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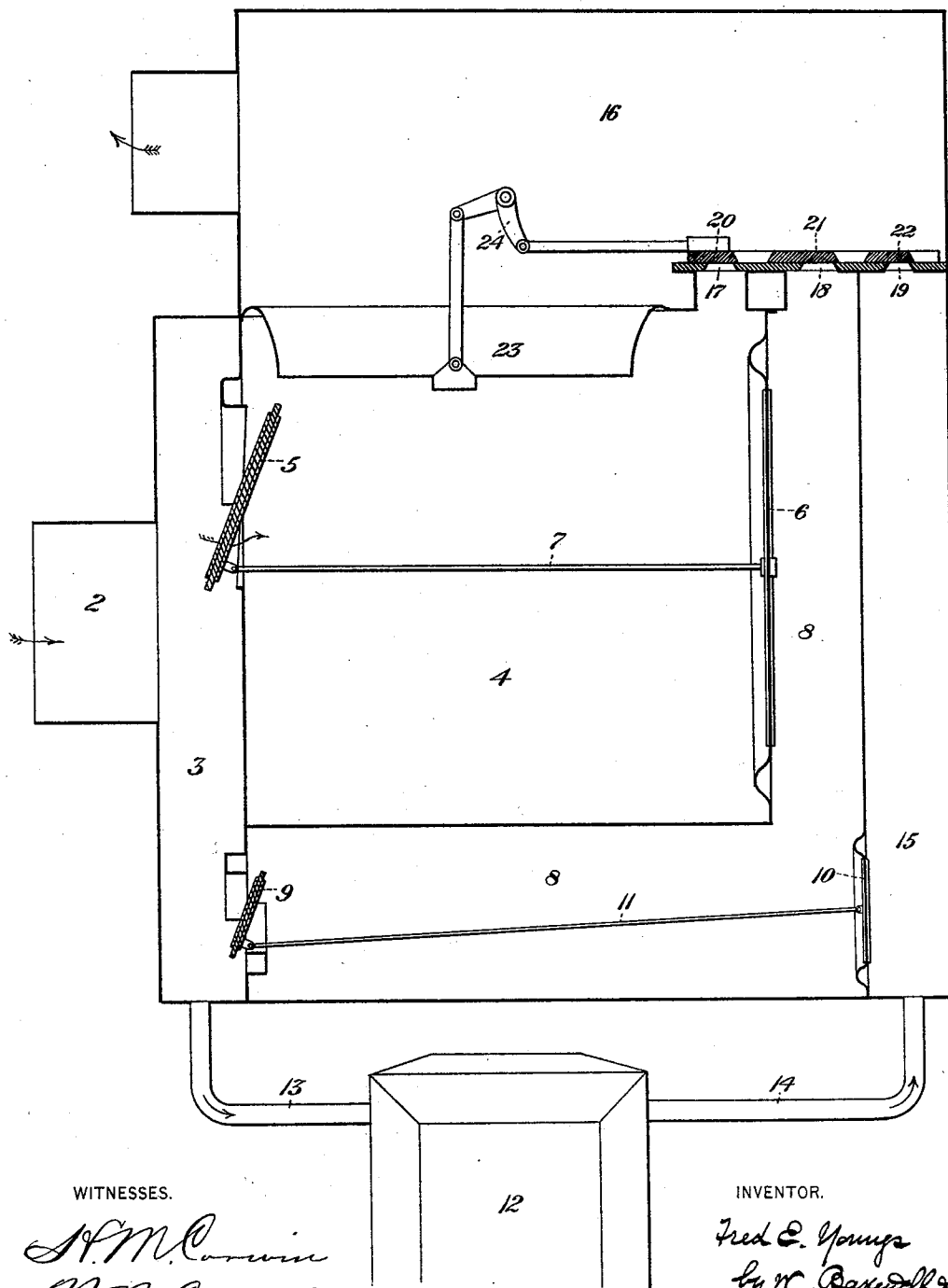
6 Sheets—Sheet 1.

F. E. YOUNGS.
PROPORTIONAL METER.

No. 583,107.

Patented May 25, 1897.

Fig. 1a.



WITNESSES.

J. M. Corwin
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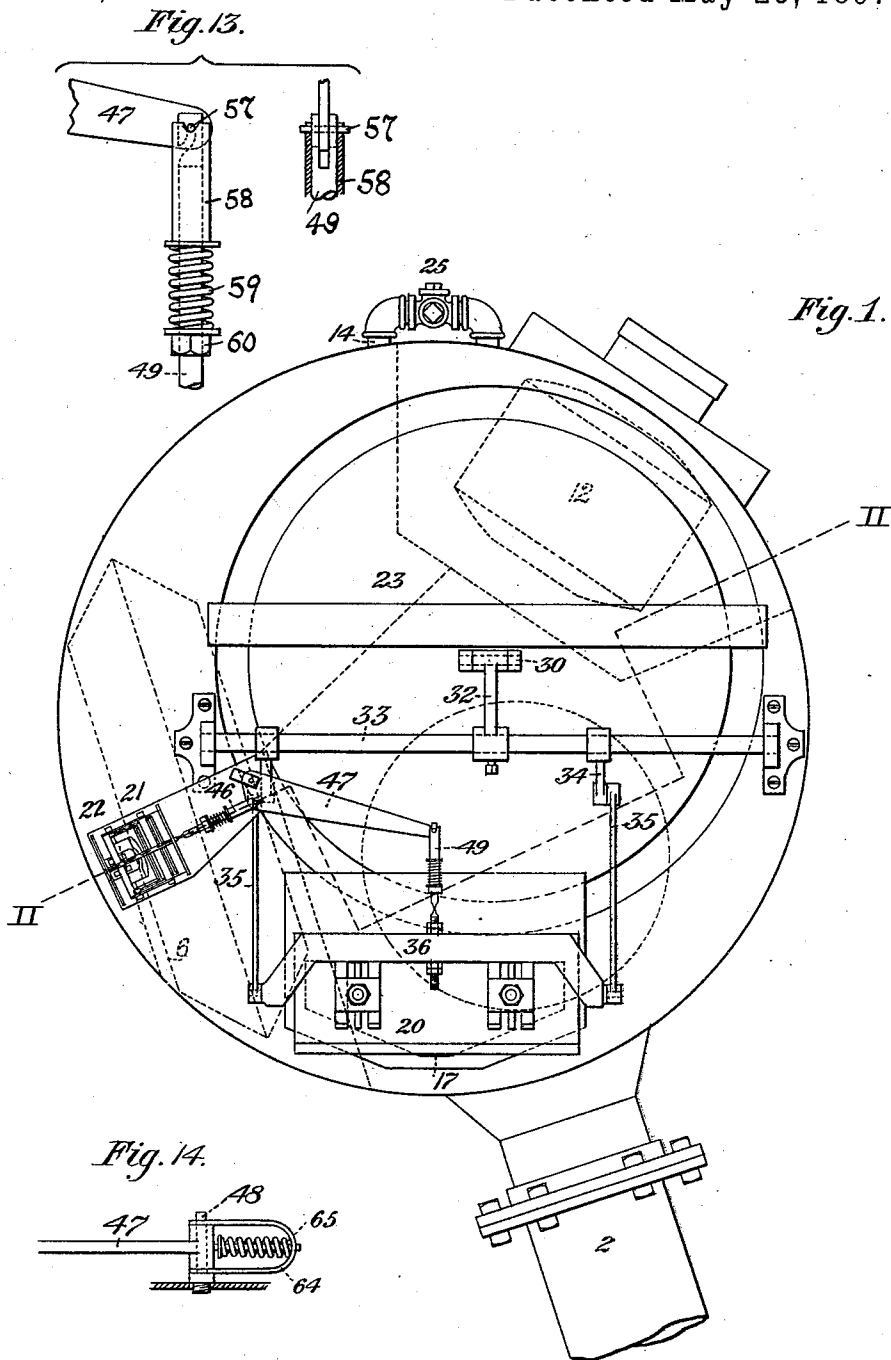
(No Model.)

6 Sheets—Sheet 2.

F. E. YOUNGS.
PROPORTIONAL METER.

No. 583,107.

Patented May 25, 1897.



WITNESSES.

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(No Model.)

6 Sheets—Sheet 3.

F. E. YOUNGS.
PROPORTIONAL METER.

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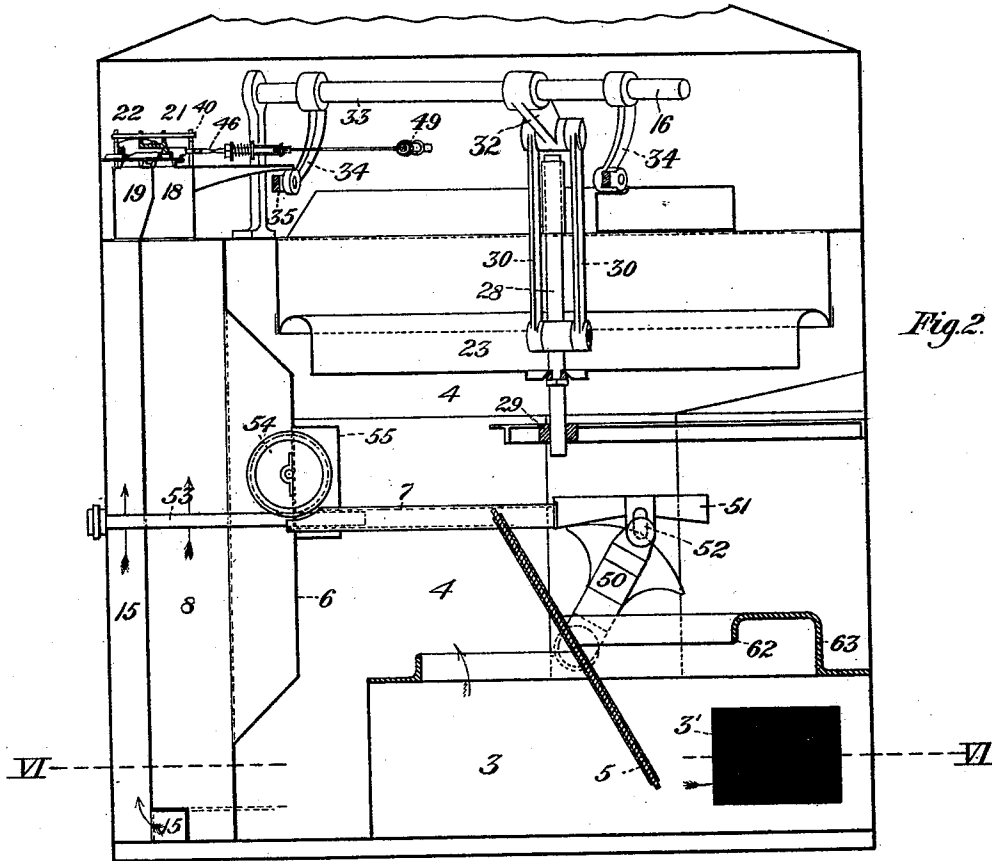


Fig. 2.

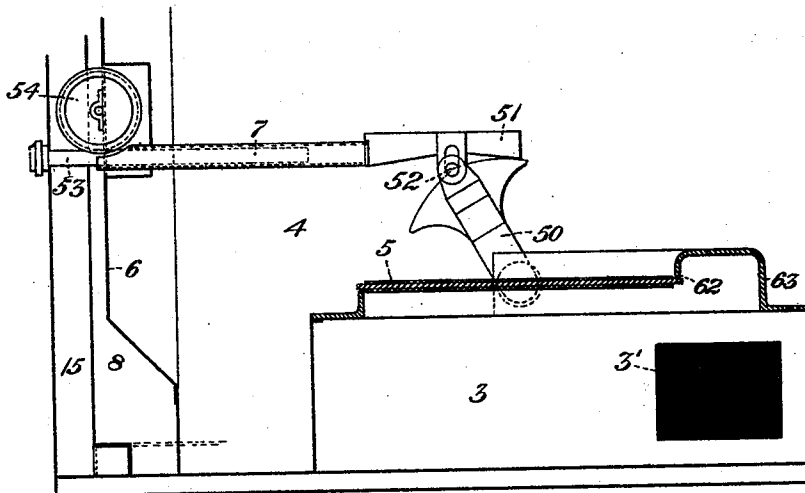


Fig. 3.

WITNESSES.

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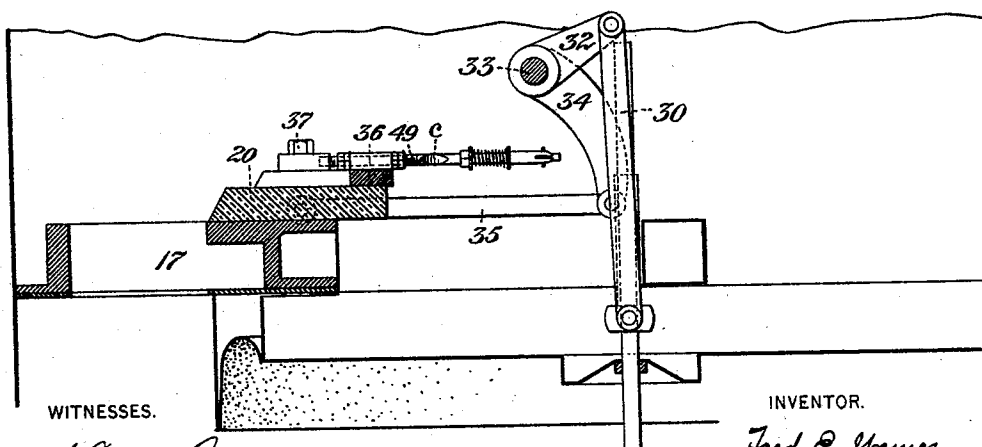
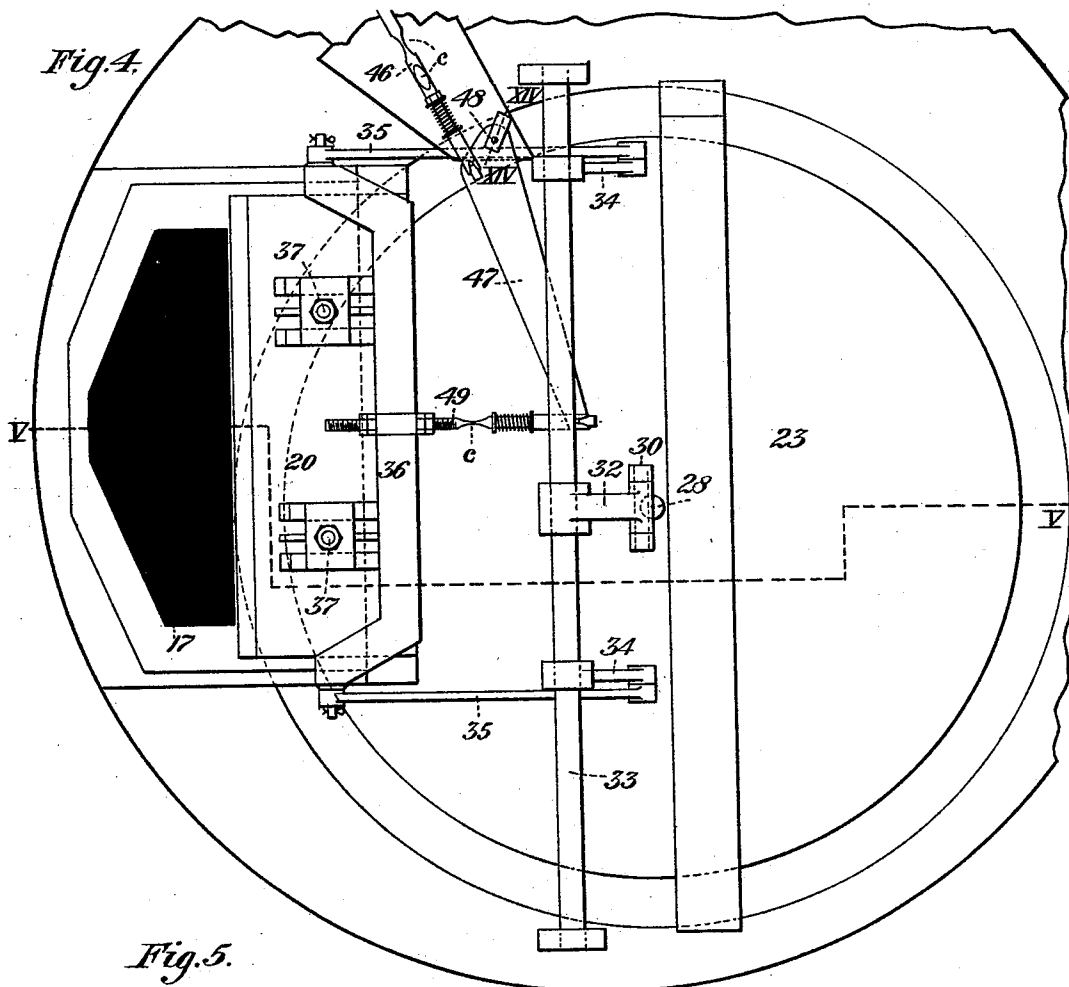
(No Model.)

6 Sheets—Sheet 4.

F. E. YOUNGS.
PROPORTIONAL METER.

No. 583,107.

Patented May 25, 1897.



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(No Model.)

6 Sheets—Sheet 5.

F. E. YOUNGS.
PROPORTIONAL METER.

No. 583,107.

Patented May 25, 1897.

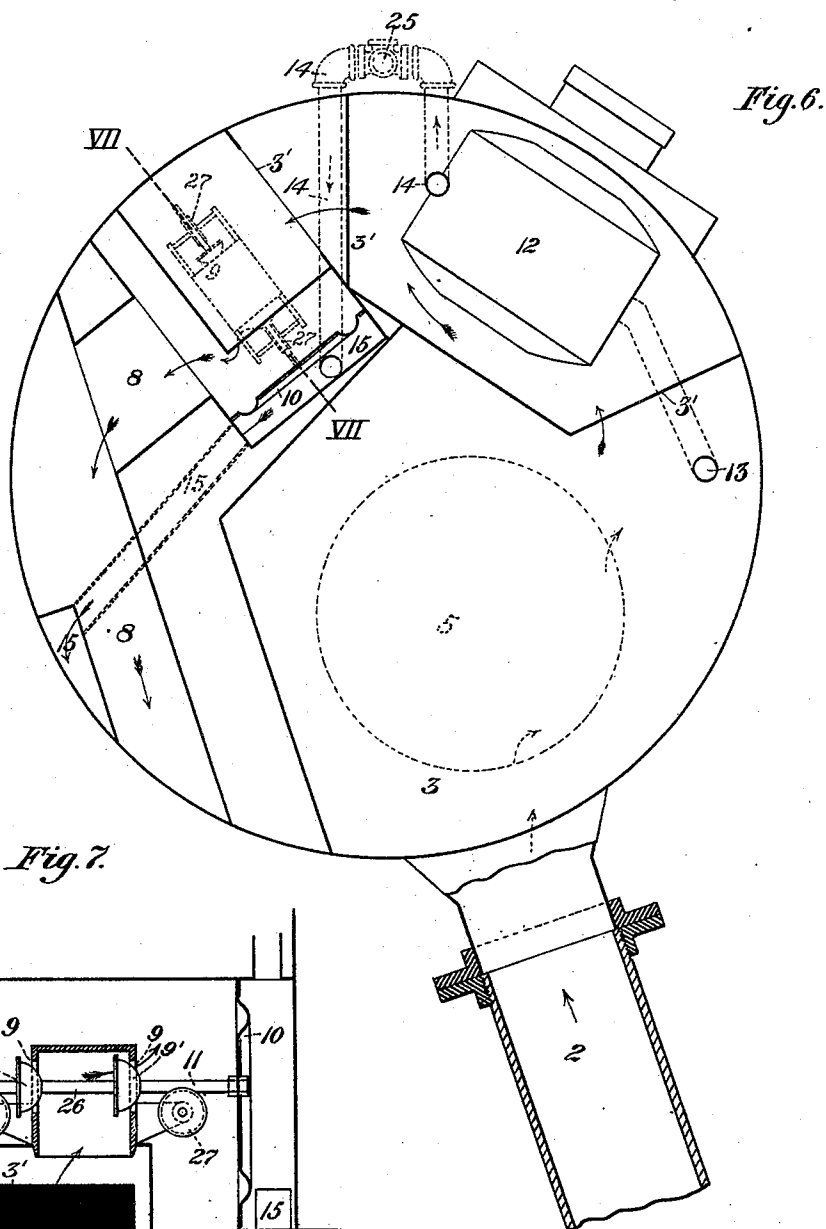
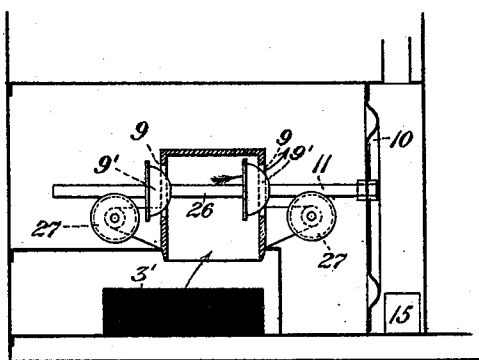


Fig. 7.



WITNESSES.

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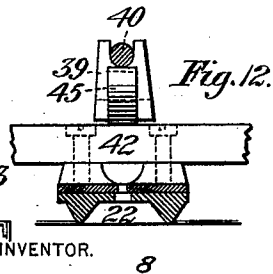
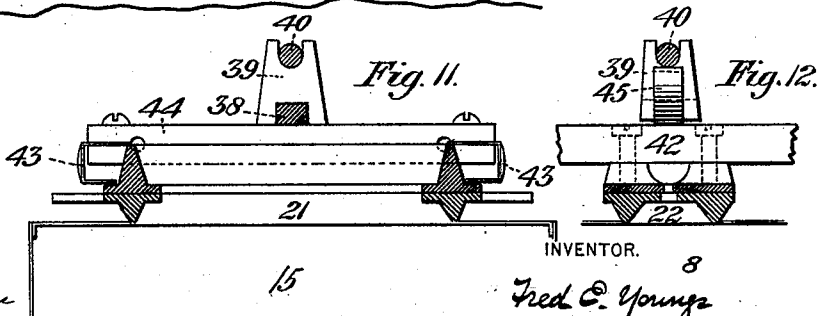
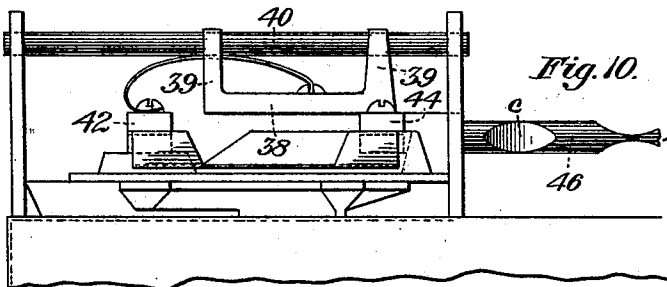
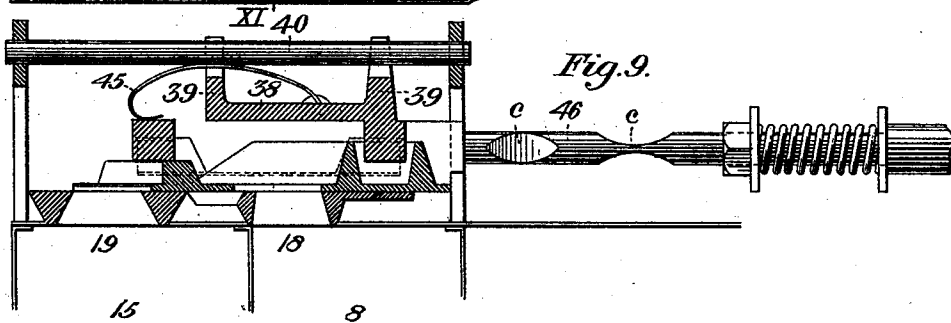
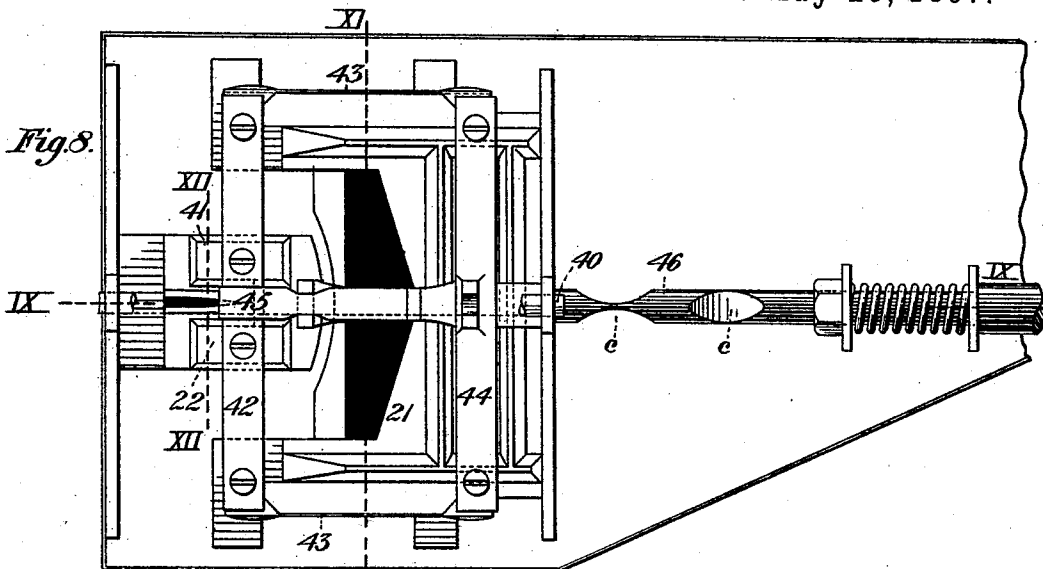
(No Model.)

6 Sheets—Sheet 6.

F. E. YOUNGS.
PROPORTIONAL METER.

No. 583,107.

Patented May 25, 1897.



WITNESSES.

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UNITED STATES PATENT OFFICE.

FRED E. YOUNGS, OF PITTSBURG, PENNSYLVANIA.

PROPORTIONAL METER.

SPECIFICATION forming part of Letters Patent No. 588,107, dated May 25, 1897.

Application filed December 26, 1890. Serial No. 375,850. (No model.)

To all whom it may concern:

Be it known that I, FRED E. YOUNGS, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Proportional Meters, of which the following is a full, clear, and exact description, reference being had to the accompanying six sheets of drawings, forming part of this specification, in which—

Figure 1^a, Sheet 1, is a vertical section of my improved proportional meter. The other figures of the drawings show a meter embodying my invention, but having parts somewhat differently constructed and arranged. Fig. 1, Sheet 2, is a top plan view of the meter, the top being removed to disclose the interior thereof. Fig. 2, Sheet 3, is a vertical section on the line II II of Fig. 1. Fig. 3 is a partial section on the line II II of Fig. 1, showing the valve 5 closed. Fig. 4, Sheet 4, is a partial detail view on an enlarged scale, illustrating the valve 20 and its operating mechanism. Fig. 5 is a vertical section on the line V V of Fig. 4. Fig. 6, Sheet 5, is a horizontal section on the line VI VI of Fig. 2. Fig. 7 is an enlarged vertical section on the line VII VII of Fig. 6, showing the balanced valve 9. Fig. 8, Sheet 6, is an enlarged plan view of the proportional valves 21 and 22. Fig. 9 is a vertical section on the line IX IX of Fig. 8. Fig. 10 is a side elevation of said valves. Fig. 11 is a cross-section on the line XI XI of Fig. 8. Fig. 12 is a cross-section on the line XII XII of Fig. 8. Fig. 13, Sheet 2, is a detail view showing in plan view and in longitudinal section the coupling between the proportional lever and the stem of the valve 20. Fig. 14, Sheet 2, is a detail view taken on section-line XIV XIV of Fig. 4.

Like symbols of reference indicate like parts in each view.

My invention relates to an improvement in that class of meters known as "proportional" meters, in which the fluid to be measured (gas or liquid) is divided into currents bearing a known ratio to each other, the larger current passing to the delivery-pipe unmeasured, while the smaller current passes through a tally-meter, where its volume is measured and indicated. The ratio in volume between the measured and unmeasured portions being known, the volume of the whole is de-

terminable by a simple process of calculation. The portion of gas which passes through the tally-meter loses a part of its pressure in operating the parts of the tally-meter, so that in its exit therefrom it is at less pressure than the unmeasured portion of the gas. This loss of pressure is variable, changing with the different conditions of pressure and volumes of gas flowing through the meter. It is therefore necessary, in order to secure accurate results, to employ regulating mechanism which reduces the unmeasured portion of the gas to the same pressure as the measured portion before these two currents unite and pass to the delivery-pipe. Such mechanism preferably consists of a diaphragm acted upon on one side by the pressure of the gas-current passing to or from the tally-meter and on the other side by the pressure of the unmeasured current of gas. Examples of meters of this class are illustrated in my prior patents, Nos. 412,824 and 413,121, dated October 15, 1889. In such meters as heretofore constructed the gas has been divided into but two currents, one of which passes through the tally-meter, while the other is unmeasured, and although this construction answers well enough in meters designed for light work, in which the ratio between the unmeasured and measured volumes is small, there are practical difficulties in its application to meters in which such ratio is very large. For example, suppose a proportional meter having a capacity of one hundred thousand feet per hour combined with a tally-meter having a capacity of only sixty feet per hour. In order to establish an equilibrium of pressure between the two gas-currents in such meter, it is necessary to employ a very large balanced valve, and the extent of stroke required to open or close it completely would cause so great displacement and require such a volume of gas to move the regulating-diaphragm that in case of a suddenly-increased demand on the proportional meter the volume passing through the tally-meter would greatly exceed its capacity and would be apt to injure it, so as to unfit it for use. I have invented a method and means by which this difficulty can be obviated and which enable the use of proportional meters of very great capacity and render it possible to measure large volumes of gas with the same degree of

accuracy that is attained in measuring small volumes in the ordinary meter. This method consists in dividing the gas into three or more streams of successively greater volume. The
 5 smallest volume is passed through a tally-meter, while the others may be unmeasured, and each volume of gas is employed to regulate the pressure of the next larger one. Thus suppose the gas is divided into three
 10 streams and that the volume of the largest is forty-nine times larger than the volume of the other two, while the second volume is thirty-two and one-third times larger than the smallest volume which passes through the
 15 tally-meter. In such case the small tally-meter current is quite capable of operating the diaphragm controlling the valve which regulates the second volume of gas without danger to the parts of the meter, while the
 20 second volume is ample to regulate the largest volume. In the case supposed, which is made quite practicable by my invention, the measured and unmeasured volumes are in the ratio of one to sixteen hundred and sixty-six
 25 and two-thirds, a ratio altogether impossible to be maintained in any proportional meter heretofore known to me. Within the principle of my invention it is possible also to construct a meter in which the gas is divided
 30 into four or more currents, each of successively greater volume and each serving to regulate the pressure of the next.

My invention consists, broadly, in the method above indicated, also in the apparatus
 35 by which it is practiced, and in certain features of construction of the parts of the apparatus, as hereinafter described, and concisely summarized in the claims.

I shall now proceed to describe my invention, so that others skilled in the art to which it pertains may make and use the same.

Fig. 1^a shows a proportional gas-meter embodying my invention in which the various chambers and valves are arranged symmetrically in a rectangular case, so that all the
 45 parts are illustrated clearly in a vertical sectional view. A meter so constructed is operative and efficient, and because of the simplicity of its construction I shall first describe my invention generally with reference thereto
 50 and shall then describe it with reference to the modified construction shown in the other figures, in which the parts, though for the most part similarly constructed, are somewhat differently arranged. The meter shown
 55 in the last-mentioned figures is contained in a cylindrical case and is the preferred form of my invention, for although apparently more complicated it is mechanically easier to construct.
 60

In Fig. 1^a, 2 is the inlet-pipe of the proportional meter, and 3 the inlet-chamber. 4 is the chamber into and through which the largest volume of gas passes. 5 is a balanced valve
 65 which controls the inlet to said chamber, and 6 is a movable diaphragm which forms the whole or part of one of the walls and is con-

nected with the balanced valve by a suitable connection 7. 8 is the chamber through which the smaller volume of gas passes, and 9 is a
 70 balanced valve which controls the passage of gas therinto. The gas in this chamber acts on the diaphragm 6 with a pressure opposite to that exerted by the gas in the chamber 4, and also acts on a diaphragm 10, which by
 75 means of a suitable connection 11 is joined to and operates the valve 9. 12 is the usual tally-meter, through which the smallest volume of gas passes. 13 14 are pipes leading to and from the tally-meter, and 15 is a chamber
 80 communicating with the pipe 14 and so situated relatively to the diaphragm 10 that the gas therein shall exert on the diaphragm a pressure opposite in direction to that exerted thereon by the gas in the chamber 8. 16 is
 85 the outlet-chamber, which by means of suitable ports 17 18 19 is connected with each of the chambers 4, 8, and 15. These ports or the valves controlling them are proportioned in area relatively to each other, so as to permit
 90 the largest volume of gas to pass from the chamber 4, a smaller volume to pass from the chamber 8, and a still smaller volume to pass from the chamber 15. They are controlled by
 95 valves 20, 21, and 22, which may be made integral with each other and are adapted by their motions to close their respective ports proportionately. These valves are operated
 100 by a diaphragm 23, which is acted upon by the gas in the chamber 4 and is connected with the valves by levers 24 in such manner that the gas-pressure in said chamber shall tend to open them. This diaphragm is weighted so that the pressure in the outlet-chamber
 105 16 shall be less by a known loss of pressure than the gas in the chambers 4, 8, and 15.

The operation of the meter when thus constructed is as follows: The whole volume of gas enters the meter at 2 and is there divided into three streams, of which the
 110 greatest in volume passes through the port controlled by the valve 5, the next greatest passes through the port controlled by the valve 9, and the smallest, which bears a known ratio in volume to the sum of the
 115 volumes of the other two streams, passes through the pipe 13 to the tally-meter, by which its volume is measured and indicated, and thence through the pipe 14 to the chamber 15. A certain amount of pressure of the
 120 smallest volume is lost in the work of operating the tally-meter, so that the gas in the chamber 15 is at a less pressure than the gas in the inlet-chamber 3. It is the function of the diaphragms 6 and 10 and the valves 5
 125 and 9 to maintain a constantly equal pressure of gas in all the chambers 4, 8, and 15, so that the difference in the volume of the currents passing through the ports 17, 18, and 19 shall be due only to the difference in
 130 the area of said ports and not to any difference in the pressure of the gas or fluid passing through them. If, for example, the gas in the inlet-chamber 3 has a pressure of ten

inches and if in passing through the tally-meter it loses one inch, so that its pressure in the chamber 15 is nine inches, this pressure exerted on the diaphragm 10 tends to open the balanced valve 9 and admits a current of gas sufficient to maintain in the chamber 8 an equal pressure of nine inches, by which the diaphragm is balanced. In like manner the gas in the chamber 8 acts on the diaphragm 6, and by reason of its connection with the balanced valve 5 maintains in the chamber 4 the same pressure (nine inches) as in each of the other chambers. This method of controlling the pressure of the largest volume of gas by means of the action of an intermediate multiple is of remarkable efficiency and is claimed by me broadly herein. It permits the ratio between the larger unmeasured volumes of gas and the measured volumes to be very large without impairing the efficiency of the apparatus or endangering the tally-meter. From the chambers 4, 8, and 15 the gas passes through the ports 17, 18, and 19 to the outlet-chamber, and as these ports are provided with valves controlled by the weighted diaphragm 23, the gravity of which tends to close them, a definite and equal reduction in pressure of each volume is caused in passing through the ports, and the area of opening of each of the latter is caused to vary proportionally to the variation in volume of the gas passing through the meter. By thus reducing the pressure of the gas in its passage to the outlet-chamber the variation in the ratio between the volumes of the measured and unmeasured portions of the gas, which may be caused by defective operation or adjustment of the valves 5 or 9, is reduced to such a small degree as not to affect appreciably the practical efficiency of the apparatus. The reason of this is explained in the specification of a prior patent, No. 413,121, granted to me on October 15, 1889.

I desire it to be understood that so far as the broad claim for the method of operating the meter is concerned, my invention is not limited to the employment of apparatus of the precise nature described, since with proper changes of construction and form of the parts the same method may be applied to the operation of proportional meters of other varieties.

I shall now describe the construction of meter shown in Figs. 1 *et seq.*, in which like reference-symbols are used to designate the parts as in Fig. 1^a. The parts of the apparatus, including the tally-meter 12, are set in a cylindrical case, their relative arrangement being shown clearly in the drawings. The balance-valve 5 (shown as a circular metal disk) is set directly above the inlet-chamber 3, between it and the chamber 4, and is connected with the diaphragm 6 by a lever 50 and a hollow stem 7, which is closed and is fixed to the diaphragm at one end and at the other end is provided with a shoe 51, which rests upon an enlarged head of the

lever 50, whose end is of circular arc and fits against a correspondingly-shaped portion of the side of the shoe. The connection between the stem and lever is made by a pin and roller and slot 52, so that as the diaphragm moves the stem it will also swing the lever and rotate the valve and that in every position of these parts the stem shall be supported by the lever and shall move in a straight line, Figs. 2 and 3. To support the diaphragm and the other end of the stem 50, I employ a fixed tube 53, closed at the outer end, which enters the tube 7, and an anti-friction-wheel 54 is journaled to the diaphragm and bears on the rod, so as to transmit to the latter the weight of the diaphragm and of the stem 7. The wheel projects through the diaphragm and on the side next the chamber 4 is inclosed in a box or casing 55, which prevents passage of gas from one side of the diaphragm to the other.

In Fig. 2 the valve 5 is shown when open, and in Fig. 3 it is shown closed. The arrangement of this valve is peculiar and constitutes one of the items of my invention.

Heretofore, even in apparatus requiring great accuracy of operation, balanced butterfly-valves have been arranged without special reference to the shape of the casing of the valve, it being supposed that if the valve-disk itself were balanced evenly on its bearings it would not be affected by the flow of the gas no matter what the shape of the case. This may be true enough for some purposes, but for a proportional meter the valve must be so perfectly balanced that even when hung to swing with as little friction as possible it will be entirely static in any position it may be placed no matter what the pressure or volume of the gas passing through it.

In the ordinary construction of balanced valves this is not possible, but in the form here shown it is accomplished to a very nice degree. The distance of the seating edge 62, Figs. 2 and 3, of the valve-case from the inside of the valve-case at 63 is made about one-half of the radius of the valve-disk. When thus constructed, there is no position in the swing of the valve where the distance from the valve-disk to the seating edge of the valve-case is not less than its distance from the inside of the case at 63. The clearance-space is thus always greater than the amount of opening of the valve. A like amount of clearance-space must be allowed on the outside of the valve on the opposite side of the pivot or shaft carrying the valve-disk. A valve of this construction may be placed between flanges in a line of pipe and will be perfectly balanced under all conditions of flow, and it is this construction that I intend to claim broadly.

From the inlet-chamber 3 a passage 3' leads to the tally-meter 12 and to the balanced valve 9, Figs. 2, 3, 6, and 7. The tally-meter may be set directly in the passage and an opening provided in it for entrance of the

gas. The pipe 14 extends from the delivery side of the tally-meter to the passage 15 and is provided with a suitable cock 25. The passage 15 extends horizontally, as shown in Fig. 6, and thence upwardly, as shown in Fig. 2. The balanced valve 9, instead of being a butterfly-valve, as in Fig. 1^a, is illustrated as a double puppet-valve having two conoidal valve portions 9' fixed to a stem 26 and adapted to control opposite ports, as shown in Fig. 7. The stem is secured to the diaphragm 10 and may be supported on antifriction-rollers 27. The valves 9' are preferably so shaped that at every position a longitudinal movement of the stem shall produce a definite change of constant degree in the area of the ports which they control.

The diaphragm 23 between the chambers 4 and 16 is fixed to a vertical rod 28, which moves in suitable guides 29 and is connected by links 30 and lever 32 to a cross-shaft 33, to which the lever 32 is keyed. This shaft is connected by crank-arms 34 and links 35 to a cross-head 36, adjustably secured by bolts 37 and slotted connections to the valve 20, which slides over and controls the port 17, one side of which is preferably made of triangular form, in the manner and for the reasons described in my prior patent, No. 412,824, and the modifications in construction indicated in the specification of that patent with reference to this valve and to the other proportional valve may be applied to the meter of the present application.

The other slide-valves 21 and 22, though connected together, are not fixed to the valve 20 in the manner illustrated in Fig. 1^a, but are remote therefrom, being situated in proper position to control the ports 18 and 19 at the ends of the passages 8 and 15. The construction and operative mechanism of these valves 21 and 22 are shown in Figs. 1, 2, and 4 and in the figures on the sixth sheet of the drawings.

The apertures in the valves 21 and 22, which control the ports 18 and 19, are preferably triangular in form, both being of about the same altitude, but having bases of different lengths. The valve 22 consists of a metal frame having a ground valve-face adapted to slide over and to close or open its port and having a cross-bar 44 and a longitudinally-projecting bar 38, with upwardly-extending forked pieces 39 situated in line with each other and fitted on a guide-rod 40. The valve 22 is situated in line with the valve 21 and is attached to a frame comprising slide-shoes 41 and a cross-bar 42. This frame is connected with the frame of the valve 21 by a flexible connection consisting, preferably, of flat leaf-springs 43, attached to the cross-bars 42 and 44 and extending between them at a plane or as near the plane of the faces of the slide-valves as possible.

45 is a bowed spring which has a bearing against the guide-rod 40 and on the valve-frames and tends to press both valves to their seats. The valves are moved on their seats

by a stem 46, connected to the valve 22, as shown in the drawings, and as the valve is moved longitudinally its connection with the valve 21 causes the latter to move in unison with it. By reason of the flexible nature of this connection each valve is capable of yielding vertically, and can therefore fit accurately on its seat without being affected by inequalities of the other valve, as if both valves were rigidly joined together. The connection of the valves by the rods or springs extending in a plane near the level of their bases is also of importance, because it enables the valve 21 to be moved without that liability of tipping on its seat which would occur if the connection were near the top. I am thus enabled to secure all the advantages resulting from the connection of these valves, together with the advantages in their adjustment and manufacture afforded by the flexibility of the connection and their capacity for independent vertical movement.

The valves 21 and 22 are connected with the valve 20, so as to be movable therewith, preferably by means of a lever 47, pivoted at 48, the long arm of the lever being connected with the stem 49 of the valve 20 and the short arm being connected with the stem 46 of the other valves. In order that these stems may be capable of yielding in their radial motion without deflecting the valves from motion in straight lines and without the disadvantages of liability to lost motion incident to pivotal connections, I prefer to notch the stem on opposite sides, as at *c*, thus diminishing the thickness of the stem and making it flexible at those places.

The stem 46 may be notched in two places, two opposite notches being at the sides of the stem and the other two notches being at the top and bottom, so as to make it flexible both laterally and vertically. The stem 49 may also be formed in this manner. In order to prevent possibility of loose motion between the pivotal connections of the lever 47, I prefer to construct both stems as shown in Fig. 13, Sheet 2, in which the connection of the stem 49 with the lever is shown in plan view and in vertical section. The end of the stem 49 is forked and made in hook form, and the hooks are fitted on a pin 57 at the end of the lever. A sleeve 58 is set on the stem and at its end bears against the side of the pin opposite to that against which the hooks have a bearing.

59 is a spring which bears in one direction against a nut or shoulder 60 on the stem and in the other direction against the sleeve, so that these parts are drawn in opposite directions against the pin and hold it, so as to prevent all loose motion which otherwise would be occasioned by wear of the parts.

On the pivot of the proportional lever 47 is placed the yoke 64, Fig. 14, in which on a suitable guide-wire is placed the spring 65, so as to cause a constant pressure against the back of the lever, holding it firmly against one side

of the pin and preventing all lost motion, so that the three valves 20, 21, and 22 move in perfect unison.

The consequence of using the lever 47 with arms of unequal length for connecting the valve 20 with the other two valves is that a motion of given length of the valve 20 transmits a proportionally shorter stroke to the others. This construction is of material advantage, because it is desirable that the opening of the valve 20 should be relatively much wider than the opening of the other valves, and if their motions were equal in degree the ports of the valves 21 and 22, especially the port of the smaller valve 21, would have to be inordinately narrow, so that inaccuracies in grinding or the settling of particles of dust on the edges of the port would appreciably affect the correctness of measurement of the meter. By shortening the proportional motion of the smaller valve by means of this lever I am enabled to make the valve-port of considerable width and thereby to enhance the accuracy of the apparatus. I intend to claim this feature in combination with a valve-actuating diaphragm, broadly, irrespective of any special construction or arrangement of the other parts of the meter. As before intimated, the openings of the valves 21 and 22 and the ratio between the arms of the lever 46 are so made that the quantity of gas permitted to pass through the valve 22 in every position of the operative mechanism shall bear a certain known proportion to the quantity of gas which passes through the valves 20 and 21, and so that the smallest volume passing through the valve 22 shall be a known multiple of the sum of the volumes passing through the other two valves.

The manner of use of the meter has been sufficiently indicated in the foregoing specification. Its advantages will be appreciated by those skilled in the art. The parts in which my invention consists are capable of varied application and in mechanical details may be modified in divers ways.

By the term "diaphragm" as used in the following claims I mean what is commonly understood in the art by such term when used broadly—viz., a flexible partition or equivalent devices, such as pistons, inverted pans working in liquid, &c.

I claim—

1. In a proportional meter, the combination with a tally-meter, of two or more by-passes for the gas, and pressure-regulators for establishing equilibrium between the gas-currents passing through the tally-meter and through the by-passes, the regulators of each of the larger currents being so located relatively to the course of the next smaller current as to be operated and controlled thereby; substantially as and for the purposes described.

2. In a proportional meter, the combination with slide-valves controlling respectively the smaller measured volume of gas and the larger unmeasured volume, of mechanism connecting them and causing them to move in unison and in definite proportion but to different extents of stroke and a diaphragm actuating the valves; substantially as and for the purposes described.

3. In a proportional meter, the combination with slide-valves controlling respectively the smaller measured volume of gas and the larger unmeasured volume, of a lever whose arms are of unequal length connecting the valves and causing them to move in unison and in definite proportion, but to different extents of stroke; substantially as and for the purposes described.

4. In a meter, the combination with a valve and diaphragm, of pivotally-jointed connecting mechanism between these parts, and a spring acting in opposite directions on the jointed parts, to prevent lost motion at the pivot; substantially as and for the purposes described.

5. In a meter, the combination with a valve and diaphragm, of a pivotally-connected lever and stem joining these parts, a sleeve set on the stem and bearing on the pivot, and a spring bearing in opposite directions on the stem and sleeve; substantially as and for the purposes described.

6. The combination of the two sliding valves adapted to move over and to control their ports, said valves being connected by a flexible connection, whereby they are caused to move in unison, but are capable of yielding independently on their seats; substantially as and for the purposes described.

7. The combination of the two sliding valves adapted to move over and to control their ports, said valves being connected near their bases by a flexible connection, whereby they are caused to move in unison, but are capable of yielding independently on their seats; substantially as and for the purposes described.

8. The combination of a pivoted balanced regulating-valve and its seat and inclosing case, said case being so situated relatively to the valve-seat and to the arc of motion of the edge of the valve that the distance from any given point of said arc to the seat shall be less than the distance from such point to the side of the case, and the seat having a vertical flange; substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 5th day of December, A. D. 1890.

FRED E. YOUNGS.

Witnesses:

THOMAS W. BAKEWELL,
W. B. CORWIN.