the control key,the performer pushes transmission rod 107a pushes to rotate an angle of 90°, which causes the transmission bridge to move downward and upwards once,and also pushes down once those transmission rods 107b in the state of connection with the transmission bridge through the swing of the swing rods.Then transmission rods 107b directly drive the keys of the instrument.

If the control keys are not released,the towing rope 114b pushed down by the control key pulls the pause swing needle 114a swinging towards the locating gaps 115 on the transmission rods 107b that have been pressed down,causes the transmission rod 107b to be unable to return to their original position,so as to cause the instrument keys unable to return to their original position and to sound continuously. When the control key returns to its original position,the pause swing needle returns to original position too,and stops sounding,this is the sounding time value controlled by the control key.Because of the clutch function of the swing rod112,the control key 2,the transmission rod 107a, the transmission bridge 111,the transmission rod 107b, and the instrument key form a connected relation,so the control key can regulate the volume of the sound directly.

On pressing the control key,the performer drives transmission bridge 111 to move downwards,thereby triggering the request signal switch so as to make preparations for performing the next set of score.

Transmission rod 7a can also be driven to rotate by the step motor 116,while the pause swing needle 14a can also be driven to swing by the

electro-magnet coil 117,both of them are under the control of the secondary bits of the score instruction.The secondary bits associated with the primary bits of the instruction drive the instrument key to perform automatically,the performer can cooperate with the program-controlled apparatus through the control keys,controlling the dynamics,rhythm,and pace of the performance to express his emotion in music.

The mechanical executing facility is also designed and constructed in accordance with the said logical expression(1), (2),and (3).During performance,the force applied to the control key is transmitted to the controlled units through the transmission mechanism,and makes those units change in motion,for example,making the piano keys operate striking the strings,and the performer can control the dynamics freely, implementing said logical expression with transmission mechanism in various ways,for example,the rear ends of the instrument key can be pulled upwards with the transmission mechanism just as the front ends can be pressed downwards through the transmission mechanism to cause the instrument to sound. Both of them are within the protected scope of the present invention.

The mechanical executing facility combined with the electrionic executing facility forms the electro-mechanical executing facility.It can control a variety of controlled units simultaneously,for example,controlling the electronic synthesizer and the piano to perform together.

Inspired by the idea of the present invention,ordinary technicians can make various improvements and modifications on the control circuit,electronic executing facility and mechanical executing facility on the basis of the present invention.All these improvements and modifications are within the protected scope of the present invention.

The characteristic coding method of the score instrumentation, according to the present invention, has provided special design for the transposition (i.e. divided into primary bits and secondary bits), thus transposition can be realized easily by shifting, multiplication, and division.

The method of transposition is applying multiplication or division on the binary number of each set of the score instruction, thereby transposition towards high or low position can be achieved. For example, the binary number of the primary bits of a certain score instruction is 000010100100 (the output of this number is key C), if transposition from key C to key D is needed, the computer multiplies this binary number with 100, when the result 001010010000 is output, transposition to key D has been made on the keyboard.

Claims

1. A man-machine co-operative musical program-controlled apparatus,

Its characteristics lie, comprising

---A request signal generator, outputting request signal in accordance with the operation of the executing facility;

---A storage device, storing the binary score instructions produced with score instruction coding method in accordance with the present invention, each bit of the primary bits of the said binary score instruction determines the operating state of the corresponding controlled unit (keys of the musical instrument);

---A computer unit, fetching the first set of said score instruction and delivering it to a control circuit, after the score instruction firmware stored with the said binary score instructions is inserted into the storage device, then, in response to each request signal, fetching sets of sore instructions and sending them to the control circuit successively;

---A control circuit, formed from an input part and an output part, the function of said output part is outputting the preceding set of the said score instruction to the executing facility as operating instruction; the function of the said input part is receiving the succeeding set of the said score instruction fetched from the said storage device by the said computer unit, for future use as the next set of operating instruction;

---An executing facility, comprising 1--99 control keys, a clutch like element in the executing facility receives operating instructions, output by control circuit;

In co-operation with the control keys, driving the controlled unit to sound in accordance with the following common logical expression, control keys also control the continuously changing volume, rhythm, and pace of the notes;

(1) $Q_{MN} = K_M.D_N$

(2) $Q_{MN} = K_M.D_N = Y_N$

(3) $Y_N = Q_{1N} + Q_{2N} + ... + Q_{MN}$

The executing facility is constructed with electronic circuits and mechanical components in accordance with the said logical expressions or their negative expressions.

2. A man-machine co-operative musical program-controlled apparatus according to claim 1 is characterized by: the request signal generator comprising mono-pulse generating units. Its input comes from control keys, its output is connected to control circuit and computer unit, coordinating the operation of the present invention so that the entire instrument can work continuously.

3. A man-machine co-operative musical program-controlled apparatus according to claim 2 is characterized by: the said executing facility is an

electronic executing facility, herein the control circuit, the electronic executing facility are designed and constructed with integrated circuitry of gate circuits, latches etc. according to the logical expressions of claim 1; herein the control keys of electronic executing facility are constructed together with repeater R; the said repeater can be electronic elements with modulable power and voltage.

4. A man-machine co-operative musical program-controlled apparatus is characterized by;herein, the said executing facility designed and constructed according to the logical expressions of claim 1 is mechanical executing facility, comprising a principal support 9, 1-99 supporting axle 8, transmission bridge 11 and transmission rod 7; swing rods 12 with equal number of the intrument keys, towing band 6, electro-magnetic coil 4, and arm rod of force 5; every control key is connected to a transmission bridge capable of triggering a request signal switch 13,every said transmission bridge is connected to 88 said transmission rods 7, herein every said transmission rod 7 may be connected to the instrument key through swing rod 12 and towing band 6; the said swing rod 12 and said transmission rod 7 are separated in oridinary condition, certain electro-magnet coils are supplied with current when an operation instruction is input into said executing facility, magnetic force is thereby produced, which causes the arm rod of force 5 to push the swing rod 12 moving toward the transmission rod 7, a hook at the lower end of said transmission rod drives the small protruding block on the swing rod, providing the function of a clutch, at that time, the pressing of said control key causes the swing rod 12 moving up and down, driving the instrument key to operate through towing band 6, and making the piano sound, as well as controlling the volume of the sound, at the same time the said control key triggers said request signal switch 13, providing the function of controlled the rhythm and pace.

5. A man-machine co-operative musical program-controlled apparatus according to claim 2 is characterized by that: herein the said executing facility designed and constructed according to logical expressions of claim 1 is another mechanical executing facility, comprising a principal support 7, a transmission rod 107a, and a transmission bridge 111, which is attached to a step motor 116, bearings 108 a and 108b, swing rods 112 of an equal number of the instrument keys and transmission rods 107 b connected to them; the electro-magnetic coil 4, and the arm rod of force 105; and the request signal switch 13 are fitted under the said transmission bridge 111 and can be triggered by it; fitted under the control key are towing 114b and a pause swing needle 114 a which connects a electro-magnetic oil 117.Every transmission rod 107 b stands on each instrument key respectively, swing rod 112 and transmission bridge 111 separate when they are not driven; some of electromagnet coils pass current when an operation instruction is being input into executing facility, and producing magnetic forces causing the arm rod of force 105 to push the swing rod 112 to move toward the underside of the transmission bridge, making transmission rod 107 b touch transmission bridge 111, providing the clutch on function, at that time the pressing of sontrol key 2 makes said swing rod 112 together with transmission rod 107 b move downwards causing instrument key to operate, so as to make the piano sound and control its volume at the time it sounds, if the control key is held, then the towing rope 114 b, pressed down by the control key, pulls the pause swing needle 114 a swinging toward the locating gap 115 on the transmission rod 107 b, causing the transmmion rod 107b not to return to its original position,that is the instrument key and continue sounding, until the control key is released, sounding stops immediately, i.e., the control key controls the time value. At the time it sounds, the control key triggers the request signal switch 13, performing the function of controlling rhythm and pace.

The transmission rod 7 a can also be driven to rotate by step motor 116, and the pause swing needle 14 a can also be driven to swing by the electro-magnetic coil 117, both of them under the control of the secondary bits of the score instruction, together with the primary bits, drives the instrument keys to perform automatically, then the performen controls the dynamics, rhythm, and pace of the automatic performance through control keys to express his musical emotion in a man-machine co-operative mode.

6. A man-machine co-operative musical program-controlled apparatus according to claims 3 and 4 is characterized by that: a LED connected to the operation instruction output terminal of the control circuit, is fitted to each instrument key, the LED is used to dispay the binary operating instruction and indicate the state of each bit.

7. A man-machine co-operative musical program-controlled apparatus according to claims 3 and 4 is characterized by that: its control key further comprises electronic components which can change power and voltage. At the time the control key controls the fetching of score instructions from the storage device, it also control the operation pace and power of controlled units.

8. Method for producing score instructions of said man-machine-co-operative musical program-controlled apparatus is characterized by that:

A. Through the computer applying data processing to the information of notes to be sounded and those not to be sounded at the same time into

the primary bits of the score instruction,which is a binary number equal to the number of instrument key, each bit of the primary bits after data processing forms a one-one correspondance with the instrument keys, transposition processing can be performed by applying shifting, multiplication, division etc. on the primary bits, without altering the internal interval relationship; other control information is appended to the primary bits as the secondary bits of this score instruction.

B. The same processing can be applied equally to the information of the notes to be sounded and not to be sounded simultaneously for the succeeding score instructions for pausing, renewal, overlapping and rest notes are produced by the same method for processing the score instruction.

C. Repeat the procedures of B, until processing of all score informations has been finished.

D. Send all sets of binary score instructions to the storage device after the processing.

9. Score instruction firmwares of various RCM, EPROM, tape , floppy disc, hard disc, cartridge tape, optical information disc, or digital record stored with score instructions produced by score-instruction-producing method according to claim 8.

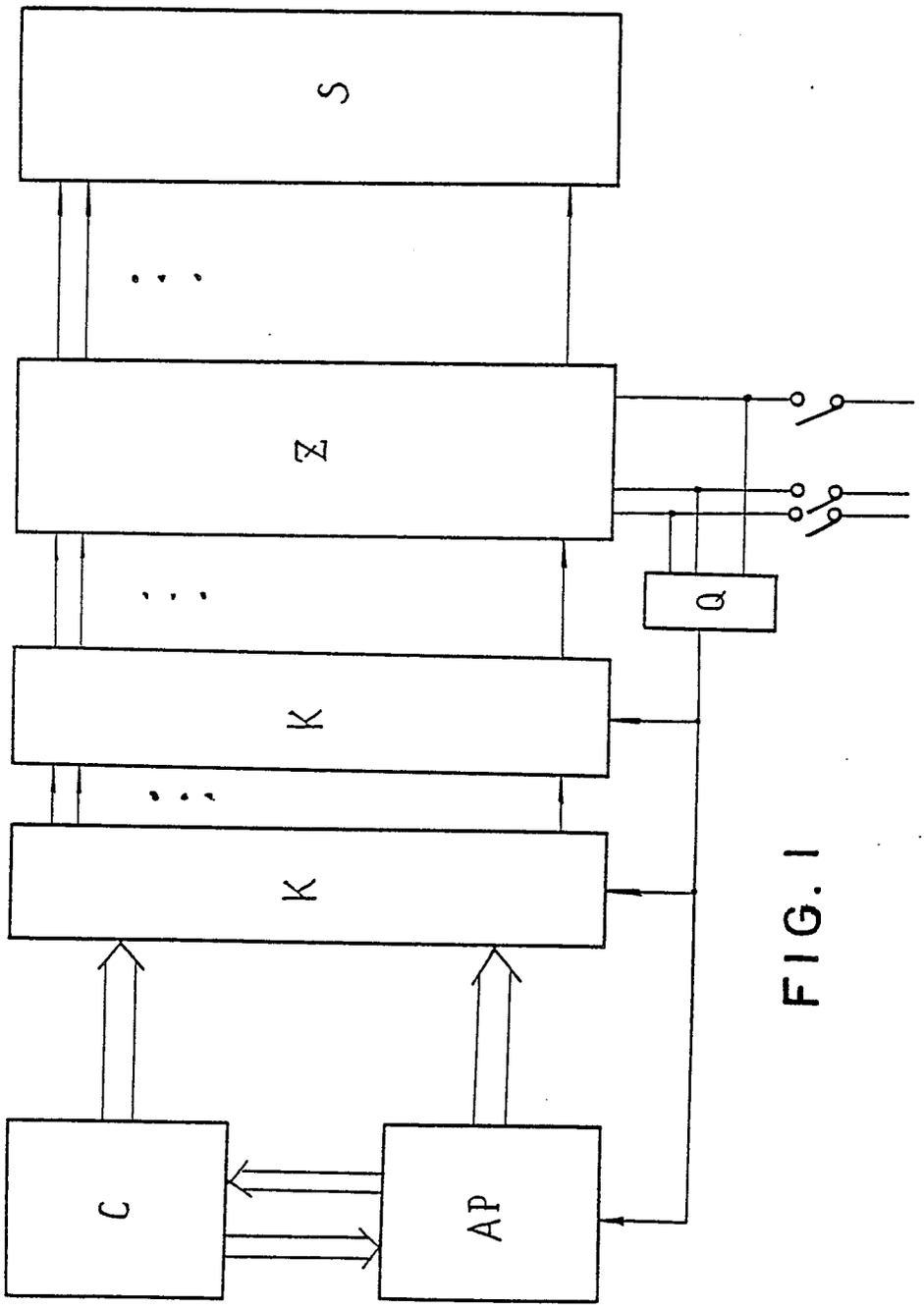


FIG. 1

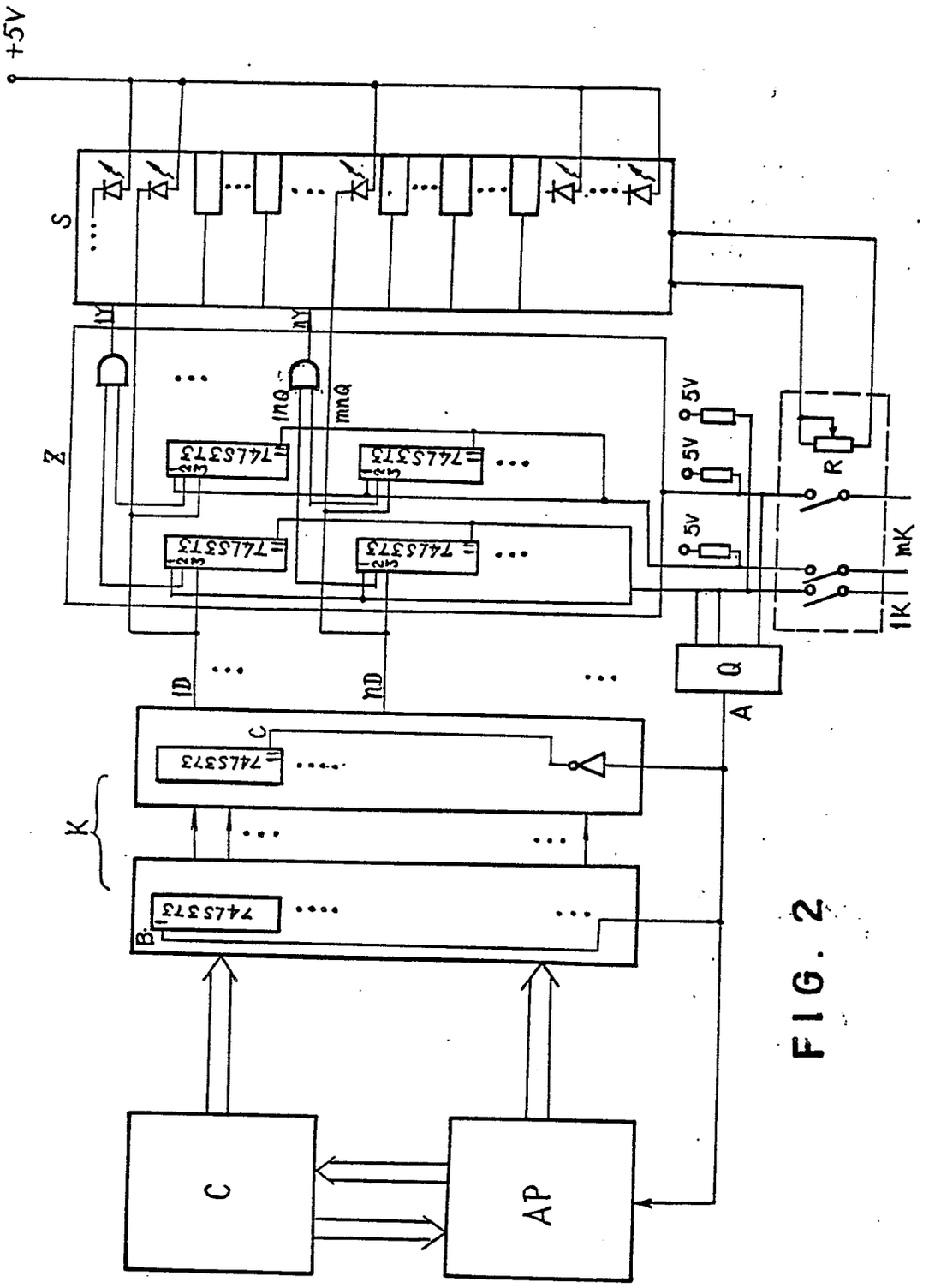
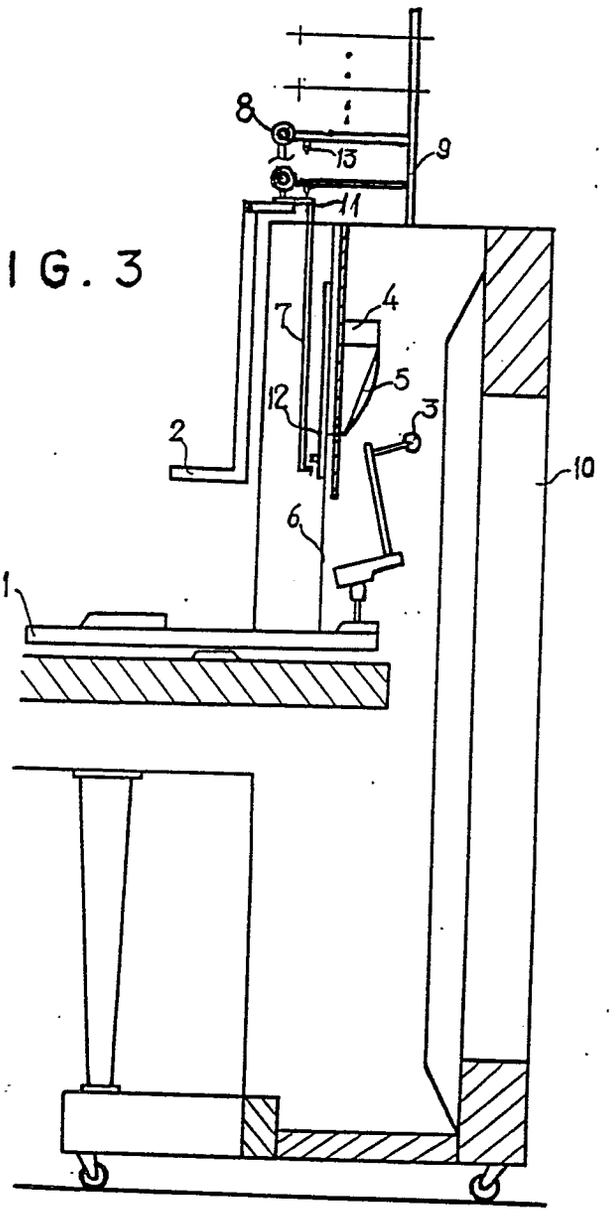


FIG. 2

FIG. 3



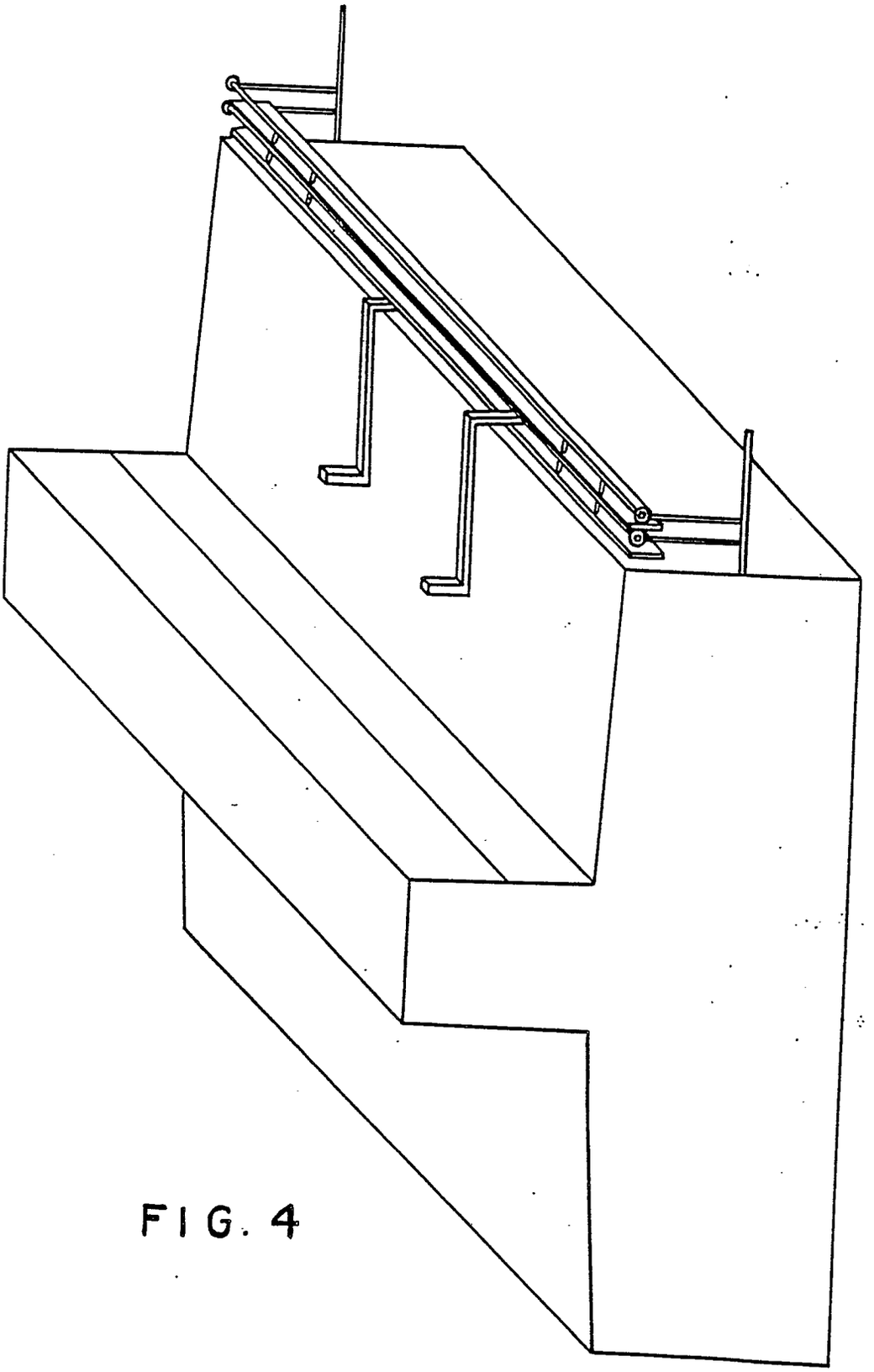


FIG. 4

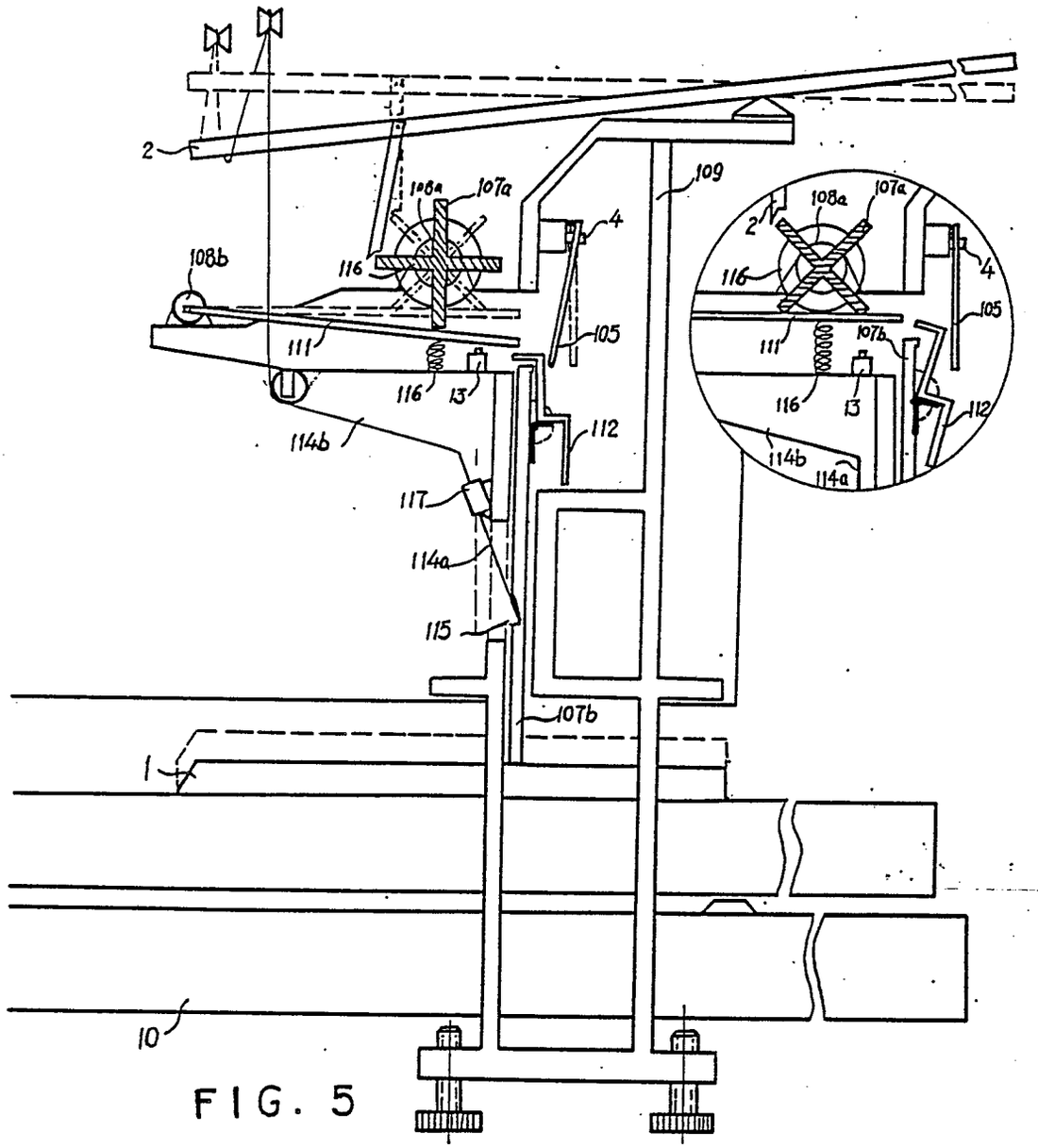

2
108a
107a
109
4
108b
116
105
111
116
13
112
114b
117
114a
115
107b
1
10
2
108a
107a
4
116
105
111
107b
116
13
112
114b
114a

FIG. 5