

(No Model.)

5 Sheets—Sheet 1.

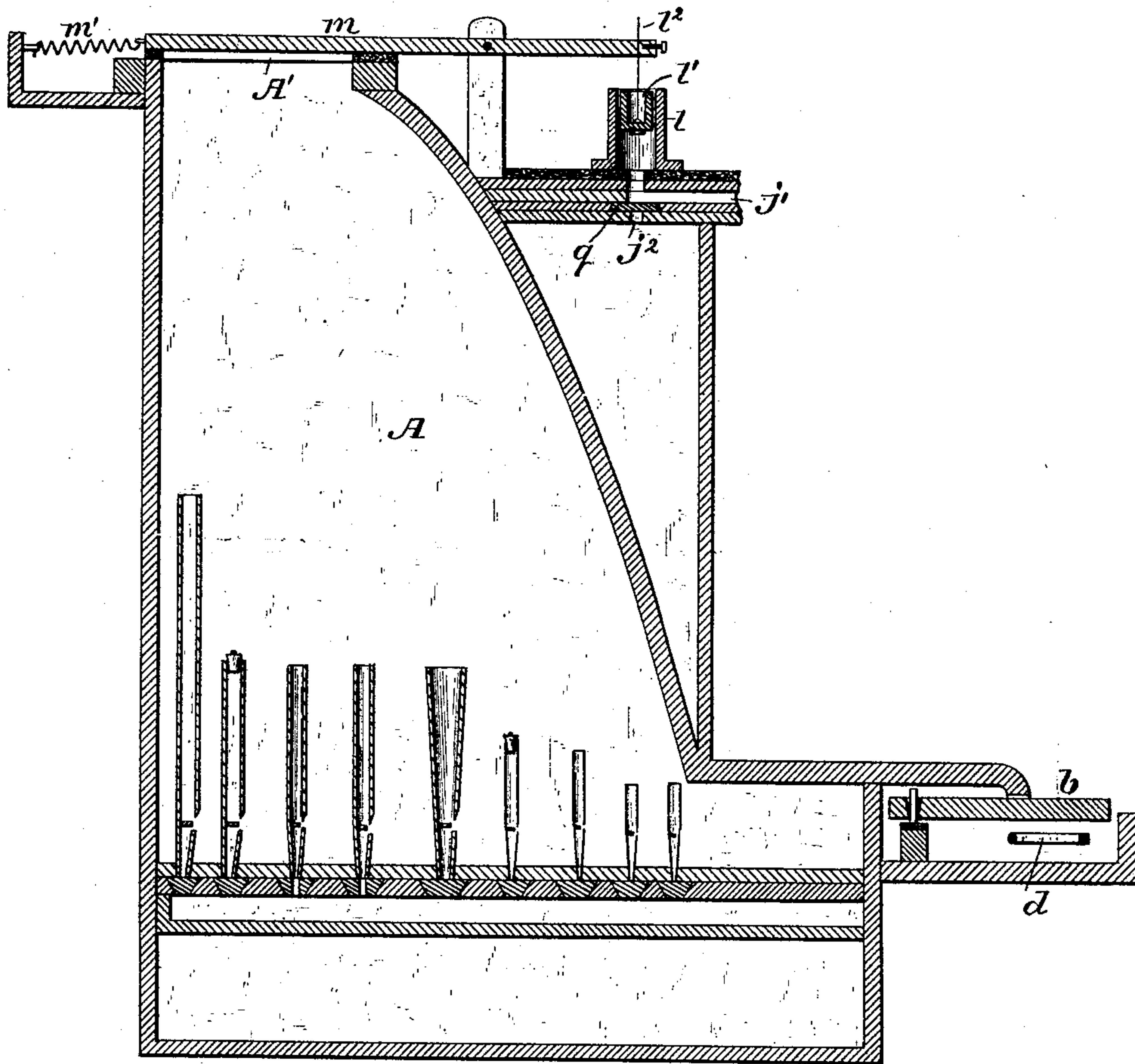
T. CAHILL.

ORGAN.

No. 359,842.

Patented Mar. 22, 1887.

FIG. 1.



ATTEST-

J. Henry Kaiser.
Harry L. Amer.

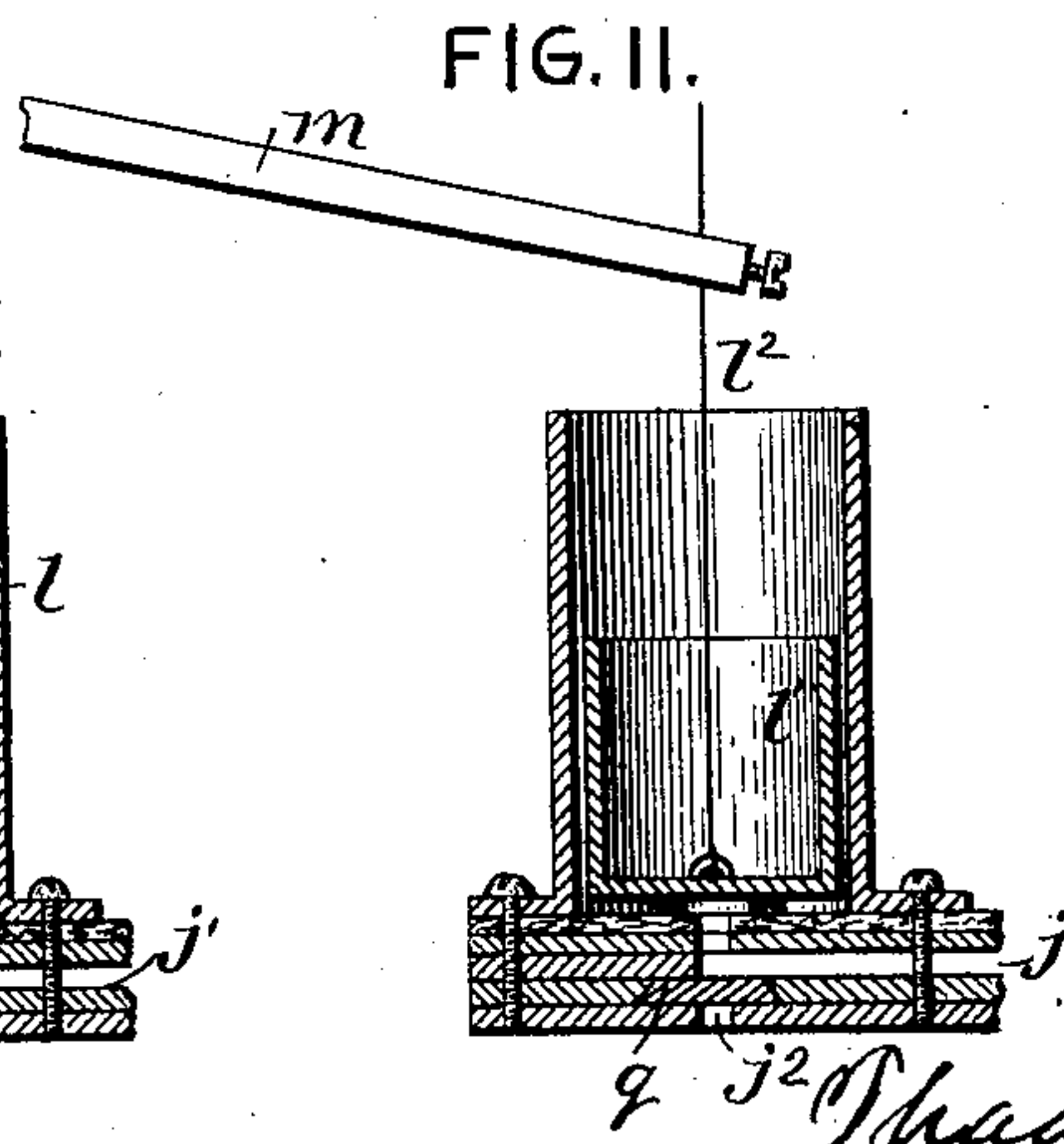
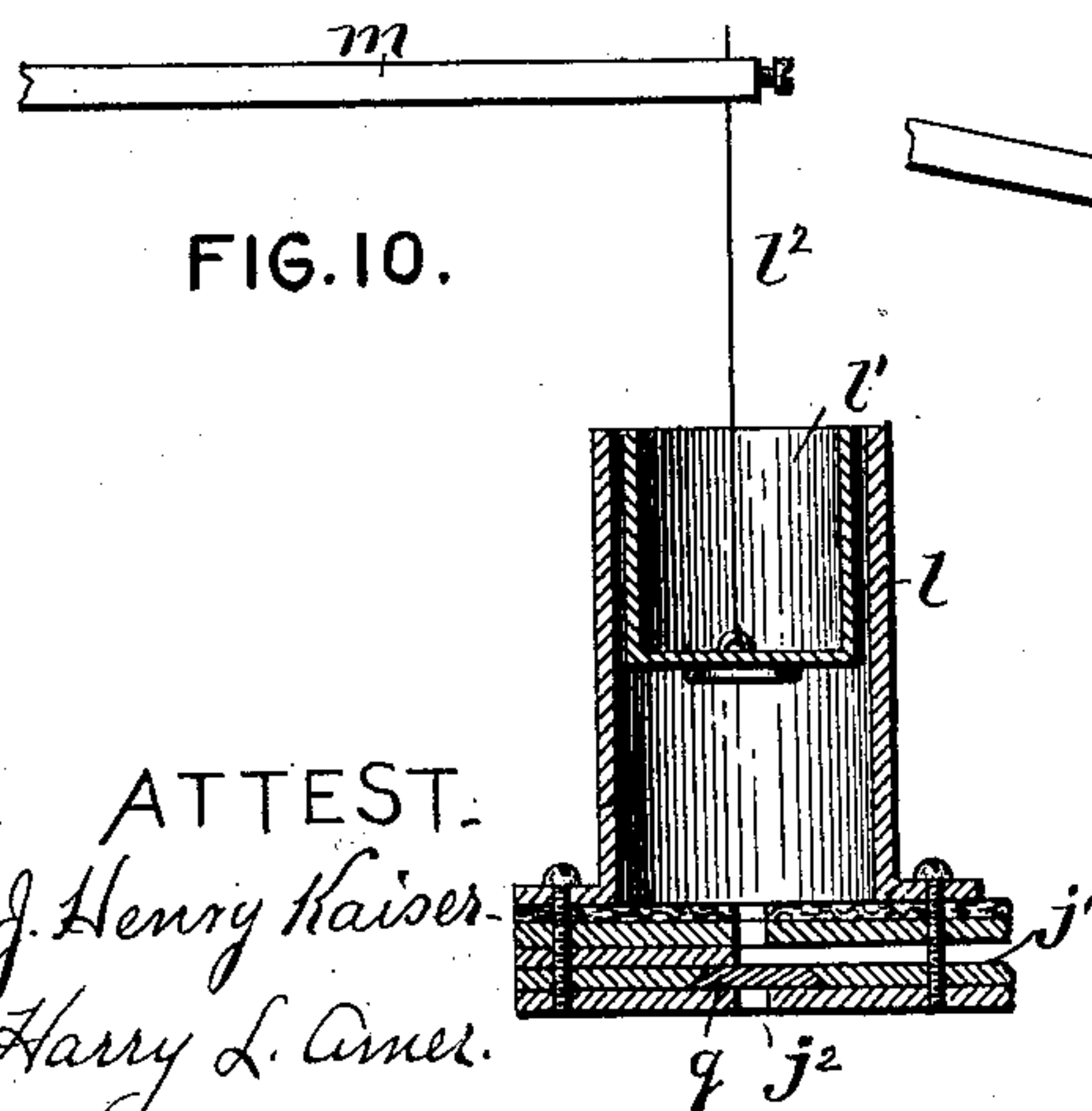
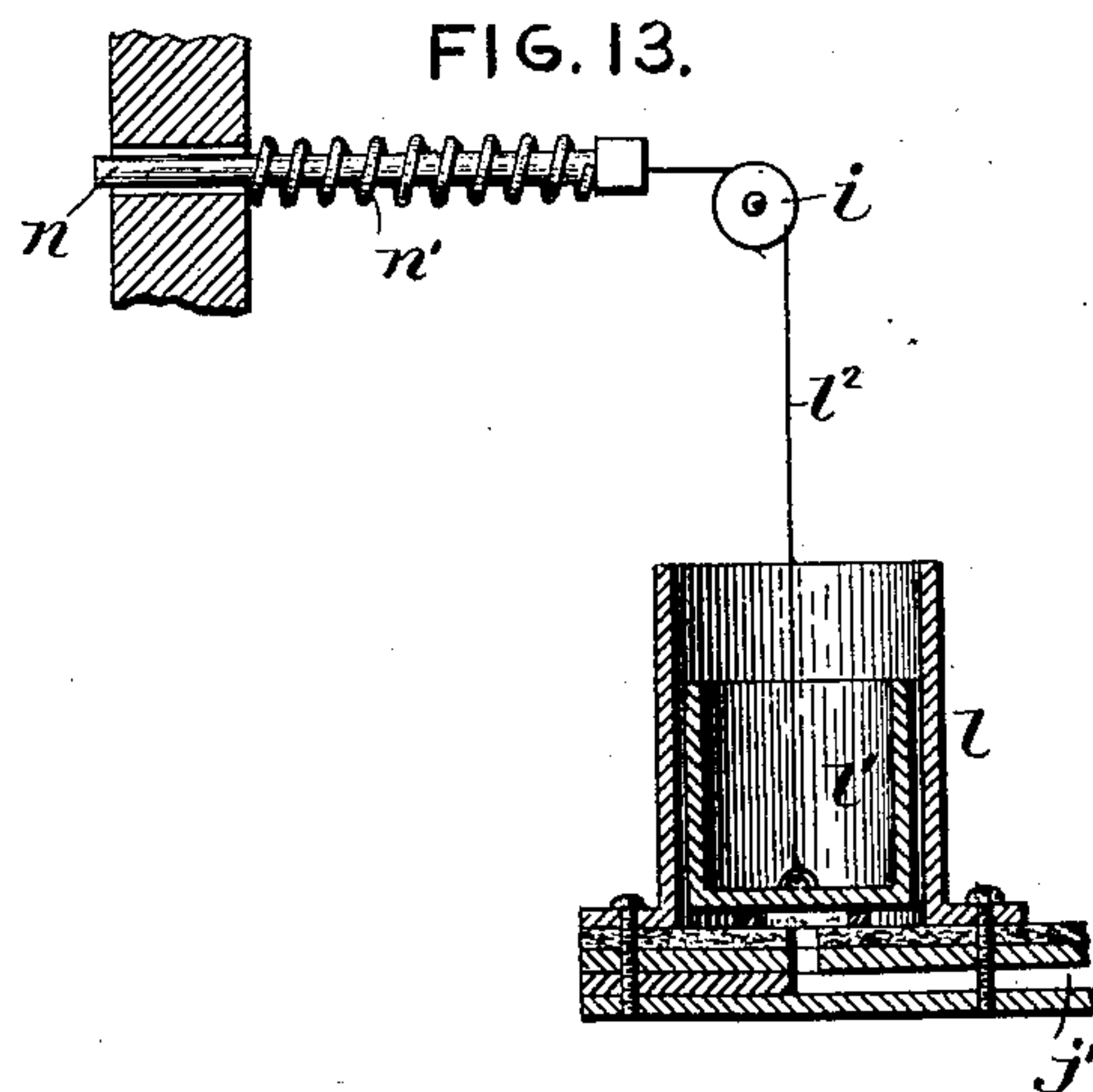
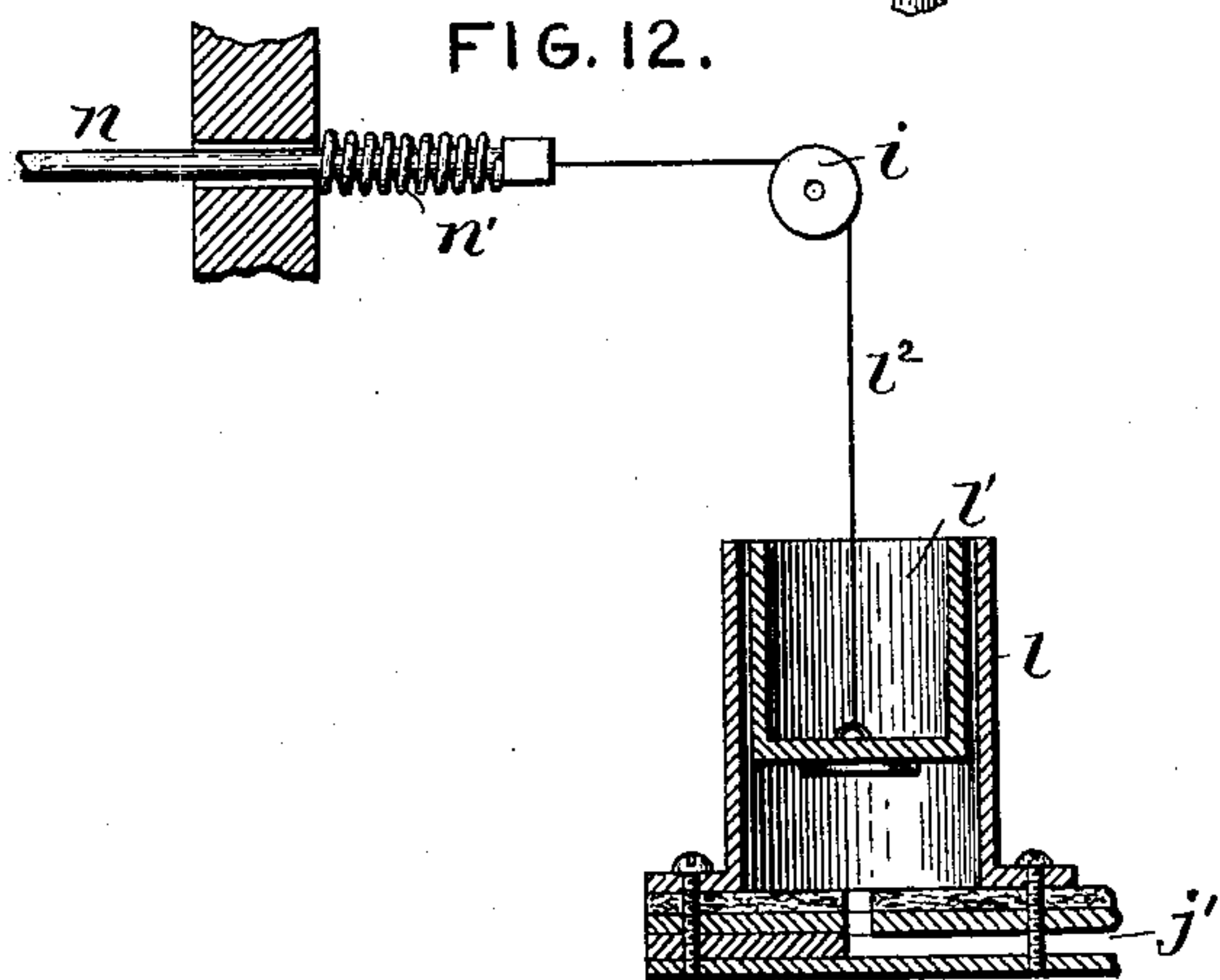
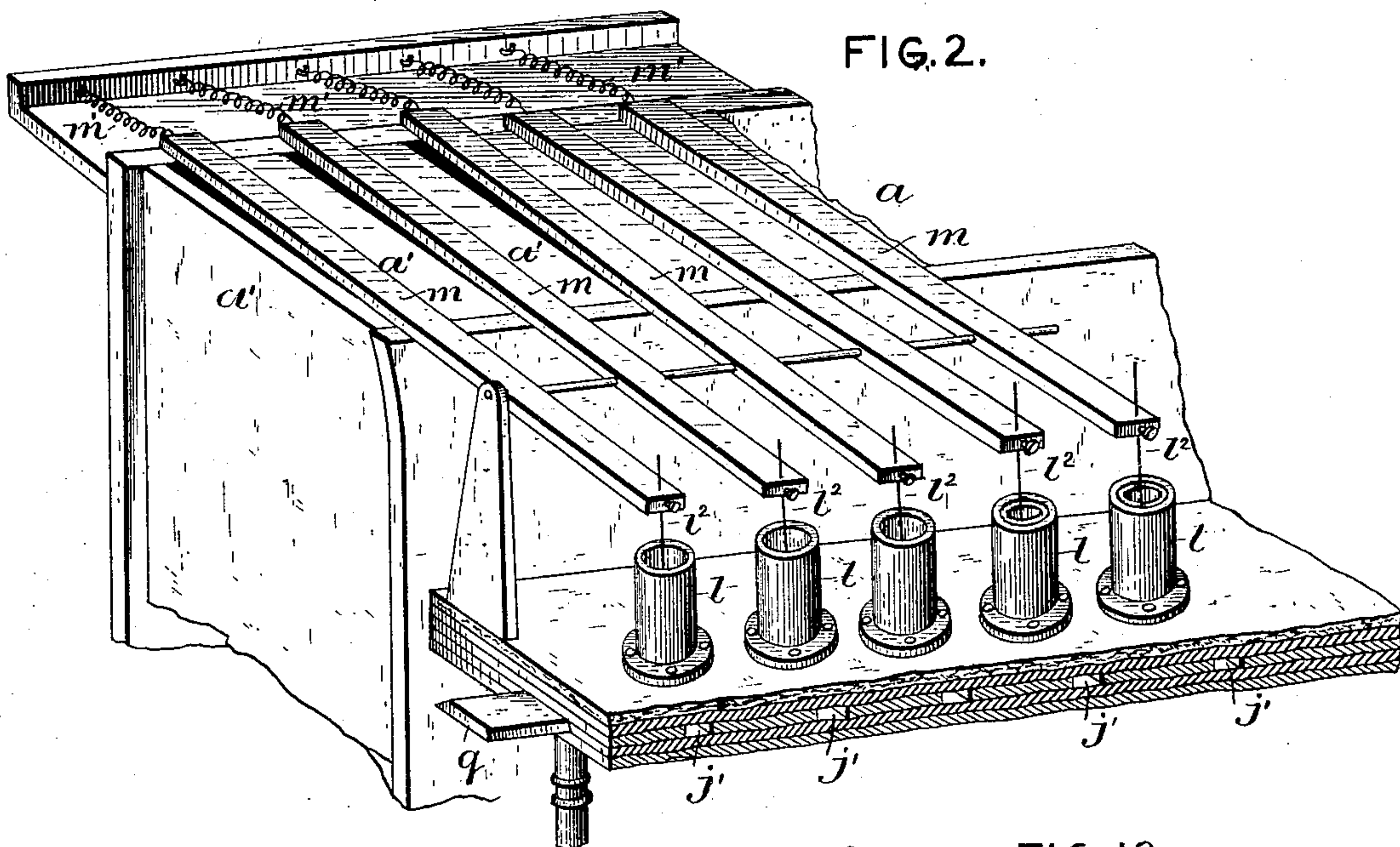
INVENTOR-

Thaddeus Cahill

T. CAHILL.
ORGAN.

No. 359,842.

Patented Mar. 22, 1887.



ATTEST.
J. Henry Kaiser
Harry L. Amer.

INVENTOR.

Thaddeus Cahill

T. CAHILL.
ORGAN.

No. 359,842.

Patented Mar. 22, 1887.

FIG. 5-

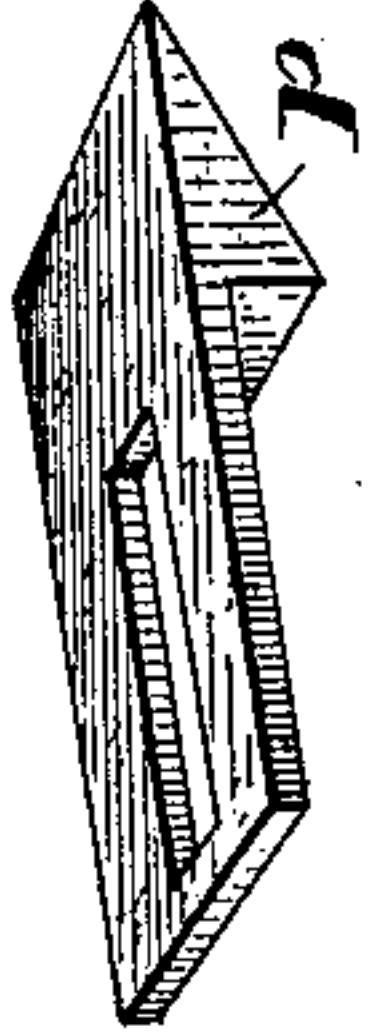


FIG. 4.

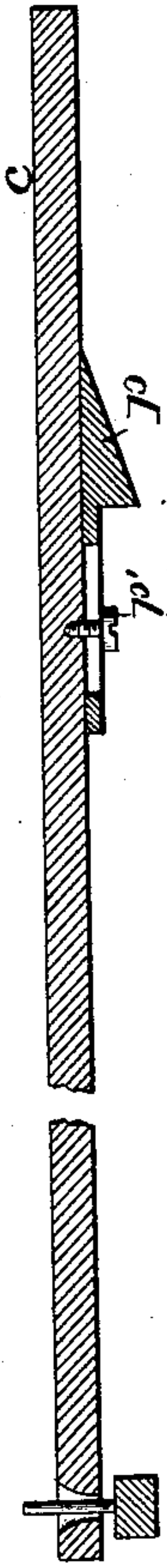
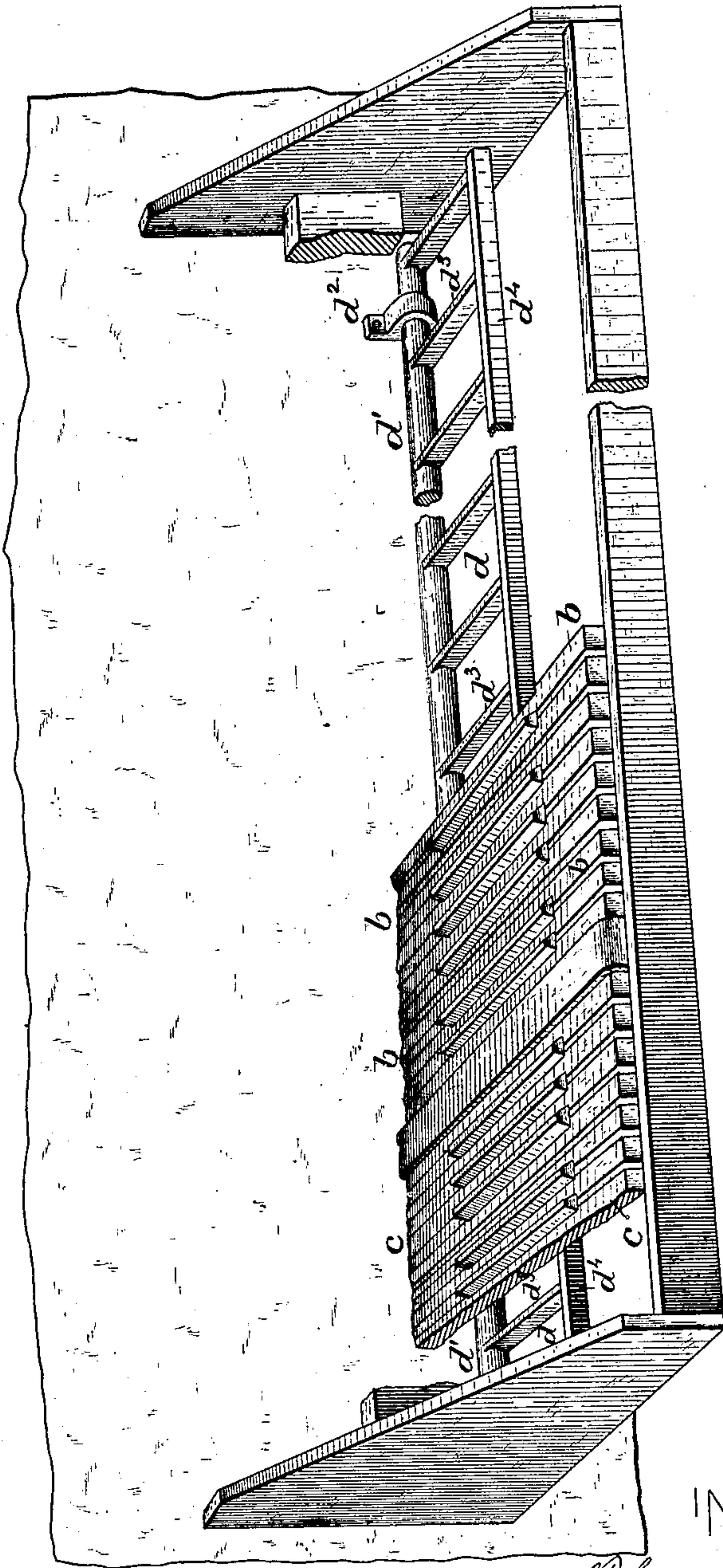


FIG. 3.



ATTEST-

J. Henry Kaiser.
Harry L. Amer.

INVENTOR-

Thaddeus Cahill

T. CAHILL.
ORGAN.

No. 359,842.

Patented Mar. 22, 1887.

FIG. 9.

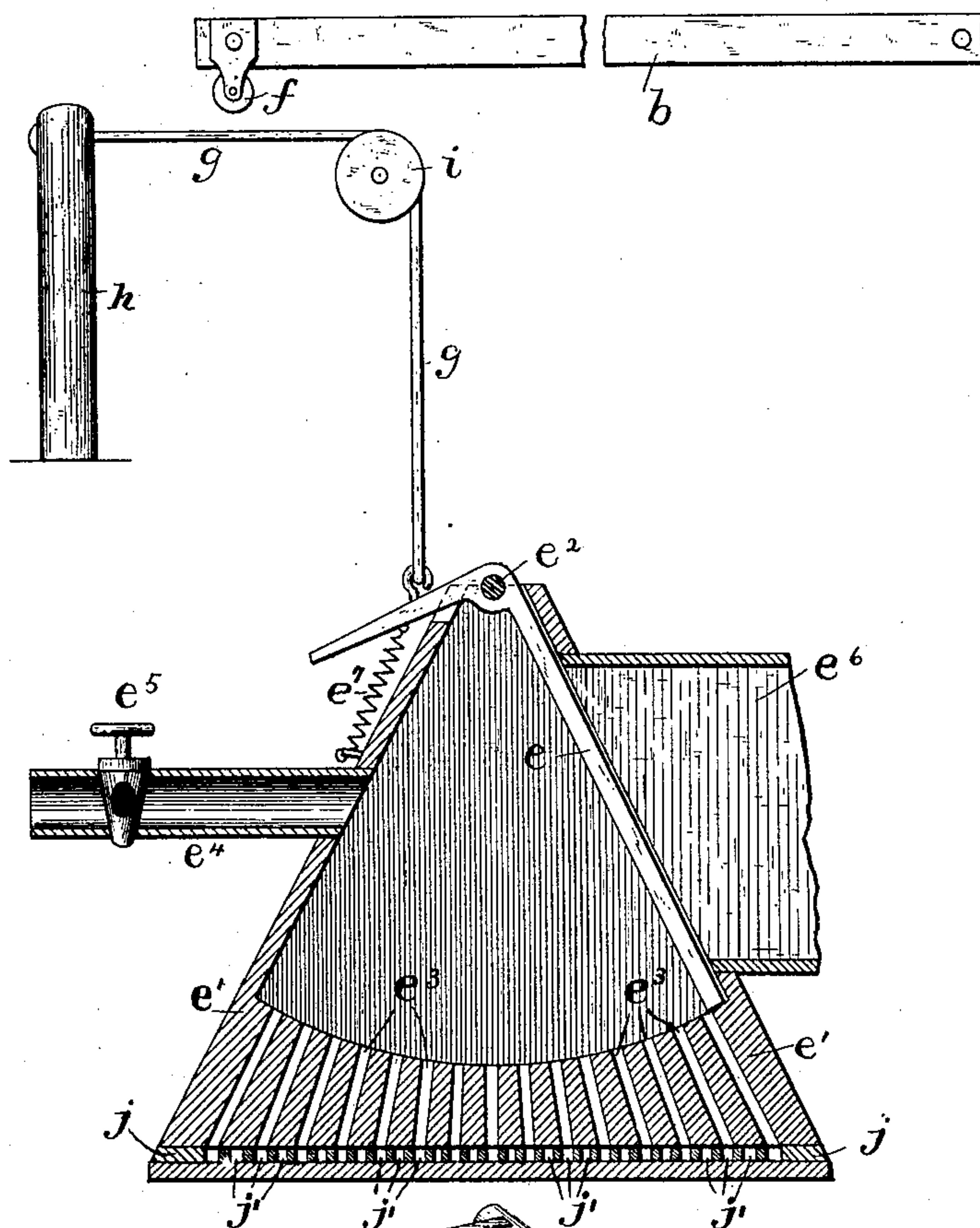
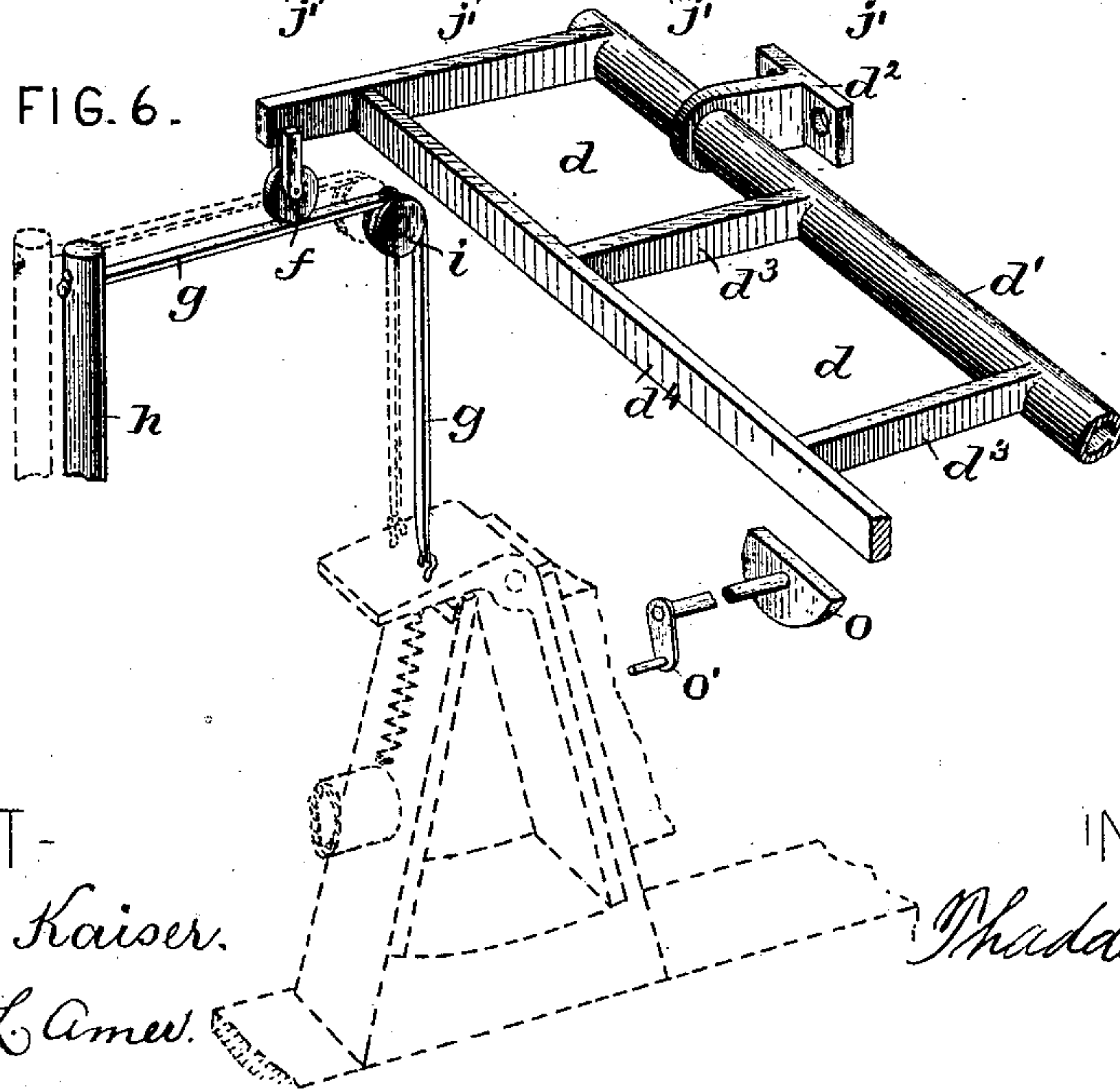


FIG. 6.



ATTEST—
J. Henry Kaiser.
Harry L. Ames.

INVENTOR—

Thaddeus Cahill

T. CAHILL.
ORGAN.

No. 359,842.

Patented Mar. 22, 1887.

FIG. 7.

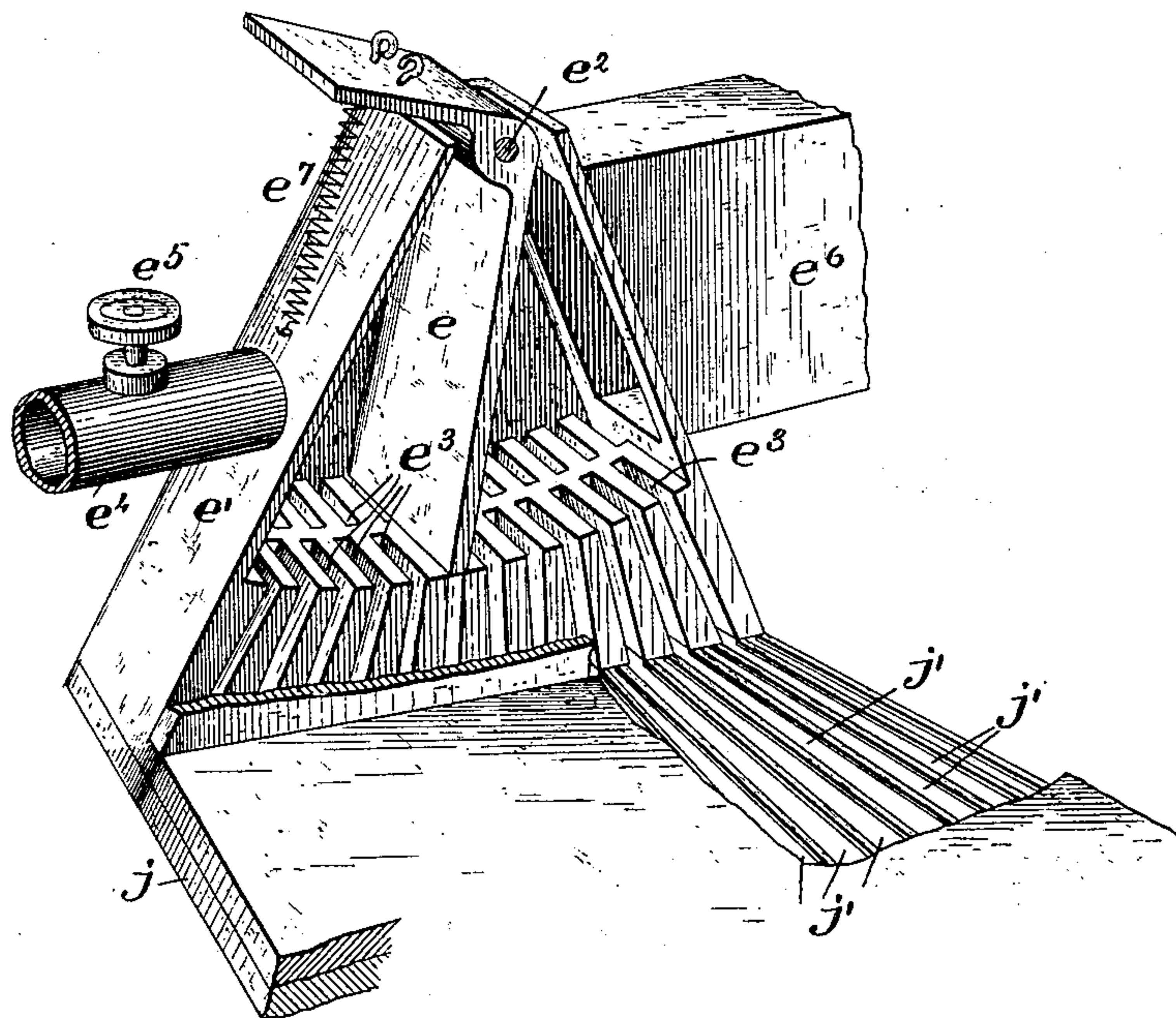
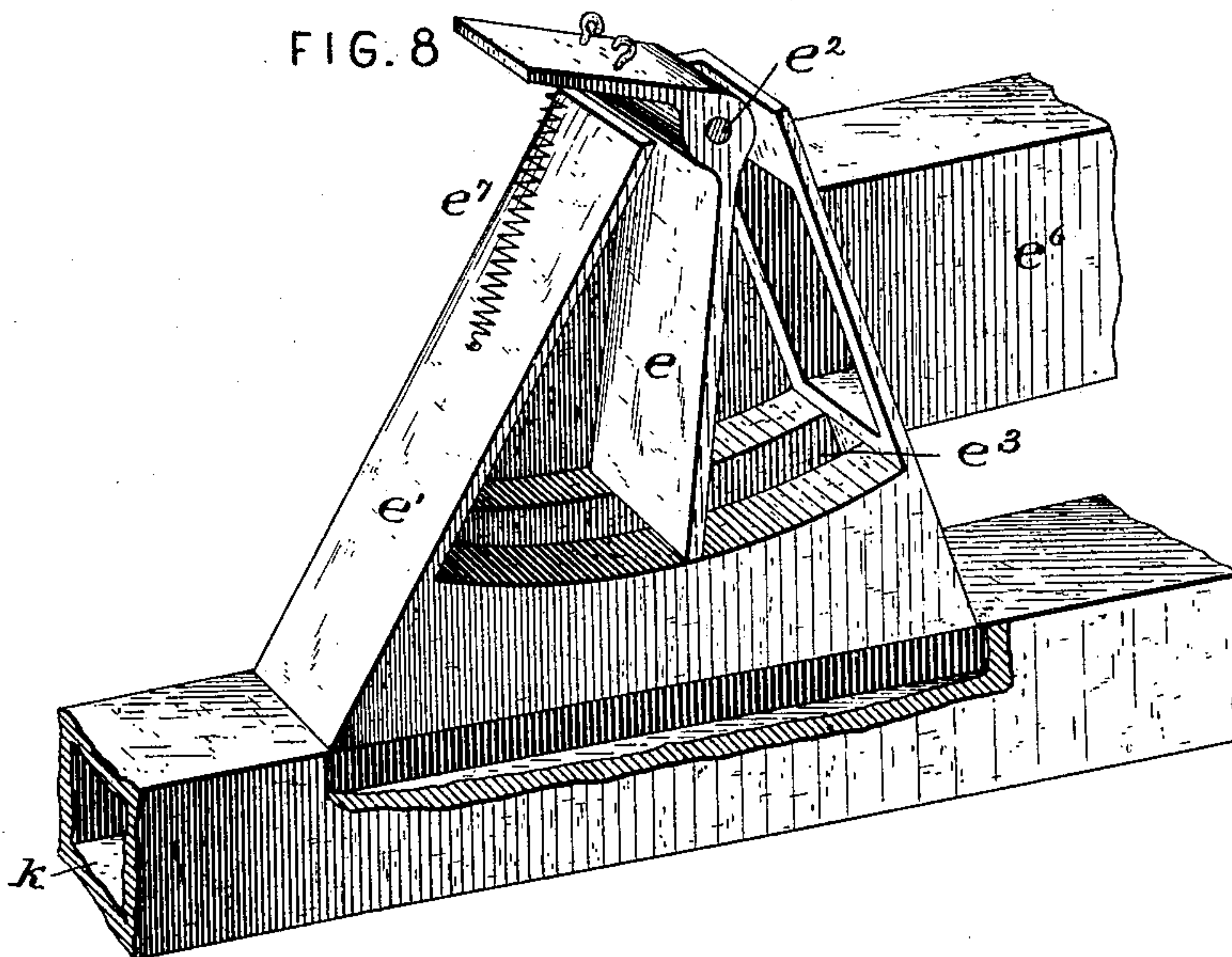


FIG. 8



ATTEST-

J. Henry Kaiser.
Harry L. Amer.

INVENTOR-

Thaddeus Cahill

UNITED STATES PATENT OFFICE.

THADDEUS CAHILL, OF OBERLIN, OHIO, ASSIGNOR OF TWO-THIRDS TO
TIMOTHY CAHILL, OF SAME PLACE.

ORGAN.

SPECIFICATION forming part of Letters Patent No. 359,842, dated March 22, 1887.

Application filed June 5, 1886. Serial No. 204,222. (No model.)

To all whom it may concern:

Be it known that I, THADDEUS CAHILL, a citizen of the United States, residing at Oberlin, in the county of Lorain and State of Ohio,
5 have invented new and useful Improvements in Organs, of which the following is a specification.

The objects of my invention are to give to organs the capability of varying their tones in
10 all degrees of loudness in accordance with the touch upon the ordinary keys of the instrument, or upon special dynamic keys, and to make these variations of loudness, especially in the latter case, correspond to the degrees of
15 a scale, which degrees have known and constant mathematical relations, so that the expression of a musical composition with regard to loudness may be written and reproduced with the same mathematical accuracy with
20 which the time and pitch can now be written and reproduced; and my invention consists, principally, in the following points: first, in the combination of the keys of an organ, or of any desired plural number of said keys, with
25 suitable dynamic-governor mechanism and with a general transmitter—that is, a movable lever or frame connected with the dynamic governor and placed transversely to the keys of the organ manual or pedal, or to those keys
30 that are arranged to operate it, so that it receives pressure and motion from any one of the keys that are arranged to actuate it when such key is depressed, and from any number of such keys that may be depressed when more
35 than one of them are depressed, and transmits the motion thus received to the before-mentioned dynamic governor, and forms a connection between whatever key or number of keys may be depressed and said dynamic governor,
40 so that the motion of said dynamic governor is governed by and in accordance with the touch upon said key or number of keys; second, in a series of separate swell-valves, as described more fully hereinafter, all placed
45 upon the same swell-box, covering ports, holes, or open areas therein, and preferably so regulated as to their size and extent of opening that each one of said swell-valves, when opened, in addition to or in conjunction with
50 those smaller than itself or below it in the se-

ries, augments the loudness of tone by one degree of the dynamic scale described hereinafter; third, in the method of governing the loudness of the tones of an organ, preferably in accordance with the degrees of the dynamic
55 scale, hereinafter described, with a series of separate swell-valves, which are all placed upon the same swell-box, covering ports, holes, or open areas therein by opening a greater or smaller number of said swell-valves, accord-
60 ing to the loudness of tone desired, as described more fully hereinafter; fourth, in the combination of a series of separate swell-valves, all placed upon the same swell-box, covering ports, holes, or open areas therein,
65 with a series of suitable power devices corresponding to said swell-valves and connected therewith, so that each power device, when supplied with power, opens the corresponding
70 swell-valve with which it is connected, and in the combination of the series of swell-valves and power devices last mentioned with a dynamic governor so constructed and arranged that it supplies power to a greater or smaller
75 number of the before-mentioned power devices, and by means of said power devices opens a greater or smaller number of said swell-valves, according to the position of the movable part of said dynamic governor; fifth, in a
80 specific form of mechanism for performing the function last mentioned—that is, in dynamic-governor-valve mechanism for an organ, consisting, essentially, of a valve-chest connected on one side or end with a suitable induction-
85 bellows or other suitable source or reservoir of fluid motive power, and preferably open to the atmosphere on the opposite side, and having a series of ports cut in one or more of its walls and connected pneumatically with the
90 before-mentioned corresponding power devices, and a movable close-fitting valve set in said valve-chest so as to move over the before-mentioned series of ports and throw a greater or smaller number of them in communication
95 with the bellows or other source or reservoir of fluid motive power, according to its position; sixth, in the combination of the before-mentioned series of swell-valves, which are all placed upon the same swell-box, covering
100 ports, holes, or open areas therein, with a

greater or smaller number of the pitch-keys of an organ, constructed to operate said series of swell-valves by connecting mechanism, preferably the general transmitter, dynamic-governor-valve mechanism, and series of power devices, before mentioned and hereinafter described more fully, whereby a greater or smaller number of said series of swell-valves are opened by and in accordance with the touch upon the keys before mentioned; seventh, in the combination of a series of suitable power devices with the keys of an organ, or with any desired number of said keys, constructed to operate said series of power devices by connecting mechanism, preferably the general transmitter and dynamic governor, hereinbefore mentioned and hereinafter described, whereby power is supplied to a greater or smaller number of said series of power devices, in accordance with the touch upon the before-mentioned keys; eighth, in the combination of a series of suitable power devices and swells, as before mentioned and hereinafter described, with the keys of an organ, or with any desired plural number of said keys, constructed and arranged to operate said series of power devices and swells by connecting mechanism, preferably the general transmitter and dynamic governor, hereinbefore mentioned and hereinafter described, whereby power is supplied to a greater or smaller number of said power devices, and a greater or smaller number of said swells are opened by and in accordance with the touch upon the before-mentioned keys; ninth, in a series of keys, preferably similar in their order and arrangement to the pitch-keys now in universal use, each of which represents a certain degree of a dynamic scale, hereinafter explained, and is so constructed and arranged that it returns to its normal position and ceases to give the dynamic degree that it represents when no longer held down; tenth, in the combination of the keys of a dynamic manual, or of any desired plural number of said keys, with a dynamic governor, preferably by means of a general transmitter, as hereinbefore mentioned and hereinafter described, said parts being so constructed and arranged with relation to each other that different keys of said dynamic manual, when depressed, move said dynamic governor into different positions; eleventh, in the combination of a series of swell-valves, as hereinbefore mentioned and hereinafter described, with the keys of a dynamic manual, or with any desired plural number of said keys, constructed and arranged to operate said swell-valves by connecting mechanism, preferably the general transmitter, dynamic governor, and power devices, hereinbefore mentioned and hereinafter described, whereby different numbers of said swells are opened by the depression of different keys; twelfth, in the combination of a series of suitable power devices, as hereinbefore mentioned and hereinafter described, with the keys of a dynamic manual, or with any desired plural number of said keys, constructed and

arranged to operate said series of power devices by connecting mechanism, preferably the general transmitter and dynamic governor, hereinbefore mentioned and hereinafter described, whereby power is supplied to different numbers of said power devices by the depression of different keys; thirteenth, in the combination of a series of suitable power devices and swells, as before mentioned and hereinafter described, with the keys of a dynamic manual, or with any desired plural number thereof, constructed and arranged to operate said series of power devices and swells by connecting mechanism, preferably the general transmitter and dynamic governor, hereinbefore mentioned and hereinafter described, whereby power is supplied to different numbers of said power devices, and different numbers of said swells are opened by the depression of different keys, as hereinafter described.

There are other points of novelty in my invention, not specifically enumerated above, which appear more clearly hereinafter. Of these the most important are a new art of exact musical dynamics; the substitution of speaking-stops, or similar mechanism, whereby wind is admitted to registers of tone-producers for the series of swell-valves mentioned in all the combinations in which a series of swell-valves is an element; the combination of a swell with a power device and with the keys of an organ, and methods and means whereby the power device which is thus combined, and whose supply of motive fluid is controlled by and in accordance with the touch upon the keys, as hereinafter described, and which is connected with a swell-valve, as hereinafter described, is made to open that swell-valve to a greater or less extent, in accordance with the touch upon the key or keys that operate its valve and control its supply of motive fluid, and in the combination of the actuating mechanism with the dynamic-governor-valve mechanism by mechanism, substantially such as that shown in the drawings and described hereinafter, whereby the ratio of the movement of the dynamic governor, imparted to it by the actuating mechanism with which it is connected, to the movement of said actuating mechanism increases or decreases in accordance with the increase or decrease in the pressure exerted by the actuating mechanism upon the mechanism that connects it with the valve actuated.

The chief novel result accomplished by my invention is, that it gives to the performer the ability to change instantly and to any extent, either by imperceptible degrees or by the decided steps of a definite dynamic scale, as hereinafter described, the loudness of the tones of an organ by and in accordance with his touch upon the pitch-keys, or by the depression of different dynamic keys, and to do this in even the largest organs, and to do it by power other than that which he supplies, the power which he supplies being used only to govern, control, and apply that which does the actual work.

What has been designated in the statement of invention as the first principal point of my invention is applicable to all organs in which the loudness of the tones is to be governed by and in accordance with the touch upon the keys; but my invention as a whole relates chiefly to the government of the loudness of the tones of organs by means of swell-valves or swells; and although I do not regard it as any part of this invention, and it should be sufficiently obvious, I may say that the interior of the organ-box or the swell-box should be so constructed as to converge the sound-waves upon the swells, so far as may be; that the organ-case, or that part of it which contains tone-producers the loudness of whose tones is to be governed by swells, should be acoustically insulated as completely and perfectly as may be found possible and practicable; that, with a view to this, the closer and tighter the organ-case is built the better; that whether there be but one dynamic governor, with its auxiliary power devices and swells, for each manual, operated by all the keys of the manual, (as I prefer for the sake of economy and simplicity,) or whether there be (as there may be at a greatly-increased expense for the sake of independent expression) many dynamic governors, each controlling its own power devices and swells, there must be as many separate close compartments or swell-boxes as there are dynamic governors controlling power devices and swells; that all the tone-producers whose loudness of tone is to be governed by a given dynamic governor controlling swells must be placed within the close compartment or swell-box upon which the swells operated by said governor are placed; that in every case in which the bellows is not in the same close compartment or swell-box with the tone-producers to which it supplies wind it should be in a close compartment which should have free pneumatic communication with that swell-box or those swell-boxes which contain tone-producers to which it supplies wind, and it should, furthermore, both inspire and expire its wind into its own compartment and the swell-box or swell-boxes pneumatically connected therewith, so that the equilibrium of the air contained in the swell-box or swell-boxes, as compared with that outside, will not be disturbed, and there will be no tendency for vibrating air to leak out of the organ-case when the swells are closed.

In the accompanying drawings I do not show, and in this specification I do not describe, the bellows, sound-board, draw-stops, valve-action for the tone-producers, couplers, nor, in short, any part of an organ that is not intimately connected with my invention, and therefore necessary to show.

When my invention is carried out in organs substantially in the way in which I prefer to carry it out—by means of swells, as will appear more clearly hereinafter—no material or essential part of the instrument—such as the bellows, sound-table, tone-producers, valve-

action for admitting wind to the pipes, draw-stops, couplers, and so forth—is dispensed with or materially changed; but the organ-case, or that part of it which contains the tone-producers, should be acoustically insulated. There is no longer any use for the swell as now constructed and operated, since so much more perfect expression can be obtained, in accordance with the touch upon the keys, by means of the dynamic-governor-valve mechanism and its auxiliaries, herein described; and it is to be understood in connection with the valve-action for supplying wind to the pipes—whether it be direct, pneumatic, or electro-magnetic—that the point to which any of the pitch-keys is depressed varies more or less with the firmness of the touch, and that the valve-action must therefore have sufficient play to allow of the different depressions of the key without being disturbed thereby, and without affecting or altering the amount of wind supplied to the pipes.

The particular dimensions of the parts used for carrying out my invention, as well as their arrangement with relation to each and to the parts of organs as now constructed, will of course have to be adapted by each builder to the size, shape, style, and other peculiarities of whatever instrument he may be building.

In the accompanying drawings I do not show, and in this specification I do not describe, every mechanism by which it is possible to carry out my invention. I only show and describe that which I consider the best means; and some of the mechanism herein described is only applicable to reed-organs, and some of it is only adapted to the largest organs, or to those which contain many speaking-registers, and I do not intend that all the mechanism herein described shall be used in any one organ; but I shall endeavor to point out, so far as possible, the mechanism and methods of operation which I prefer, stating, so far as may be, the advantages and disadvantages of each method of operation and mechanism described, and leaving the rest to the judgment of the builder and the necessities of the case.

In the accompanying drawings, Figure 1 is a sectional view in elevation on a line parallel to the keys of an organ-case and part of the mechanism most intimately connected with my invention, showing a pneumatic cylinder and swell on the top of the organ-case and the general transmitter in its position beneath the keys of the manual. Fig. 2 is a view in perspective of so much of the top of the organ-case as has not been broken away, and shows a number of pneumatic cylinders and swells in their respective positions, some of the swells being represented as open and others as closed. Fig. 3 is a view in perspective of the ordinary or pitch manual and the dynamic or loudness manual, (the use of which is hereinafter described;) and in this drawing some of the keys of each manual are removed, so as to show the general transmitters in their positions beneath the keys. Fig. 4 is a view in longitudi-

nal section of a key of the dynamic manual and a slotted wedge-shaped piece which is attached to the lower side of said key, immediately above the general transmitter upon which it acts, said wedge-shaped piece being adjustable by a screw and slot longitudinally upon the key, so as to regulate for what fraction of its depression the key shall act upon the general transmitter. Fig. 5 is a view in longitudinal section of said adjustable wedge-shaped piece. Fig. 6 is a view in perspective of the general transmitter of one of the manuals, showing its construction and connection with the dynamic-governor-valve mechanism, which latter is shown in dotted lines. Figs. 7 and 9 represent a form of the dynamic-governor-valve mechanism hereinbefore mentioned as an important feature of my invention, Fig. 7 showing said mechanism in perspective, viewed from behind, with the back of the chest removed to show the interior more clearly, and Fig. 9 showing it in sectional elevation as viewed from behind. Fig. 8 is a view in perspective of a form of dynamic-governor-valve mechanism intended, principally, for use in reed-organs, differing from the dynamic-governor-valve mechanism shown in Figs. 7 and 9 in that, instead of having many ports connected with many pneumatic power devices, it has but one port, through which wind for the production of tone passes between the bellows and the wind-trunk that supplies the reeds, and that it is not open to the free air on one side, as the dynamic-governor-valve mechanism shown in Figs. 7 and 9 should be, but, like them, it is connected with the general transmitter, as shown in Figs. 6 and 9. Figs. 10 and 11 are sectional views in elevation of a pneumatic cylinder and swell-valve to which the piston of said cylinder is attached, the former view showing the parts in their normal positions with the cylinder full of air, the piston raised, and the swell-valve closed, and the latter showing them in the positions they assume when the cylinder is thrown in communication with an induction-bellows or other vacuous source or reservoir of fluid motive power, into which the air contained in the cylinder escapes, and the piston is forced down by the superior pressure of the external atmosphere and the swell is opened; and Figs. 12 and 13 are views of the same cylinder shown in the two preceding figures and a part of the speaking-stop mechanism, with which the piston of said cylinder is connected by a cord or chain passing over a small pulley, so that when the power device is not supplied with power the stop is closed and the piston is sustained in its normal position by a contractile spring, but when the cylinder is in communication with the vacuous reservoir the piston descends and opens the stop.

In the accompanying drawings, A represents the organ-case, which is made close and tight all around, and has a number of sound-ports in its top, covered by close-fitting swell-valves which open outward, and has its front

wall curved, so as to converge the sound-waves upon the swell-valves.

A' represents the sound-ports in the top of the organ-case covered by the swell-valves.

b represents the tone-producing keys—the keys of the pitch-manual.

c represents the keys that govern the loudness—the keys of the dynamic manual.

d represents the general transmitter, which, as shown, consists of a metal rod or tube, d', (which is nicely fitted to and movably set in fixed bearings d²,) small metal cross-arms d³, rigidly and transversely attached to the rod or tube d', and a light but stiff wooden or metal rail, rod, or tube, d⁴, to which also the cross-arms d³ are rigidly and transversely attached, so that said rail, rod, or tube d⁴ becomes the front of the frame and the part upon which the keys rest or press when forced down.

e is the dynamic governor-valve. e' is the chest in which it is set. e² is the center on which it is set.

e³ are the ports in the bottom of the valve-chest e', over which the valve e moves.

e⁴ is a short pipe on one side of the chest, which opens upon the atmosphere by the valve e⁵. e⁶ is a pipe on the other side of the valve-chest, which connects it with an induction-bellows or other suitable source or reservoir of fluid motive power.

e⁷ is a contractile spring fastened to a hook on the outside of the valve-chest and to the shorter right-angled arm of the valve e, so as to hold it in its normal position of close proximity to the mouth of the pipe e⁶, which leads to the bellows.

f is a small roller or wheel attached to the general transmitter d, or to the key b, as shown in Figs. 6 and 9.

g is a cord, belt, or chain, of which one end is fixed and the other attached to the dynamic governor-valve, for transmitting motion from the general transmitter d, or other mechanism, which acts upon it transversely, to the dynamic-governor mechanism, to which it is attached, so that the ratio of the motion of said dynamic-governor mechanism to that of the actuating mechanism shall increase gradually in accordance with the pressure exerted by said actuating mechanism.

h is a post or fixed piece, to which the end of the belt, cord, or chain g is fastened.

i is a small pulley, over which the cord, belt, or chain g passes.

j is a grooved or channeled board, table, or frame similar in its construction to the sound board or table of a pipe-organ. j' refers to the grooves or channels in said board or table, each of which grooves or channels communicates pneumatically with one of the ports e³ in the bottom of the valve-chest e', and with one of the pneumatic power devices, and forms a connection between them.

k is a wind-trunk, through which the wind that produces the tone passes between the bellows of a reed-organ and the free reeds thereof.

l is a pneumatic cylinder. l' is a close-fitting

movable piston belonging to said cylinder. l' is a cord, chain, or rod that connects said piston with a swell or draw stop.

m is a swell valve or lever movably set on a rod covering a port or hole, A' , in the top of the organ-case.

n is a sliding stop, which when opened admits wind to a register of pipes or other tone-producers, but is normally held closed by a contractile spring.

o is a mechanical stop placed under the general transmitter of the pitch-manual, having a handle, o' , by which it may be rotated into such a position as to block the motion of the general transmitter of the pitch-manual when the dynamic manual is to be played upon, if so desired.

q is a leak-hole stop placed in the grooved or channeled board beneath the pneumatic power devices, so as to permit air to leak into the cylinders when the sliding stop q' is opened, as hereinafter described.

As shown in Figs. 1, 2, 3, 4, 5, 6, 7, 9, 10, and 11, which show mechanism for carrying out my invention in the manner which I prefer, the pitch-manual and the dynamic manual are placed in the same horizontal plane, with their respective keys parallel to each other. The general transmitter of the pitch-manual is placed transversely thereto, beneath the front ends of the shorter or black keys, a distance preferably equal to the space through which the keys must be depressed in order to open to a proper extent the corresponding valves and supply the proper amount of wind to the corresponding tone-producers. The keys of the pitch-manual are not arrested when depressed by a fixed bar covered with felt, as is the case in organs as now constructed; but whatever number of the keys of the pitch-manual is depressed, whether one or many, presses upon the general transmitter d . The general transmitter d (or, more exactly speaking, a little roller or wheel, f , attached thereto) is normally in contact with the cord, belt, or chain g , and its weight is nicely balanced by suitable weights or springs, so that though normally in contact with said cord, belt, or chain it does not press upon it of itself; but when it is pressed upon by any of the keys it in its turn presses transversely upon the belt, cord, or chain g , and by means of it so transmits motion to the dynamic governor-valve e that the ratio of the motion of said valve to the motion of the general transmitter d increases or decreases in accordance with the increase or decrease in the intensity of the pressure transmitted from the keys by the general transmitter d to the cord, belt, or chain g , or similar connecting mechanism. The dynamic governor-valve e is set on an axle, e^2 , in the valve-chest e' , which has a small top filled by the circular or wheel-shaped part of the valve e , so as to prevent loss of motive fluid by leakage, two sectional sides, two radial sides, and a concave bottom. The ports e^3 are cut in the path of motion of the valve

through the arc-like bottom of the valve-chest e' alternately in opposite rows. One radial side of the valve-chest opens upon the atmosphere by the pipe e^4 and valve e^5 , and the other radial side is connected with an induction-bellows or other suitable source or reservoir of fluid motive power by the pipe e^6 . The valve e moves easily and yet fits closely the concave bottom and the sectoral sides of the valve-chest e' , and divides it into two separate chambers, which have as common bounding-walls the sectoral sides and the concave bottom (in which are the numerous ports e^3) of the valve-chest, as individual bounding-walls, respectively, the radial side connected with the bellows and the radial side open to the atmosphere, and as a common separating and magnitude-limiting wall the valve e . The governor-chest e' is placed upon a grooved or channeled board or table, j , which is similar to the grooved or channeled sound-board or sound-table used in organs for conveying wind from the valves to the pipes, except that it is narrow where the valve-chest is placed upon it, and becomes gradually wider as it leads to the power devices.

The grooved or channeled board or table j contains many grooves or channels, each of which connects pneumatically one of the ports e^3 in the valve-chest with its corresponding pneumatic cylinder l . The pneumatic cylinders l are placed on the top of the organ-case in a row, and each of them is furnished with a light close-fitting movable piston, l' , which is connected, by a cord, chain, rod, or other suitable connector, with the corresponding swell-valve. The swell-levers m are arranged in a row on the top of the organ-case, and each swell is suitably set upon a rod or axle, and covers a sound-port, A' , in the top of the organ-case, upon which it is held by its own weight, which also sustains the weight of the cord, chain, or rod l' and the piston l' . The different swell-valves are so regulated as to size and extent of opening that the opening of each additional one augments the loudness of tone by one degree of the dynamic scale, as hereinafter explained.

The general transmitter d of the dynamic manual need not differ in any respect from the general transmitter d of the pitch-manual, and it is connected with the dynamic governor by either the same mechanism as the general transmitter of the pitch-manual or by mechanism similar thereto.

The keys of the dynamic manual, unlike the keys of the pitch-manual, actuate no mechanism whatever save dynamic-governor mechanism—that is, mechanism for governing the loudness or intensity of the sound that shall reach the ear of the auditor. The keys of the dynamic manual are similar to the keys commonly used in organs, both with respect to their order and arrangement, and are mounted in the same manner and returned to their normal positions in the same manner—that is, by springs or weights—and have their depression

limited and their motion arrested in the same manner—that is, by a fixed bar placed under their front ends and covered with felt.

There is attached to the lower side of each key of the dynamic manual, immediately above the rail, rod, or tube d^4 , which forms the front of its general transmitter d , an adjustable slotted wedge-shaped piece, which is so adjusted, each on its own key, that each key advancing from left to right depresses the general transmitter d , placed below it, and moves the dynamic governor-valve connected therewith, as hereinbefore described, so much more than the next key to the left of it that an additional swell is opened, and the loudness of tone is augmented by one degree of a dynamic scale, as hereinafter described.

The operation of the parts described may be stated briefly as follows: The depression of different keys of the dynamic manual, or changes in pressure upon the keys of the pitch-manual, produce corresponding changes in the position of the valve e in the valve-chest e' , and changes in the position of said valve produce corresponding changes in the number of ports e^2 and power devices l connected with the bellows, and in the number of swells opened, and in the volume of sound which is able to escape from the organ-box.

As the first element of the combination mentioned in the statement of invention as the first principal point of my invention, I prefer to use all the keys of a key-board, as I have shown in the drawings; but I do not limit myself to so doing, for I may employ the keys of the lower part of the manual in one combination and the keys of the upper part of the manual in another similar combination; or I may have a larger number of combinations, in each of which a plural number of keys constitutes the first element; or, on the other hand, all the keys of several manuals or pedals may be used as one element of such a combination, for several transmitters may be connected with the same dynamic-governor-valve mechanism, either by separate connecting mechanism for each transmitter or by one lever or other similar mechanism, on which all of said general transmitters act.

As the second element of the combination designated in the statement of invention as the first principal point of my invention, I prefer to use the dynamic-governor-valve mechanism designated in the statement of invention as the fifth principal point of my invention; but I do not limit myself thereto, for I may employ instead of it any other suitable dynamic-governor mechanism whatever—as, for instance, that shown in Fig. 8, intended for free reeds, which operates by governing the quantity of wind permitted to pass between the bellows and the reeds.

As the third element of the combination mentioned in the statement of invention as the first principal point of my invention, I prefer to employ a parallelogrammatic frame, as shown in the drawings, placed under the front

ends of said keys transversely to their greatest length, of which one of the longer sides is the axis and the opposite side the part upon which the keys act; but I by no means limit myself to the particular form or arrangement shown, for the general transmitter may be made in other forms and placed in other positions almost as well, if not as well. The only points which must be observed by the builder in connection with the general transmitter are, that it be easily movable, that it be placed in such a position with relation to the keys that are arranged to actuate it that it receives pressure and motion from such keys when depressed, and that it be so connected with or attached to the dynamic governor that it transmits to it the motion which it receives from the keys. The general transmitter should be placed transversely to the keys, or to those keys that are arranged to actuate it—that is, it should be placed across the keys, (not necessarily at a right angle to them, nor with its greatest length, in all cases, transverse to their greatest length,) so that every one of them can actuate it.

I prefer to connect the general transmitter with the dynamic governor by such mechanism as that shown in the drawings—that is, mechanism whereby the ratio of the motion of the dynamic governor to the motion of the general transmitter increases or decreases in accordance with the increase or decrease in the pressure exerted by the general transmitter upon the connecting mechanism; but I do not limit myself to such a way of connecting them, for they may be connected in many other ways.

The advantages arising from the employment of the combinations designated as the first principal point of my invention are simplicity and economy both in the cost of the instrument and the space required by it, and these advantages are due to the fact that with this feature of my invention but one dynamic governor controlling swells, or other mechanism for governing the loudness of tone, is required to govern, in accordance with the touch upon the keys, the loudness of the tones of a whole organ, or of an organ manual or pedal, or of any desired part thereof; and with this feature of my invention it becomes easily possible to furnish an organ with a complex, complete, and perfect dynamic organism serving for the whole instrument, or for a large part of it, when it would be utterly impossible to furnish such a complex, complete, and perfect dynamic organism for every individual key, following the plan heretofore pursued, in organs in which the loudness of tone is governed by and in accordance with the touch upon the keys, of having a separate dynamic governor for every key, and as many dynamic governors in the instrument as there are keys; and when this feature of my invention is used in connection with dynamic-governor mechanism for reed-organs—such as that shown in Fig. 8, in which the loudness of the tones is governed by changes in the amount of wind supplied to the reeds—there is the additional

advantage that, as the same change in wind-pressure is made simultaneously for all the reeds that may be sounding, there is not that danger of changes in their relative rates of vibration that there would be if the wind-supply were governed independently by each key for its own reeds in accordance with the touch upon it, as has been done heretofore.

I show in the drawings as the dynamic-governor-valve mechanism mentioned in the statement of invention as the fifth principal point of my invention a sectoral valve-chest and a radial valve, and I show the ports cut in the concave bottom of the valve-chest; but the ports may be cut in one or both of the sectoral sides, the pneumatic connections being correspondingly changed; but I do not limit myself to the radial valve and sectoral valve-chest shown, since my invention may be carried out almost as well, if not as well, with other forms of valve and valve-chest, if only they be so constructed and arranged that the valve when in different positions throws different numbers of the power devices in communication with the source or reservoir of power.

The ports in the dynamic-governor-valve mechanism shown in the drawings and designated in the statement of invention as the fifth principal point of my invention may be connected with the corresponding power devices by any suitable pneumatic connections whatever. In the drawings I show for this purpose a grooved or channeled board or table having a groove or channel for connecting each port with the corresponding power device. It consists of an upper board and a lower board, which are glued together, between which are a number of convergent grooves or channels corresponding to the number of ports and power devices. These grooves may be cut in one or both of the boards, or they may be formed more conveniently by gluing small slips of wood between the boards and leaving spaces between the slips to form the channels. When the wind-pressure used is too great for wood to stand, a metal grooved or channeled board or table, or a system of metal pipes, may be used. As shown in the drawings, the greater part of this grooved or channeled board or table is broken away, only the part of it near the governor and the part of it near the power devices being seen. These two parts of the grooved board—or, more correctly, these two grooved boards—though parallel, are not in the same horizontal plane, and must be so connected that their channels shall form continuous passages between the ports in the dynamic governor and the power devices on the top of the organ-case. This can be done when the pressure used is small by means of a similar grooved or channeled board or table placed in a perpendicular or nearly perpendicular position, with each of its grooves or channels connected with one of the grooves or channels in the lower grooved or channeled board or table upon which the governor is set, and with the corresponding groove or channel in the

upper grooved or channeled board or table upon which the power devices are set, so as to form one continuous passage from the power device to the corresponding port or ports in the dynamic governor; but when the pressure used is considerable, or it is deemed desirable for any other reason, metal pipes—one for each power device—reaching from the power devices, or from the grooves in the grooved table upon which the power devices are set, to the lower grooved or channeled board or table connecting each power device with the corresponding groove therein, and forming a continuous passage between each power device and the corresponding port or ports in the dynamic governor, may be used.

As shown in the drawings, the valve-chest is placed below the keys in close proximity to the actuating mechanism. It may, however, be placed in any other suitable position whatever—as, for instance, on top of the organ-case near the pneumatic power devices—and be connected with the keys or dynamic governor by any suitable connecting mechanism whatever; but, in whatever position it may be placed, I prefer, as before said, to connect the actuating mechanism with the dynamic-governor-valve mechanism by mechanism such, for instance, as that shown, whereby the ratio of the motion of the dynamic governor-valve to that of the actuating mechanism increases or decreases in accordance with the increase or decrease in the intensity of the pressure exerted by the actuating mechanism upon the connecting mechanism.

As pneumatic power devices I have shown small metal cylinders bored true and furnished with movable close-fitting pistons. These I prefer to work by exhausting the air from the cylinders, so that when the port or ports connected with any given cylinder are, by the motion of the dynamic governor-valve, thrown in communication with an induction-bellows or other vacuum reservoir, a part of the air contained in the cylinder escapes to the induction-bellows, the density and pressure of what remains is reduced, and the superior external pressure of the atmosphere forces down the piston, which, by a suitable connector, opens a swell. I do not, however, claim anything for the particular form of power device shown; nor do I limit myself thereto, as any other suitable form of power device, may be used instead.

In many places in this specification, and all through the accompanying claims, I use the single word "bellows" to refer to the source or reservoir of fluid motive power with which the power devices are to be connected. I do not use the word as referring to any particular machine or apparatus, but generically to any and every machine or apparatus suitable for the purpose. Many forms of such machines are known and in use for similar purposes in organs. They are well known, form no part of my invention, and require no description; but I prefer, for the operation of the

swells, to employ a pressure of several pounds—say from four to eight—upon a small piston in a small cylinder, rather than to employ, as is now done in organs for a similar purpose, a low pressure upon a bellows used as a power device, for the cylinder and piston under high pressure occupy much less space than a power-bellows large enough to perform the same work under low pressure, and nothing but low pressure can be used in a leathern bellows. Moreover, the cylinder, with its well-fitted piston, is much less liable to loss of motive fluid by leakage than is a large leathern bellows, and it can open the swell with much greater celerity.

As the series of swell-valves which constitute the second point of my invention, and by means of which the third point of my invention is carried out, I show in the drawings a number of swell-levers, (but only a part of the whole series, the greater part of which is broken away,) all of which are mounted upon the top of the organ-case and cover sound-ports therein. I do not, however, claim anything for the particular form of swell-valve shown; nor do I limit myself thereto, as any other suitable form of swell-valve whatever may be used instead, and several swell-valves may be joined together, so as to act as one, and be actuated by the same power device, and be, to all intents and purposes of this specification, the same as a single larger swell.

In the main I consider it desirable that each one of the series of swells open to its full extent as quickly as possible, so that, when taken in connection with the other necessary members of the series, it shall give promptly the required dynamic degree; but for the production of true crescendo and diminuendo effects by imperceptible degrees it is necessary that each successive swell that is opened or closed be made to open or close gradually, and that the last swell opened (and every swell is in its turn, or in some particular combination of swells corresponding to a particular dynamic degree, the last swell opened) be made to open and remain open to a greater or less extent, in accordance with the touch upon the keys. When this is desired, the leak-hole stop *q*, which is placed beneath the cylinders in the grooved or channeled table in a groove of its own, which is transverse to the channels *j'*, that connect the power devices with the corresponding ports in the governor, is opened in order to bring a leak-hole in the bottom of the channeled table in communication with the corresponding groove or channel, *j'*, that opens upon the cylinder, in order that air may leak into the cylinder, and that the ratio of leak and supply and the pressure of the air upon the piston may vary according to the position of the valve over the corresponding port, and so the swell opens to a greater or less extent until it reaches an equilibrium between the pressure exerted upon it by the piston, tending to open it, and the resistance of the contractile spring, which is arranged, as shown in the drawings, with one end

attached to a fixed bar on the top of the organ-case and the other end attached to the end of the swell-lever, so as to exert upon it a strain transverse to its path of motion and an opposition to its opening, which increases as the lesser right-angled component of its motion increases.

But this method of causing a variable pressure upon a piston or other actuating part of a power device to open a swell-valve to an extent proportional to that pressure, as above described, is not the only way by which the same result can be attained. Such mechanism as that used for connecting one part of the actuating mechanism—the general transmitter or key—with one part of the dynamic governor—the governor-valve—so that the extent of motion of the latter is proportional to the pressure upon the former, and so that the ratio of the motion of the latter to that of the former increases or decreases in accordance with the increase or decrease in the pressure upon the former, can obviously be used for connecting another part of the actuating mechanism—the power device—with another part of the dynamic governor mechanism—the swell-valve—so that the extent of opening of the latter is proportional to the pressure upon the former, and so that the ratio of the motion of the latter to that of the former increases or decreases in accordance with the increase or decrease in the pressure upon the former.

I describe in this specification two different methods of governing the loudness of the tones of an organ by means of swells. One of these methods, which is embodied in the mechanism whose mode of operation has been described in the last two paragraphs, consists in governing the loudness of the tones of an organ with swells by opening them to a greater or less extent, in accordance with the loudness of tone desired. This method of operation is old, and is found in all organs that have swells. The other method of operation, which has been designated in the statement of invention as the third principal point of my invention, consists in governing the loudness of the tones of an organ with a series of swells by opening a greater or smaller number of the swells of said series, in accordance with the loudness of tone desired. I prefer, in accordance with what I have shown in the drawings and described in this specification, to employ the last-mentioned method for producing the degrees of the dynamic scale hereinafter described, and for producing all the important changes in the loudness of tone, and to employ the first-mentioned method only for giving, when desired, a tone that is softer than that given by the particular number of swell opened when the last one of said swells is opened to its full extent, (all the others that are opened will be opened to their full extent anyway,) and louder than that given by the number of swells next below this number, and for the production of crescendo and diminuendo by imperceptible degrees, when such

effects are desired. My reasons for this preference are the following: Where the loudness of tone is governed by and in accordance with the touch upon the keys, with a single swell-valve or with an aggregation of swell-valves or swell-shutters equivalent to a single large swell, by opening said swells to a greater or less extent, in accordance with the loudness of tone desired, the whole mass of said swells must be set in motion for every change in the loudness of tone, however small that change may be, and to make a great increase or decrease in the extent of opening of said swells and in the loudness of tone must necessarily take a much longer time than is required to make a small increase or decrease in the extent of opening of said swells and in the loudness of tone, and in being moved all the swells necessarily acquire a momentum which, when they have reached what should be the limit of their motion, carries them on beyond it a greater or less distance, and which, when taken in connection with the opposing spring or gravitational resistance which must necessarily exist, causes them to vibrate for a longer or shorter period of time, and to produce during that period corresponding vibrations or tremolos in the loudness of tone; but when the loudness of tone is governed by the method designated in the statement of invention as the third principal point of my invention—that is, by opening a greater or smaller number of swells, according to the loudness of tone desired—but a small mass, perhaps a single swell only out of forty or fifty swells, is set in motion in order to make a slight change in the loudness of tone, and to make a great increase or decrease in the number of swells opened and in the loudness of tone takes no longer time than is required to make a small increase or decrease in the number of swells opened and in the loudness of tone, for power can be supplied to any number of the swells of the series practically at the same instant, so that they will all open at the same instant, and the momentum which each individual swell acquires in opening or closing is instantly destroyed by the cushioned obstacles against which it strikes, so that there is no chance for it to execute any vibrations or produce a tremolo, and each swell can be opened and closed with such celerity that there will be no perceptible crescendo or diminuendo, and the ear will get the benefit of a clearly-marked and instantaneous change in the loudness.

Instead of connecting each of the power devices with a swell-valve, as shown in Figs. 10 and 11, some of the power devices, or all of them, may be connected with speaking-stops or similar mechanism whereby wind is admitted to a speaking-register, as shown in Figs. 12 and 13. Thus changes in the touch upon the keys of the pitch-manual or the depression of different keys of the dynamic manual results in the opening of different numbers of speaking-stops; but on account of the expense

incident to a large number of speaking-registers, and on account of the fact that it interferes with the performer's free control of the registration, I do not consider this method of governing the loudness of tone in accordance with the touch by any means so practical, in the great majority of cases, as that by swells, nor suitable for any but the largest organs, more especially for large pedal organs, for which it may be used, while the method of governing the loudness of the tones by means of swells is used for the tones produced by the manuals of the same instrument, in which the pipes are not so large and do not require so much speaking-room as do the pipes of the pedal organ.

In the present state of the art of organ-building it will be readily understood that in all large organs I may use the power devices that are controlled directly by the dynamic governor to actuate the swells or speaking stops, not directly, but by means of any suitable form of pneumatic or electro-magnetic power devices, which actuate the swells, and are themselves governed by the power devices that are controlled directly by the dynamic governor, and that I may cause the keys of the dynamic manual to actuate the dynamic governor or general transmitter, not directly, but by means of any suitable form of pneumatic or electro-magnetic power devices, and that in these cases the pneumatic or electro-magnetic power devices thus used instead of the keys of the dynamic manual, or the power devices controlled directly by the dynamic governor, as a relay to overcome the final resistances, are, to all intents and purposes of this specification, and in all the combinations herein described, the equivalents of the keys or power devices whose work they perform and by which they are controlled.

By the term "pitch-manual" I mean a keyboard in which each key corresponds to a certain definite pitch of tone, which is obtained by depressing the key. By the term "pitch-key" I mean a key of a pitch-manual. By the term "dynamic manual" I mean a keyboard in which each of the keys corresponds not to any particular pitch, but to a certain definite loudness of tone, which is obtained by depressing the key, if any notes are sounding; and by the term "dynamic key," when used with reference to a material object or element of a machine or combination, I mean a key of a dynamic manual. By the term "pitch-tuning" I refer to that which is generally understood by the word "tuning"—that is, regulating or adjusting the pitch of a sound; and by the term "dynamic tuning" I refer to a somewhat similar regulating or adjusting of the loudness of a sound. By a "dynamic scale" I mean a scale of loudness or intensity of sonorous vibrations, in contradistinction to a scale of pitch or rapidity of sonorous vibrations. I prefer to employ a dynamic scale whose degrees bear the same mathematical relations to each other as do the degrees of the

diatonic pitch-scale, which, when the scale is natural and not tempered, are to each other, as is well known, as the numbers 24, 27, 30, 32, 36, 40, 45, 48, and so on through succeeding 5 octaves. The degrees of such a diatonic dynamic scale may be represented by the characters commonly called "notes," written upon a staff, in exactly the same way in which the degrees of the diatonic pitch-scale are com- 10 monly represented, the position of the degree in the scale being indicated by its position upon the staff, and the length of time it is to be held being indicated by the character used.

The diatonic dynamic scale may have, and 15 should have, intermediate "soft" and "loud" degrees corresponding to the "sharp" and "flat" degrees of the diatonic pitch-scale, and by means of these soft and loud degrees transposition can be made into dynamic keys cor- 20 responding to the twenty-four pitch-keys, both major and minor.

The same signs now used to indicate sharp, flat, and natural, with reference to the de- 25 grees of the pitch-scale, may be used in the same way with reference to the degrees of the dynamic scale written on the dynamic staff, which may be distinguished, when necessary, from the staves on which the pitch-notes are written by a different clef.

30 The dynamic degree written, or any dynamic degree desired, may be produced from the instrument by depressing the corresponding key of the dynamic manual, or by exerting the corresponding pressure upon the pitch-keys. 35 The former way admits of the most rapid and accurate execution of dynamic passages; but it requires one of the performer's hands for the dynamic manual, and so leaves him only his other hand and his feet for the production of 40 the harmony; and for its highest development and the production of the most brilliant effects two performers are required—the first to produce the harmony and the other to gov- 45 ern the dynamics.

50 The second method of producing the dynamic degrees is more difficult to acquire, for the ear must be trained to recognize accurately and instantly the dynamic degree desired, and the muscles must be trained to produce it; but it does not subtract anything from the per- 55 former's power to manipulate the pitch-keys and produce the harmony.

The advantages to be derived from the use of a dynamic scale and an organ attuned 60 thereto and the imperfections in the present state of the art of music, which may be overcome by the proper use of the dynamic scale and dynamically-tuned organs, may be seen from the following:

65 The science of music is generally divided, elementarily, into three departments. These are rhythmic, melodic, and dynamics. The first of these relates to the length of the notes and the number of beats, or units of time, to a measure. The second relates to the pitch of a note, and the third to its loudness. Rhythmic and melodic have long been re-

duced to rule and system and a mathematical basis, so that the pitch of a sound and its du- 70 ration can be and are expressed by means of characters which bear to each other well-known constant and definite relations. Thus the semibreve, or whole note, is equal to two minims, or half-notes, and to four crotchets, or 75 quarter-notes. A note and its octave are to each other as one to two, a note and its fifth as two to three, and so on; but the third department of music—dynamics—has never been reduced to a mathematical basis, or become, in any sense, 80 a definite and well-understood art, even as to its first principles. The loudness of sounds is not written or otherwise expressed in any terms, or by any characters that can be said to mean anything definite, or to convey any ex- 85 act or mathematical idea as to the relative loudness of two or more successive notes, chords, measures, or passages.

The one important rule of dynamics is, that the first beat in a measure should be accented—that is, should be more intense than any 90 other—but how much more intense it is to be than the other notes of the measure, or how those notes are to differ from each other in intensity, is not indicated. A number of words—as 95 "pianissimo," "piano," "mezzo piano," "mezzo," "mezzo forte," "forte," "fortissimo," "crescendo," "diminuendo," "sforzando," and a number of even more vague terms—are used to convey some idea of the 100 dynamics of a musical composition; but they are exceedingly indefinite, and do not by any means necessarily convey the same idea to any two different persons at the same time, nor even to the same person at different 105 times.

A great composer may write a musical com- 110 position and convey to the minds of other musicians an exact idea of the melodic and rhythmic relations of the individual sounds that make up the composition, so that they can exactly and perfectly reproduce those parts of 115 his musical creation; but his art furnishes him no means of conveying to others in writing or by words, or in any other intelligent manner, an exact and definite idea, (if, indeed, he him- 120 self can have a definite and accurate idea of that which has never been reduced to rule or system or definitely and accurately expressed in any intelligent or permanent manner, either 125 by writing or otherwise,) nor even an approximately exact idea, of the dynamic relations of the notes—those relations upon which depend the light and shade and the life of the expres- 130 sion—that which distinguishes the playing of the master from that of the common performer.

By the introduction of a dynamic scale, as herein described, and the use of dynamically-tuned organs, both composers and executants can get a definite idea of musical dynamics and of what is necessary to produce the peculiar 135 effects desired and what is to be avoided; and the dynamic part of those musical creations which come to the mind of a great composer only in moments of so-called "inspiration,"

and is forever after lost, because it cannot be expressed or recollected in any definite way, can be written, as well as the rhythmic and melodic part, so that the complete whole may be reproduced thereafter by the composer himself or by others exactly as it then appeared to him; and the mediocre performer or mere executant, who is thus able to reproduce not merely the exact skeleton—the exact rhythmic and melodies—but the rhythmic, melodies, and dynamics—the exact and complete whole—will be able to gain far more correct ideas of the nature of true expression in a short time than he can now acquire at all.

A succession of different instantaneous changes in the pitch of a sound in accordance with the degrees of the pitch-scale, constituting pitch melody, is pleasing to the ear; so, also, to a less extent, is a succession of different instantaneous changes in the loudness of a sound in accordance with the degrees of the dynamic scale, constituting dynamic melody, pleasing to the ear, and the highest perfection of music is to be attained in a proper and judicious combination of these two. The use of a dynamic scale, as herein described, and an instrument attuned to it, as well as to the diatonic pitch-scale, lays open to the artist and to the world this new field—this new branch of musical science.

Having set forth to some extent the advantages of dynamically-tuned instruments, and having said hereinbefore that each swell should be so regulated as to its size (or, more correctly, the size of the port it covers) and extent of opening that when opened, in addition to the swells smaller than itself, or below it in the series, it augments the loudness of tone by one additional degree of the dynamic scale, I shall describe a way in which this may be done. In the first place it should be understood that this particular method of dynamic tuning relates to the regulation of the amount of tone that shall escape from the organ-box, rather than to the regulation of the amount of tone that shall be produced. The tone-producers of each register are to be voiced, as they are now, so that all give equally loud tones, whatever their pitch may be. Then the dynamic tuning is done upon the swells, so that the dynamic governor controls in the same way and to the same extent the loudness of any particular tone or tones that may be sounding. The areas of the different ports and the sizes of the different swell-valves should increase as the values of the numbers that express the relations of the different corresponding dynamic degrees (that is, the different dynamic degrees which should be given by the different swells when each of them is opened in conjunction with all the swells that are below it in the series, and with those only) increase. This must be attended to in the building of the instrument. Then the extent to which each swell is opened should be made to be easily adjustable. This may be done by means of the adjustable slotted wedge-shaped

piece shown in Fig. 5, or by means of a screw and lock-nut, or by means of any of the many contrivances known to mechanics for regulating the magnitude of the angular motion of a lever.

The correctness of pitch-tuning is proved by the smoothness and unitary character of the sounds when produced simultaneously; but in my method of dynamic tuning the truth of the dynamic degree for which the swells are adjusted is verified by the smoothness with which successive and instantaneous changes can be made from a tone or number of unison tones inside the swell-box of the organ to a tone or number of tones outside that swell-box of exactly the same quality and pitch as that in the organ and of the exact loudness desired—a standard tone with which that inside the organ is compared—and by the unitary character which the sound preserves through all such changes from one source of sound to the other; and if the sound from inside the swell-box of the organ is softer or louder than that from outside it the extent of opening of the swell should be increased or decreased until the two sounds are exactly equal and cannot be distinguished from one another. This should be done, first, for the swell that is smallest or lowest in the series, in order to obtain by means of it the lowest dynamic degree; then, augmenting the loudness of the standard tone outside the box by one degree, or employing another standard that is louder by one degree, and keeping the first swell open, it should be done with the next lowest swell, so as to obtain the next dynamic degree, which is the resultant of the actions of these two swells; then, keeping the swells already tuned open and again augmenting the loudness of the standard tone by one degree, or employing another standard that is louder by one degree, the next lowest swell should be tuned with its standard, so as to obtain the next dynamic degree, which is the resultant of the actions of the particular swell tuned so as to obtain it and of all the swells below it in the series, (each of which has been in its turn tuned to give a particular degree of the dynamic scale,) and so on through the whole series of swells.

The tones required as dynamic standards for tuning may be obtained by means of a series of tone-producers of different sizes and power, but all of the same pitch and quality of tone, each of which corresponds to a different degree of the dynamic scale; or by means of a great number of small tone-producers of exactly the same pitch, loudness, and quality of tone, different numbers of which are sounded simultaneously to produce the required dynamic degree; or by means of a small swell-box and series of swells that have been accurately tuned in the manner that I have just described; or, which is the best way, by a combination of two or more of these methods, preferably a combination of the last two.

In a large organ there are of course several

key-boards. All the tone-producers of all the different key-boards may be inclosed in one and the same swell-box, or organ-case serving as a swell-box, and, as before said, the swells
 5 for governing their loudness of tone may be governed by one dynamic governor, which is itself actuated by the touch upon any one of the key-boards, or upon any number of them, or upon a dynamic key-board; but when the
 10 additional expense can be incurred it is in many respects better to inclose the tone-producers of each key-board in a swell-box of their own, and to have for every key-board a dynamic governor controlling the swells placed
 15 upon the corresponding swell-box and itself controlled by the touch upon the keys of that key-board, and to have a dynamic manual corresponding to each pitch-manual and controlling the same dynamic governor.

20 While the dynamic manual, dynamic scale, and dynamically-tuned swells are parts of my invention, and, in my judgment, by no means unimportant parts, yet they are only parts, and the other parts can be used without them;
 25 for whether the dynamic manual be used or not, and whether the swells be dynamically tuned or not, all the points of invention that are enumerated in the first eight clauses of the statement of invention, and some others
 30 that are not so enumerated, can still be carried out by the mechanism described, and the loudness of the tones of even the largest organ can be governed by the touch upon the keys as perfectly and instantaneously as
 35 the loudness of the tones of a bowed instrument can be governed by the bowing; and whether the dynamic manual and dynamically-tuned swells be used or not—but more especially when they are used—a skillful performer upon such an organ, which has this
 40 ability to emphasize and accent each individual chord or note, and to control its loudness at will, and to increase or decrease its loudness while it sounds, in addition to its power
 45 to sustain its tones perfectly for any desired length of time, and to produce any required volume of tone, and to produce different qualities and combinations of tones, can produce not only musical effects which have hitherto
 50 required a large orchestra and many performers, but also many musical effects which have hitherto been impossible.

As I have described hereinbefore not only the novel combination of a number of swell-
 55 valves and power devices and dynamic-governor-valve mechanism with an organ-key or with organ-keys, whereby a greater or smaller number of the said power devices are supplied with power and a greater or smaller
 60 number of the said swell-valves are opened, and whereby any individual swell may be opened to a greater or less extent, according to the touch upon the keys, but also—which is included in the former—the novel combination
 65 of each single swell-valve and power device, and therefore of a single swell-valve and power device, with dynamic-governor-valve mechanism,

ism, and with an organ-key or with organ-keys, whereby the supply of motive fluid to said power device and the extent to which the
 70 said swell is opened is governed by and in accordance with the touch upon the key or keys which operate it, I wish it to be understood that the loudness of the tones of an organ may be governed in this way with a single swell-
 75 valve and power device by supplying more or less motive fluid to the power device and opening the swell to a greater or less extent, and that the said swell, though it be large and heavy, may be moved with a very considerable
 80 degree of celerity, because whatever amount of power may be required to move it, however large or heavy it may be, is supplied by and in accordance with the touch upon the keys from an external source—as, for instance, an
 85 air-rarefying, air-compressing, or pumping engine—instead of being supplied by the muscles of the performer acting upon the keys—the plan pursued heretofore in organs in which the extent of opening of the swells is governed
 90 by and in accordance with the touch upon the keys; and when a single swell-valve and power device is thus used alone and apart from such a series as that hereinbefore described, as the said power device is or may be always connected
 95 with the source or reservoir of motive power, so that more or less motive fluid can pass between it and the source of supply, the valve-chest, through which the motive fluid passes between the two parts before mentioned,
 100 need not be, and should not be, open to the atmosphere on one side, and as it is not necessary that there be in the said valve-chest any more valve-governed ports than there are power devices a single such port will of course
 105 suffice for a single power device.

For a "swell," "single swell," "power device," "single power device," "power device and swell," "single power device and swell," mentioned in the preceding paragraphs
 110 and in other parts of this specification, it will be understood that an aggregation of the parts named, the same in function and mode of operation as a single one of them, may of course be used.
 115

I am aware that a number or series of swell-valves or swell-shutters, all mounted or set upon the same swell-box, covering ports, holes, or open areas therein, and all connected together, so as to act as one, at the same instant
 120 and to the same extent—a mere aggregation, the equivalent of a single large swell—is in common use in organs. In this case a single swell-valve of the series, with its operating-connections, forms a perfect dynamic governor of its kind by itself, and its mode of operation by which it governs the loudness of tone—that is, opening to a greater or less extent—is complete in itself, and is in no way
 125 affected by the presence or absence of any or all the other members of the series; but I employ, preferably, a series of swell-valves which are all placed upon the same swell-box, covering ports, holes, or open areas therein, which
 130

are independent of each other, so far as their individual construction is concerned, (considered alone and apart from their connections,) but which are completely bound together in their function and mode of operation and in their operative connections, so that, with the single exception, in some respects, of the first member of the series, no one can act at all until those smaller than itself or below it in the series have first acted, so that no one stands for anything by itself, or produces any dynamic degree by itself, but only in conjunction with those smaller than itself or below it in the series—a series of swells used for carrying out a mode of operation which requires for its embodiment a series as such, and which could not be carried out with but a single swell or an aggregation of swells equivalent to a single swell. As I know no more convenient and definite term by which to describe such a series, I shall hereinafter call it a series of quasi-dependent quasi-independent swell-valves, when necessary.

I have described some mechanisms and elements of combinations that are novel and many combinations that are novel. For these, when used in a manner and for a purpose substantially similar to that herein described, I desire protection; but my invention does not by any means reside wholly, or even principally, in the mere devices and mechanisms shown, but rather in the novel modes of operation of which those devices and mechanisms are only particular embodiments, for this specification is not merely a disclosure of novel devices, mechanisms, and combinations for performing old functions and carrying out old modes of operation. It is rather a disclosure of mechanisms, devices, and combinations that embody modes of operation that have not existed heretofore for the performance of functions that have never been performed heretofore. I do not therefore limit myself to the special details herein shown and described; but

What I claim, and desire to secure by Letters Patent, is—

1. In an organ or other similar instrument, dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest having a number of ports and a valve so constructed and arranged as to move over said ports and establish communication or shut off communication between the bellows and a smaller or greater number of said ports, substantially as described in the foregoing specification.

2. In an organ or other similar instrument, dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest having communication with the bellows on one side and with the atmosphere on the other, and having a number of ports and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a smaller or greater number of said ports, and shut off communication between the atmosphere and those ports which are in com-

munication with the bellows, substantially as described in the foregoing specification.

3. The combination of the key of an organ or other similar instrument with dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest having a number of ports and a valve so constructed and arranged as to move over said ports and establish communication or shut off communication between the bellows and a greater or smaller number of said ports, substantially as hereinbefore described.

4. The combination of the key of an organ with dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest having communication with the bellows on one side and with the atmosphere on the other, and having a number of ports and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a smaller or greater number of said ports, and shut off communication between the atmosphere and the port or ports which are in communication with the bellows, substantially as described in the foregoing specification.

5. The combination of the keys of an organ or other similar instrument, or of any desired plural number of said keys, as hereinbefore described, with a general transmitter, as hereinbefore described, placed transversely to said keys; and so constructed and arranged that it receives pressure and motion from any one of the keys that is arranged to actuate it when such key is depressed, and from any number of such keys that may be depressed when more than one of them are depressed, substantially as hereinbefore described.

6. In an organ or other similar instrument, the combination of a number of suitable pneumatic power devices, as hereinbefore described, with dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest pneumatically connected with the bellows, and having a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve so constructed and arranged as to move over said ports and establish communication or shut off communication between the bellows and a smaller or greater number of said ports and pneumatic power devices, substantially as set forth in the foregoing specification.

7. The combination of a number of suitable pneumatic power devices, as hereinbefore described, and dynamic-governor-valve mechanism, as hereinbefore described, consisting, essentially, of a valve-chest which is pneumatically connected with the bellows, and has a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a smaller or greater number of said ports and power devices, according to its position, with the key of an organ or other similar instrument, which is connected with

the before-mentioned valve, so that the position of said valve and the number of power devices to which power is supplied are governed by and in accordance with the touch upon said key, all substantially as described in the foregoing specification.

8. The combination of the keys of an organ or other similar instrument, or of any desired plural number of said keys, as hereinbefore described, and a dynamic governor, as hereinbefore described, with a general transmitter, as hereinbefore described, mechanically connected with said dynamic governor and placed transversely to the before-mentioned keys, and so constructed and arranged with relation to said keys that it receives pressure and motion from any of the keys that are arranged to actuate it when such key is depressed, and from any number of such keys that may be depressed when more than one of them are depressed, and transmits the motion thus received to the before-mentioned dynamic governor, and forms a connection between whatever key or number of keys may be depressed and said dynamic governor, so that the motion of said dynamic governor is governed by and in accordance with the touch upon said key or number of keys, all substantially as described in the foregoing specification.

9. The combination of a number of suitable pneumatic power devices, as hereinbefore described, and dynamic-governor-valve mechanism, as hereinbefore described, consisting, essentially, of a valve-chest pneumatically connected with the bellows, and having a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a greater or smaller number of said ports and power devices, according to its position with the keys of an organ, or with any desired plural number of said keys, as hereinbefore described, and a general transmitter, as hereinbefore described, mechanically connected with the before-mentioned valve, and placed transversely to the before-mentioned keys, and so constructed and arranged that it receives pressure and motion from any one of the keys that are arranged to actuate it when such a key is depressed, and from any number of such keys that may be depressed when more than one of them are depressed, and transmits the motion thus received to the before-mentioned dynamic governor-valve, and forms a connection between said valve and whatever key or number of the keys arranged to actuate it may be depressed, so that the position of said dynamic governor-valve and the number of power devices to which power is supplied are governed by and in accordance with the touch upon said key or number of keys, all substantially as described in the foregoing specification.

10. In an organ or other similar instrument, the combination of a number of suitable swell-valves and power devices, as hereinbefore de-

scribed, with dynamic-governor-valve mechanism, as hereinbefore described, consisting, essentially, of a valve-chest connected with the bellows, and having a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a smaller or greater number of said ports and power devices, according to its position, substantially as described in the foregoing specification.

11. The combination, with the key of an organ or other similar instrument, of a number of suitable pneumatic power devices and swells, as hereinbefore described, and suitable dynamic-governor-valve mechanism, consisting, essentially, of a valve-chest connected with the bellows, and having a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve connected with the before-mentioned organ-key, and so constructed and arranged as to move over said ports and establish communication or shut off communication between the bellows and a greater or smaller number of said ports and pneumatic power devices, in accordance with the touch on the before-mentioned key, substantially as described in the foregoing specification.

12. The combination of a number of suitable pneumatic power devices and swells, as hereinbefore described, and dynamic-governor-valve mechanism, as hereinbefore described, consisting, essentially, of a valve-chest pneumatically connected with the bellows, having a number of ports corresponding to the before-mentioned power devices and pneumatically connected therewith, and a valve so constructed and arranged as to move over said ports and establish communication between the bellows and a greater or smaller number of said ports and power devices, according to its position, with the keys of an organ, or with any desired plural number of said keys, as hereinbefore described, and a general transmitter, as hereinbefore described, mechanically connected with the before-mentioned dynamic governor-valve, and placed transversely to the before-mentioned keys, and so constructed and arranged that it receives pressure and motion from any one of the keys that are arranged to actuate it when such key is depressed, and from any number of the keys arranged to actuate it that may be depressed when more than one of them are depressed, and transmits the motion thus received to the before-mentioned dynamic governor-valve, and forms a connection between said valve and whatever key or number of the keys arranged to actuate it may be depressed, so that the position of said dynamic governor-valve, and the number of ports and power devices in communication with the bellows, and the number of power devices to which power is supplied, and the number of swells opened are governed by and in accordance with the touch

upon the before-mentioned key, or number of keys, all substantially as described in the foregoing specification.

13. In an organ or other similar instrument, the combination of suitable dynamic-governor mechanism, and the key or other part that actuates said mechanism, with the cord, belt, or flexible chain *g* and pulley *i*, and constructed and arranged substantially as hereinbefore described, or equivalent mechanism for transmitting motion from said key to said governor mechanism, whereby the ratio of the motion of said governor mechanism to the motion of said key increases gradually in accordance with the touch upon said key, substantially as described in the foregoing specification.

14. The combination, with the keys of an organ or other similar instrument, or with any suitable number of said keys, and a general transmitter placed transversely to said keys, or otherwise suitably set with relation thereto, and suitable dynamic-governor mechanism, of the flexible chain, cord, or belt *g* and the pulley *i*, or equivalent mechanism, for transmitting motion from any one or number of said keys to said dynamic-governor mechanism, whereby the ratio of the motion of said governor mechanism to the motion of said key or keys increases in accordance with the touch upon said key or keys, substantially as described in the foregoing specification.

15. In an organ or other similar instrument, a dynamic manual having a number of keys, each of which corresponds to a certain degree of a suitable dynamic scale, as hereinbefore described, which degrees have constant mathematical relations—as, for instance, those of the diatonic scale—said keys being arranged progressively from the softer degrees to the louder degrees, and being so constructed as to return to their normal positions when no longer held down by the player, substantially as described in the foregoing specification.

16. In an organ or other similar instrument, the combination of the keys of a dynamic manual, or of a plural number of said keys, with a general transmitter, as hereinbefore described, placed transversely to said keys, said parts being in such a manner constructed and arranged with relation to each other that the different keys, when depressed, move said general transmitter into correspondingly different positions, substantially as described in the foregoing specification.

17. In an organ or other similar instrument, the combination of a dynamic governor, as hereinbefore described, with the keys of a dynamic manual, as hereinbefore described, or with a plural number of said keys, and a general transmitter, as hereinbefore described, connected with or attached to said dynamic governor and placed transversely to the before-mentioned keys, said keys and general transmitter being arranged with relation to each other in such a manner that different keys, when depressed, move said general trans-

mitter and dynamic governor into correspondingly different positions, substantially as described in the foregoing specification. 70

18. In an organ or other similar instrument, the combination of a dynamic governor, as hereinbefore described, with all the keys of a dynamic manual, as hereinbefore described, or with a suitable plural number of said keys, said parts being constructed and arranged with relation to each other in such a manner that different keys, when depressed, move the before-mentioned dynamic governor into correspondingly different positions, substantially as described in the foregoing specification. 75 80

19. The combination of a suitable swell-valve, as hereinbefore described, or an aggregation of such swell-valves, and a suitable pneumatic power device, as hereinbefore described, or an aggregation of such power devices, and suitable dynamic-governor-valve mechanism—such, for instance, as that hereinbefore described—consisting of a valve-chest pneumatically connected with the bellows and with the before-mentioned power device or aggregation of power devices, and having a port or number of ports, through which the motive fluid must pass, between the bellows and the before-mentioned power device or aggregation of power devices, and a valve so constructed and arranged that it uncovers said port or ports to a greater or less extent, according to its position, and permits more or less fluid to pass between the bellows and the before-mentioned power device or aggregation of power devices, according to its position, with all the keys of an organ, or with any desired plural number of the keys of an organ, constructed and arranged to operate the before-mentioned dynamic governor-valve by suitable connecting mechanism—as, for instance, a general transmitter, as hereinbefore described—connected with or attached to the before-mentioned valve and placed transversely to the before-mentioned keys, and so constructed and arranged that it receives pressure and motion from any one of the keys that are arranged to actuate it when such key is depressed, and from any number of the keys that are arranged to actuate it that may be depressed when more than one of them are depressed, and transmits the motion thus received to the before-mentioned dynamic governor-valve, with which it is connected or to which it is attached, whereby the position of the before-mentioned dynamic governor-valve and the quantity of motive fluid permitted to pass between the bellows and the before-mentioned power device or aggregation of power devices, and the extent to which the swell or swells connected with said power device or power devices are opened, is governed by and in accordance with the touch upon the before-mentioned key or number of keys, substantially as described in the foregoing specification. 85 90 95 100 105 110 115 120 125 130

20. The combination of a suitable swell-valve, as hereinbefore described, or an aggregation of such swell-valves, and a suitable

pneumatic power device, as hereinbefore described, or an aggregation of such power devices, and suitable dynamic-governor-valve mechanism—such, for instance, as that hereinbefore described—consisting of a valve-chest pneumatically connected with the bellows and with the before-mentioned power device or aggregation of power devices, and having a port or number of ports, through which the motive fluid must pass, between the bellows and the before-mentioned power device or aggregation of power devices, and a valve so constructed and arranged that it uncovers said port or ports to a greater or less extent, according to its position, and permits more or less motive fluid to pass between the bellows and the before-mentioned power device or aggregation of power devices, according to its position with the key of an organ connected with the before mentioned valve, as hereinbefore described, so that the position of said valve and the quantity of motive fluid permitted to pass between the bellows and the before-mentioned power device or aggregation of power devices and the extent to which the swell or swells connected with said power device or power devices are opened is governed by and in accordance with the touch upon the before-mentioned key, substantially as described in the foregoing specification.

21. The combination of a series of swell-valves which are, with regard to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, and with an organ-key constructed and arranged to operate said series of swell-valves by suitable intervening mechanism—as, for instance, such dynamic-governor-valve mechanism as that described in the foregoing specification and a series of suitable pneumatic power devices, as hereinbefore described—whereby a greater or smaller number of said swell-valves are opened, according to the touch upon the before-mentioned key.

22. The combination of a series of swell-valves which are, with regard to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, with all the keys of an organ, or with any desired plural number of said keys, constructed and arranged to operate the before-mentioned series of swell-valves by suitable intervening mechanism—as, for instance, a general transmitter, as hereinbefore described, such dynamic-governor-valve mechanism as that described in the foregoing specification, and a series of suitable pneumatic power devices, as hereinbefore described—whereby a greater or smaller number of said swell-valves are opened, according to the touch upon whatever key or number of the before-mentioned keys may be depressed.

23. The combination of a series of swell-valves which are, with respect to each other,

quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, and a series of suitable pneumatic power devices, as hereinbefore described, each of which is connected by its piston or other actuating part with one of the swell-valves before mentioned, so that it opens it when supplied with power, with an organ-key constructed and arranged to operate said series of power devices and swells by suitable intervening mechanism—as, for instance, such dynamic-governor-valve mechanism as that described in the foregoing specification—whereby the number of the before-mentioned power devices to which power is supplied and the number of the before-mentioned swell-valves opened is governed by and in accordance with the touch upon the before-mentioned key.

24. The combination of a series of swell-valves which are, with respect to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas, and a series of suitable pneumatic power devices, as hereinbefore described, each of which is connected by its piston or other actuating part with one of the swell-valves before mentioned, so that it opens it when supplied with power, with all the keys of an organ, or with any desired plural number of said keys, constructed and arranged to operate the before-mentioned series of power devices and swells by suitable intervening mechanism—as, for instance, a general transmitter, as hereinbefore described, and such dynamic-governor-valve mechanism as that described in the foregoing specification—whereby the number of the before mentioned power devices to which power is supplied and the number of the before-mentioned swell-valves opened is governed by and in accordance with the touch upon whatever key or number of the before-mentioned keys may be depressed.

25. The combination of a series of swell-valves which are, with respect to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, with all the keys of a dynamic manual, or with any desired plural number of said keys, constructed and arranged to operate the before-mentioned swell-valves by suitable intervening mechanism—as, for instance, a general transmitter, as hereinbefore described, such dynamic-governor-valve mechanism as that described in the foregoing specification, and a series of suitable pneumatic power devices, as hereinbefore described—whereby different numbers of the before-mentioned swell-valves are opened by the depression of different dynamic keys.

26. The combination of a series of swell-valves which are, with respect to each other, quasi-dependent and quasi-independent, as

hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, and a series of suitable pneumatic power devices, as hereinbefore described, each of which is connected by its piston or other actuating mechanism with one of the swell-valves before mentioned, so that it opens it when supplied with power, with all the keys of a dynamic manual, as hereinbefore described, or with any suitable plural number of said keys, constructed and arranged to operate the before-mentioned series of power devices and swell-valves by suitable intervening mechanism—as, for instance, a general transmitter, as hereinbefore described, and such dynamic-governor-valve mechanism as that described in the foregoing specification—whereby power is supplied to different numbers of the before-mentioned power devices, and different numbers of the before-mentioned swell-valves are opened by the depression of different dynamic keys.

27. In an organ in which the loudness of tone is governed by and in accordance with the touch upon the keys, as a part of the mechanism for this purpose, a series of swell-valves which are, with respect to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, in combination with a series of suitable pneumatic power devices, as hereinbefore described, each of which is connected by its piston or other actuating part with one of the swell-valves before mentioned,

so that it opens it when supplied with power, said series of swell-valves and power devices being made to embody the mode of operation hereinbefore described, which consists in governing the loudness of the tones of an organ by and in accordance with the touch upon the keys of the pitch-manual, or by the depression of different keys of the dynamic manual, by supplying power to a greater or smaller number of power devices connected with swell-valves and opening a greater or smaller number of said swell-valves, according to the loudness of tone required.

28. In an organ in which the loudness of tone is governed by and in accordance with the touch upon the keys, as a part of the mechanism for this purpose, a series of swell-valves which are, with regard to each other, quasi-dependent and quasi-independent, as hereinbefore described, and which are all placed upon the same swell-box, covering ports, holes, or open areas therein, and which are made to embody the mode of operation hereinbefore described, which consists in governing the loudness of the tones of an organ by and in accordance with the touch upon the keys of a pitch-manual, or by and in accordance with the depression of different keys of a dynamic manual, by opening a greater or smaller number of said swell-valves, according to the loudness of tone required.

THADDEUS CAHILL.

Attest:

PHILIP MAURO,
J. HENRY KAISER.