(No Model.) 5 Sheets—Sheet 1.

# F. SEILER.

## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

No. 481,287. Patented Aug. 23, 1892.

Fig. 3

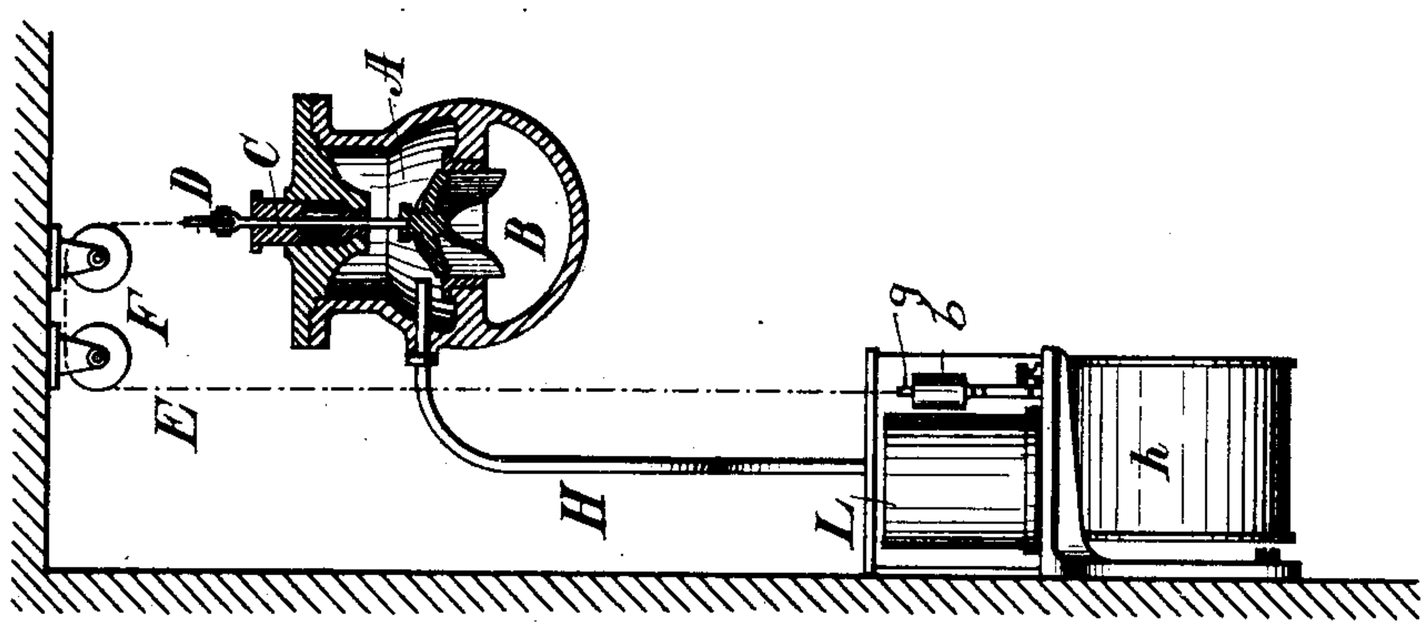



Fig. 1

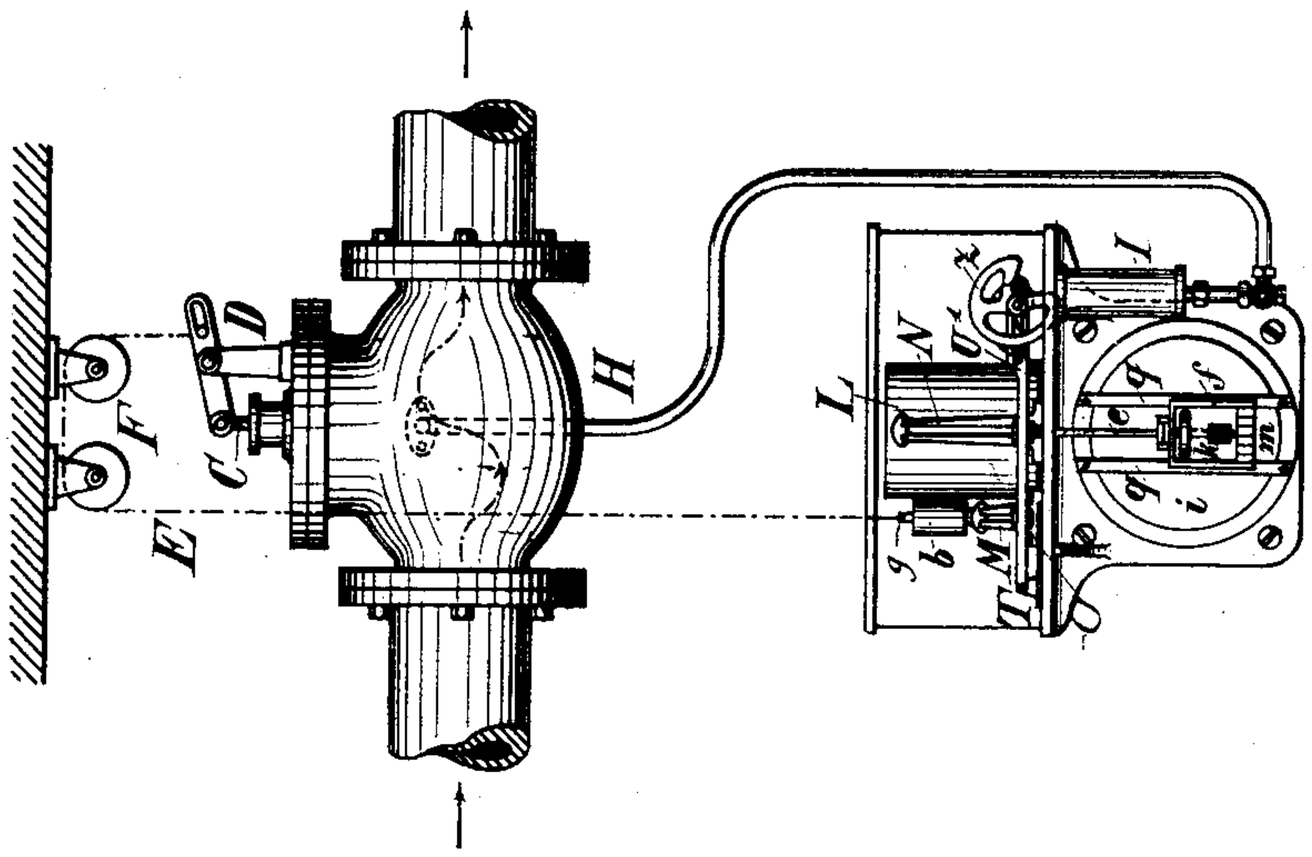
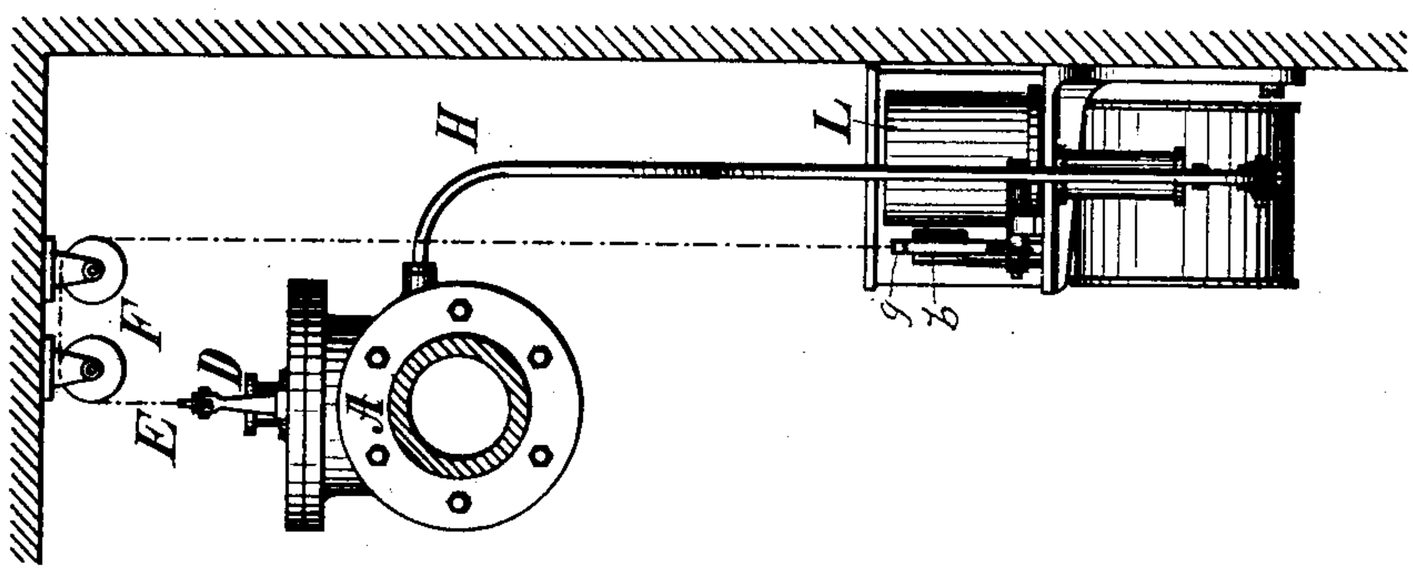



Fig. 2

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(No Model.) 5 Sheets—Sheet 2.

# F. SEILER.

## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

No. 481,287. Patented Aug. 23, 1892.

*Fig. 4.*

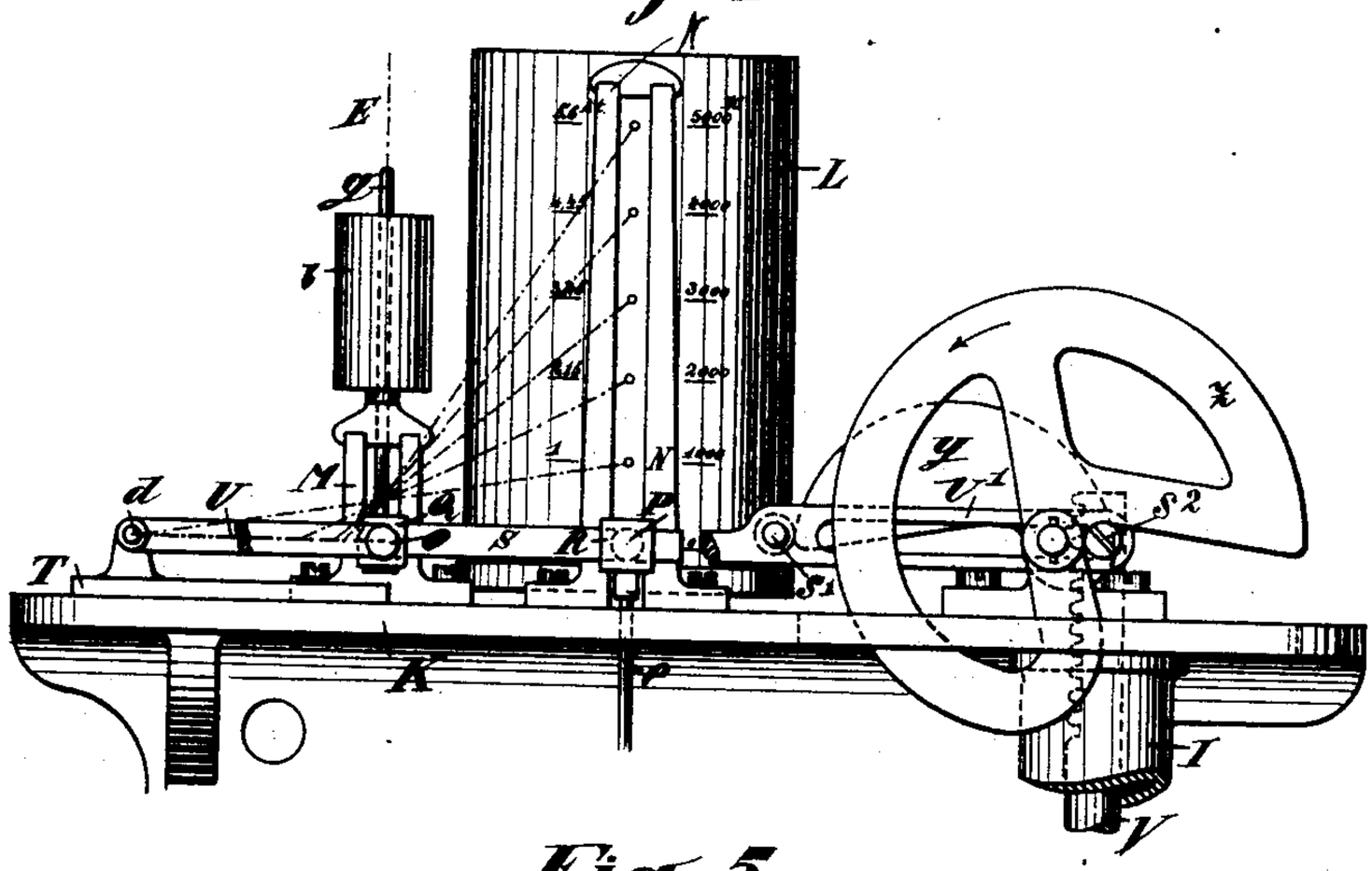



*Fig. 5.*

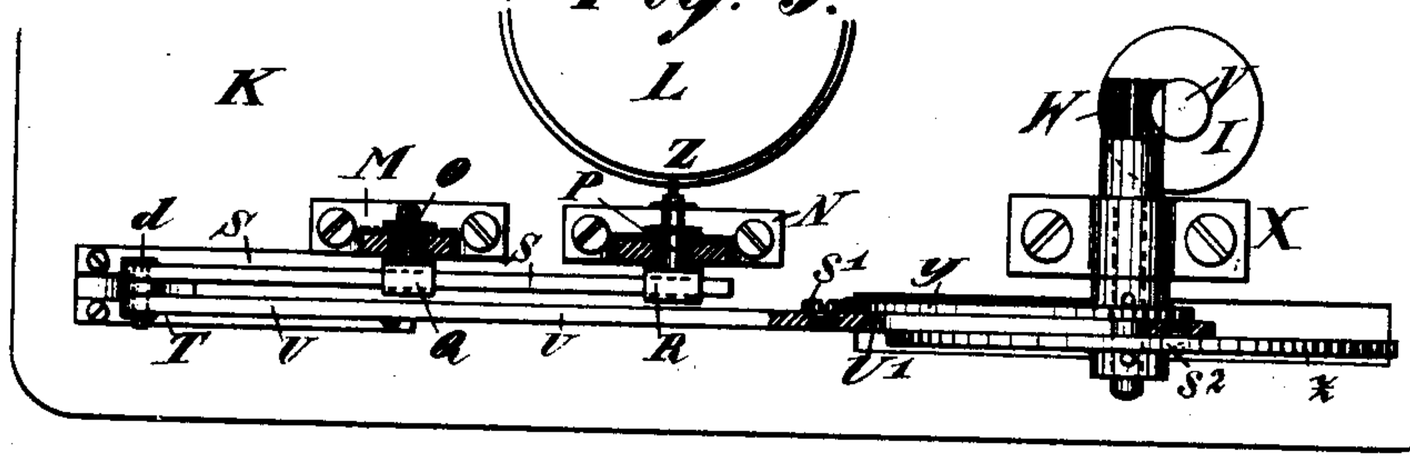
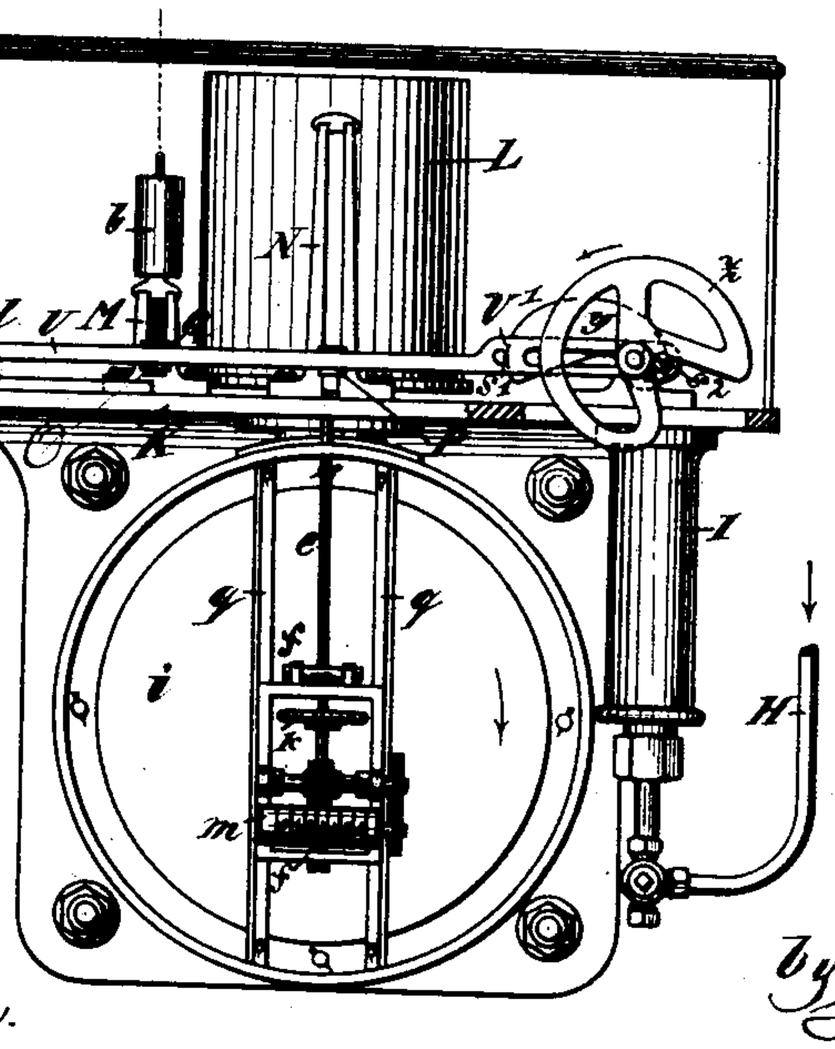



*Fig. 6.*

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(No Model.) 5 Sheets—Sheet 3.

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## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

No. 481,287. Patented Aug. 23, 1892.

*Fig. 7*

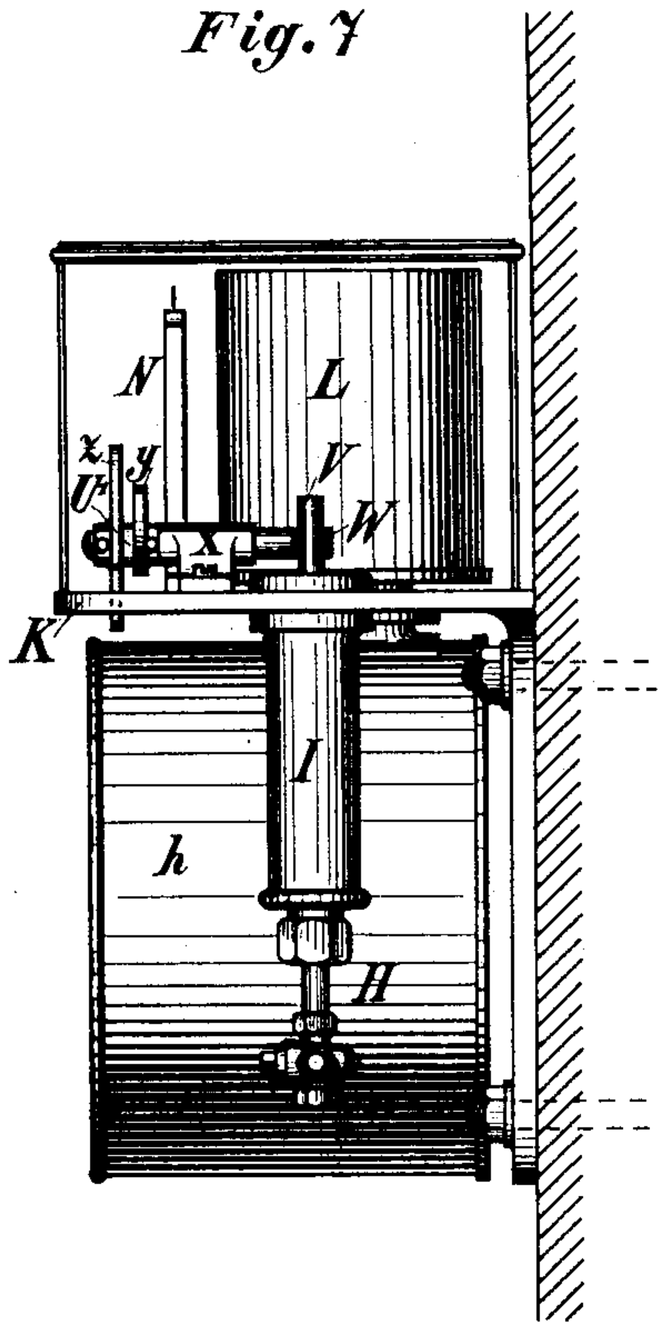



*Fig. 8*

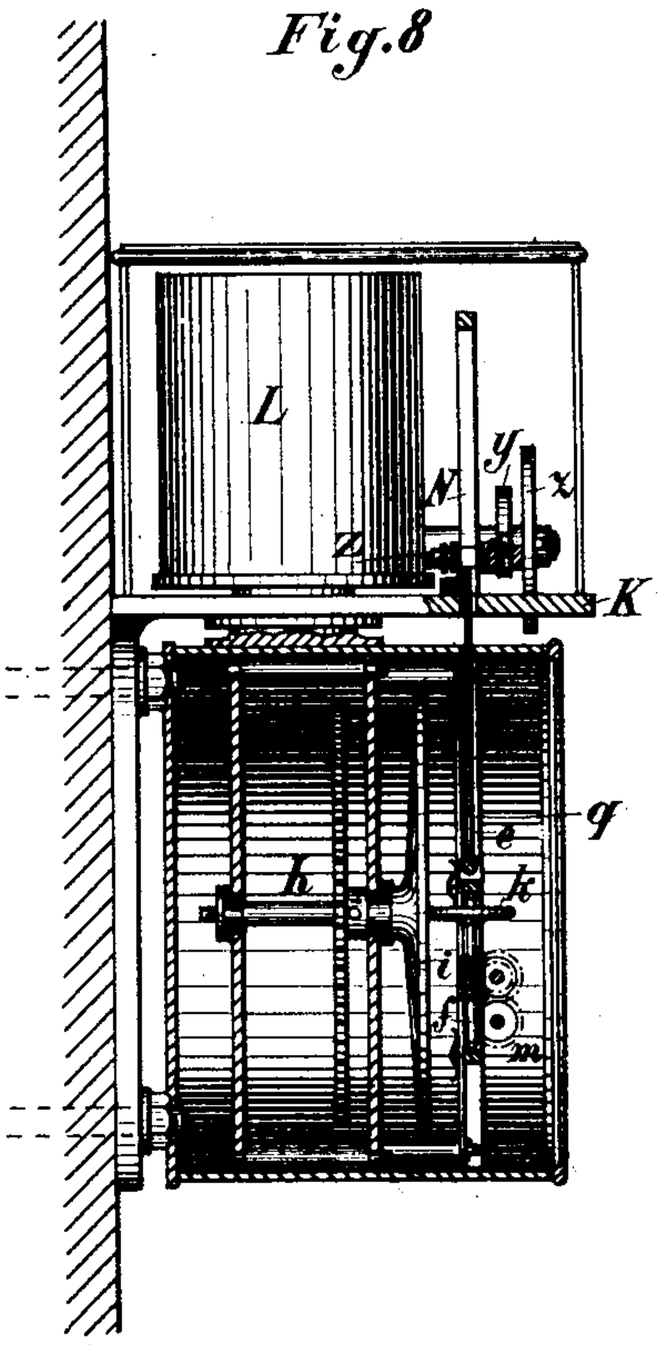



*Fig. 6a*

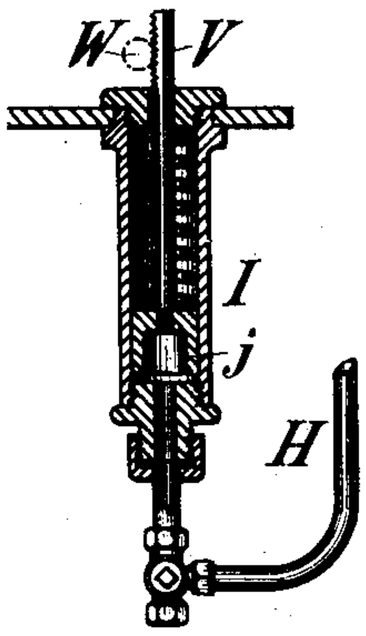
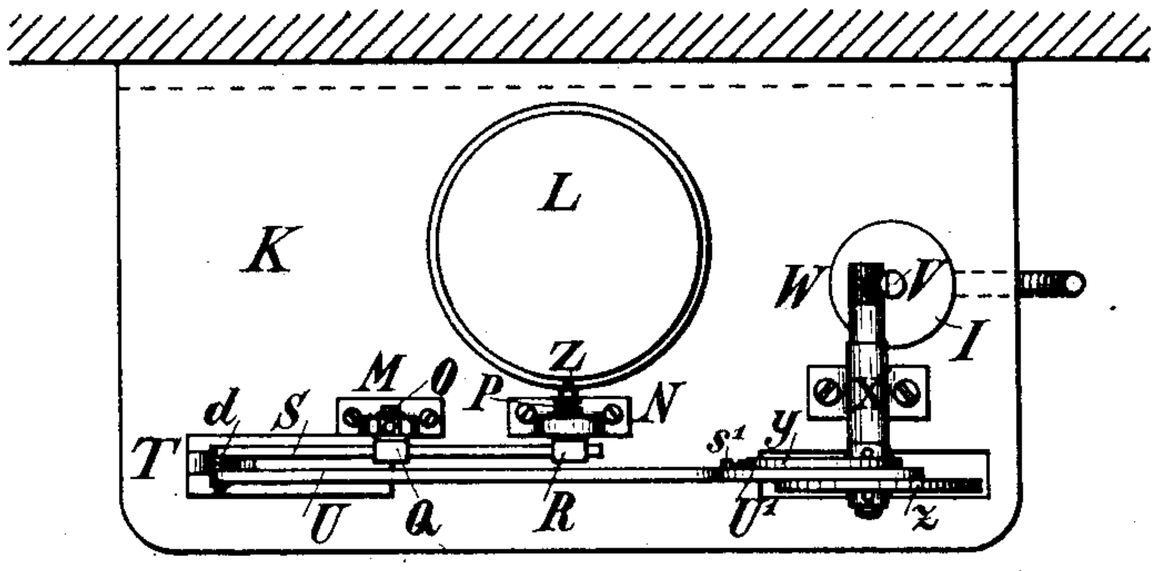



*Fig. 9*

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(No Model.) 5 Sheets—Sheet 4.

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## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

No. 481,287. Patented Aug. 23, 1892.

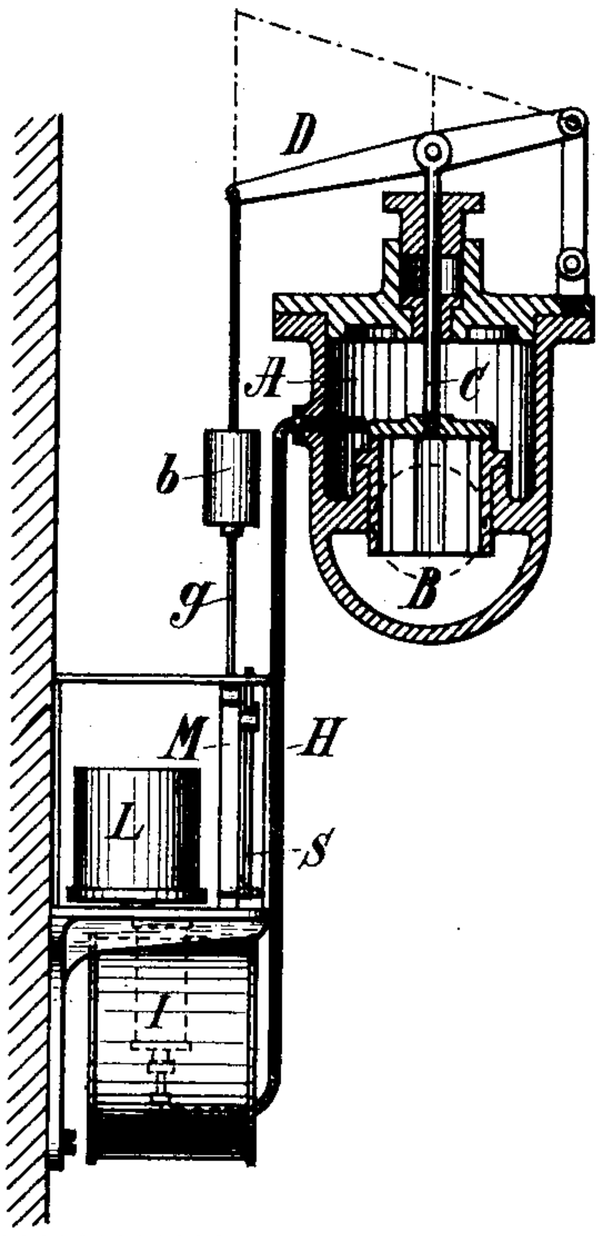



Fig. 10

Fig. 11

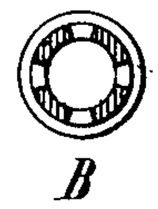
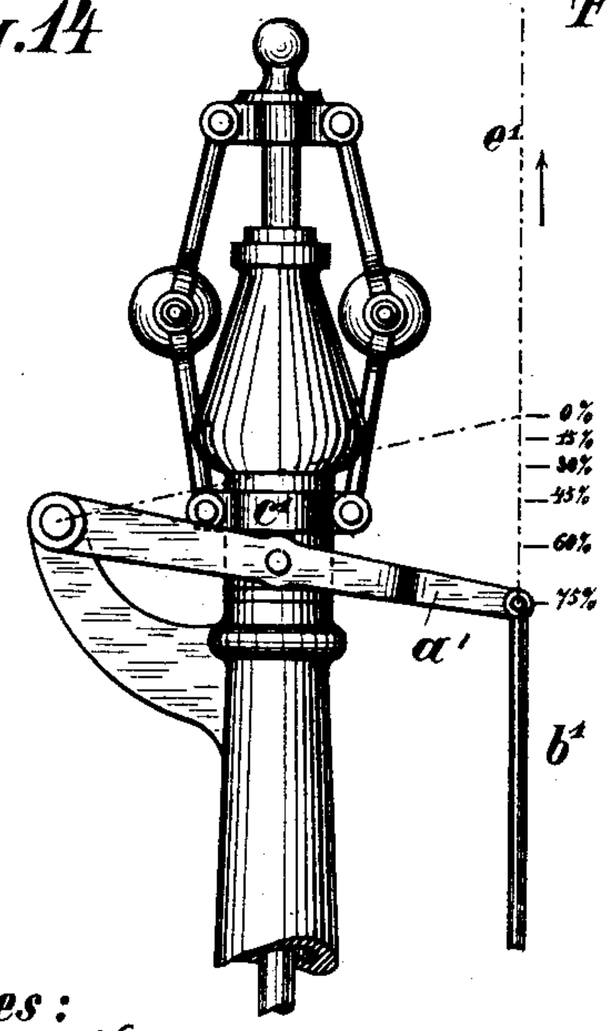



Fig. 14







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# F. SEILER.

## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

No. 481,287. Patented Aug. 23, 1892.

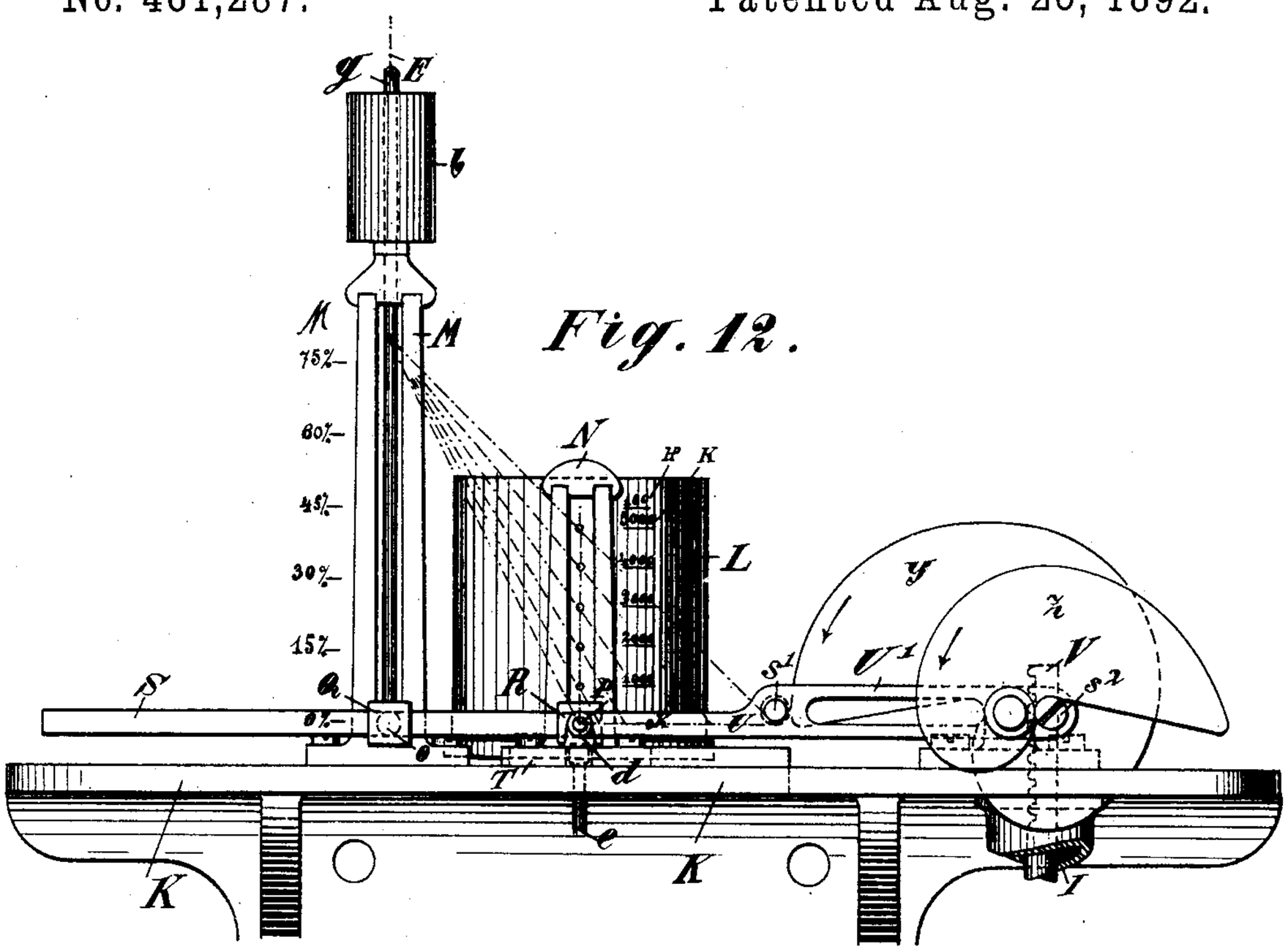


Fig. 12.

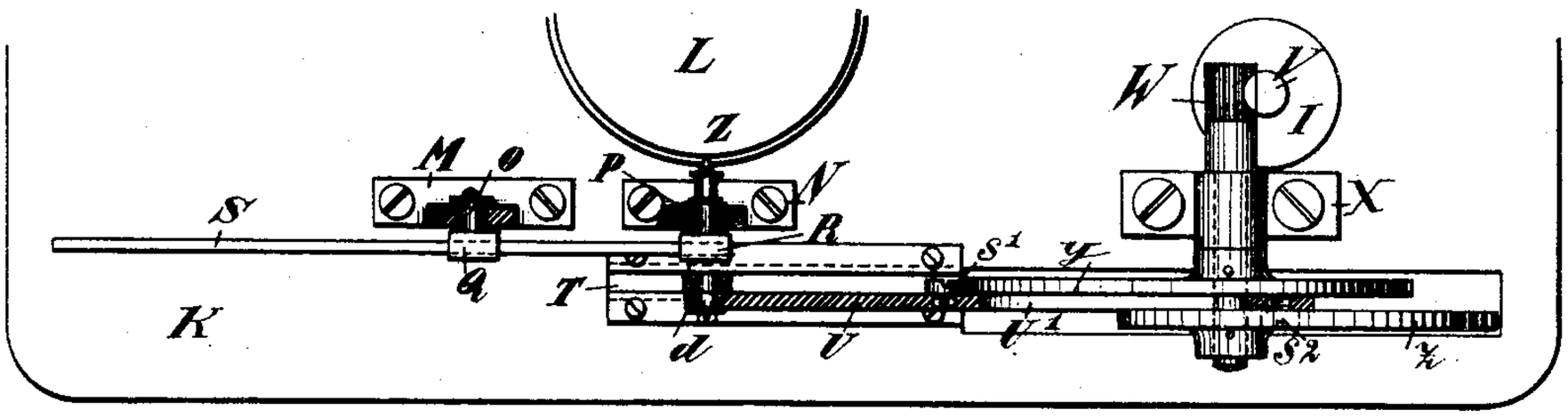


Fig. 13.

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# UNITED STATES PATENT OFFICE.

FRANZ SEILER, OF MANNHEIM, GERMANY.

## APPARATUS FOR RECORDING AND REGISTERING QUANTITIES OF STEAM, &c.

SPECIFICATION forming part of Letters Patent No. 481,287, dated August 23, 1892.

Application filed March 30, 1892. Serial No. 427,043. (No model.) Patented in Switzerland October 9, 1891, No. 4,184.

*To all whom it may concern:*

Be it known that I, FRANZ SEILER, a citizen of the Republic of Switzerland, residing at Mannheim, Germany, have invented certain new and useful Apparatus for Measuring Quantities of Steam and for Measuring the Work Performed by Steam-Pressure Engines, (for which I have obtained Letters Patent in Switzerland, No. 4,184, dated October 9, 1891,) of which the following is a specification.

The weight of steam passing during any given period of time through a conduit can be determined if the weight be known of the quantity of steam which passes through the same cross-sectional area of pipe in a given unit of time, the pressure or density of the steam being assumed to be known in each case, because the weight of the quantity of steam passing in the unit of time is the product obtained by multiplying the volume of steam which has passed the known cross-section by the density of the steam which is proportional to the pressure. If now the cross-section of passage in the said steam-conduit be assumed to be variable as by inserting an automatically-movable valve, the weight of the quantity of steam will still be the same, whether the volume or the pressure or the density of the steam in the cross-section of passage of the said valve be varied or only the product of the two factors remains the same. These variations between the volume and the pressures of steam in the conduit must, however, be considered to be known. Now since the pressure or density (specific weight) of the quantity of steam passing through a steam-conduit in a given unit of time is also variable there can be constructed from the products of these variable values from zero to the maximum volume and from zero to the maximum pressure or density a scale in which the numbers of the weights from these products are proportional to the series of numbers in units, tens, hundreds, &c. If now these numerical values when marked at equal intervals of a scale represent the weights of the quantities of steam that have passed through the steam-conduit, it is possible to construct an instrument or apparatus which shall form these products of the volume of steam and density or pressure in an automatic manner and shall mark the same on a registering mechanism as ordinates of a diagram or shall add or sum up the same by means of a so-called "integrator."

The invention consists of a steam-measuring device for the purpose mentioned, composed of an automatically-lifting valve, which may be a disk, piston, or flap-valve, and which is gaged for all positions of its lift, and an indicator with a so-called "multiplying mechanism" and recording and indicating device.

The invention also consists in the construction and combination of parts and details, which will be fully described hereinafter, and finally pointed out in the claims.

In the accompanying drawings, Figure 1 is a front elevation of my improved apparatus for measuring steam. Fig. 2 is a side elevation of the same. Fig. 3 is a transverse sectional view of the same. Fig. 4 is a front elevation of the recording apparatus. Fig. 5 is a plan view of the same. Fig. 6 is a front elevation of the recording apparatus combined with the integrating device. Fig. 6ª is a transverse detail sectional view of the indicator shown in Fig. 6. Fig. 7 is a side elevation of the recording apparatus combined with the integrating device. Fig. 8 is a transverse sectional view of the same. Fig. 9 is a plan view of the same. Fig. 10 is a vertical sectional view showing a modification. Fig. 11 is a horizontal sectional view of the valve shown in Fig. 10. Fig. 12 is an elevation of a modification of the device shown in Figs. 4 and 5. Fig. 13 is a plan view of the same. Fig. 14 is an elevation of the apparatus as applied to steam-engine governors.

The same letters of reference indicate the same or corresponding parts.

I will first describe the apparatus employed as a steam-meter for steam-conduits, Figs. 1 to 13. A is a valve-casing with valve B, which is shown as a disk-valve in Fig. 3 and as a piston-valve in Figs. 10 and 11. This casing is arranged to form part of the steam-conduit, the weight of the steam passing through which is to be measured. C is the valve-stem which transmits the lift of the valve to the lever D. From this lever D either a thin metal wire E, Figs. 1 to 3, passes over two or more guide-pulleys F F to the

pull-rod *g* of a sliding or guide piece O, hereinafter referred to, or the lever D is connected directly to the pull-rod *g*, Fig. 10. H is a steam-pipe, one end of which passes through the valve-casing A right up to the valve-seat and the other end of which leads to an indicator I, forming part of the recording apparatus for the purpose of transmitting to the indicator the pressure existing between the valve and its seat.

The recording and the integrating apparatus have direct connection with the multiplying mechanism and mark the products of the volume and the pressures of the steam—that is to say, the variable weights of the quantities of steam—as ordinates in a diagram and at the same time adds up the same in the counting mechanism of a so-called "integrator" and comprises the following devices, part of which are directly attached to a bracket-plate K. L is a recording-drum driven by a clockwork, which causes a strip of paper wound on a cylinder L to rotate past a pencil Z at a suitable rate—for example, once in twelve or twenty-four hours—for the purpose of drawing a diagram. M and N are upright guides, in which two slide-pieces O and P move up and down. The slide-piece O is connected with the disk or piston-valve B through the medium of the pull-rod *g*, provided with a weight *b* and the wire E, Figs. 1 to 4, or through the medium of the extended pull-rod *g*, lever D, and valve-rod C, Fig. 10. The slide-block P, which carries the pencil Z of the recording mechanism, is connected by a rod *e* with the sliding frame *f*, Fig. 6, or with the planimeter-wheel *k* and the counter mechanism *m*, connected therewith.

In the slide-pieces O and P are pivot-pins with guides Q and R, the latter connected to the slide-piece P, carrying the pencil Z, and through which passes the multiplying or reducing lever S, which is movable therein. This lever S is mounted on a movable sliding carriage T by the pivot *d*. The pivot *d* has also connected to it a pull-rod U U′, which serves to move the same together with the lever S. Opposite to this mechanism and screwed to the bracket-plate K is a spring-indicator I, Fig. 6[a], a membrane or diaphragm indicator, the piston-rod V of which is formed with teeth at its upper end and engages with a pinion on a shaft W, which is mounted in the bearing X and carries two cams *y* and *z*, which rotate in the direction of the arrow, Fig. 5, when the indicator-piston or the piston-rod V rises. On the pinion and cam-shaft W there slides forward and backward the movable slotted link U′, which forms a prolongation of the rod U, according as the stops or pins $s'$ and $s^2$ of the slotted links are moved to the right or to the left by rotation of the cams *y* and *z*. These cams *y* and *z*, of which one is always opposite the other, are constructed in such a manner that the movements of the slotted link U′ and the rod U and sliding carriage T, which is connected with the rod U by the pivot *d*, together with the multiplying-lever S, which is capable of turning and sliding in the slide-pieces O and P and guides Q and R, respectively, will correspond to the pressures under the indicator-piston—that is to say, to the steam-pressure existing at all times beneath the valve B and its seat.

The integrating device, as can be seen from the drawings, Figs. 6 to 9, is arranged under the bracket-plate K. It comprises the clockwork *h*, which rotates a plane disk *i*, for instance, once in a minute, and a planimeter-wheel *k*, mounted in a straight line, reciprocating frame *f*, and bearing on the plane disk *i*, the revolutions of the wheel *k* being quicker or slower, according to its position on the disk *i*, and the revolutions of the wheels *k* being transmitted by worm-gear and intermediate wheels to a counter *m*. The guide-frame *f*, which, with the planimeter-wheel and counter, is guided under the guide-fillets *q* and is pressed by flat springs against the plane disk *i*, is connected by means of the rod *e* with the slide-piece P that carries the pencil Z, so that the planimeter-wheel *k* follows exactly the same path up and down as the pencil Z.

The operation of the complete steam-meter for steam-conduits is as follows: When no steam passes through the conduit—viz., between the valve B and its seat—and there is also no pressure therein, the multiplying mechanism, with the indicator and the recording and integrating apparatus, are in the zero position, as shown in the figures; but as soon as the steam passes through the conduit between the valve B and its seat the valve B rises, according to the volume of steam passing. This movement of the valve is transmitted either by the valve-rod C and lever mechanism D or by means of the wire E and the rod *g* to the slide-piece O, and consequently the multiplying-lever S is raised together with the slide-piece P, pencil Z, and planimeter-wheel *k*. Now as soon as the steam-pressure in the passage area between the disk or piston-valve B and its seat, and also under the indicator-piston *j*, increases the pivot *d* of the multiplying-lever S, which lever is capable of turning in the slide-pieces O and P and capable of moving endwise in the guides Q and R, is shifted or caused to move according to the pressure by means of the rod and slotted link U U′ in consequence of the rising of the indicator-piston *j* and rotation of the cams *y* and *z*. Consequently there takes place a farther rising of the guide R and slide-piece P, which carries the pencil Z, and of the guide-frame *f*, suspended therefrom and carrying the planimeter-wheel *k*. These changes of position of the measuring-valve B of the multiplying mechanism and of the recording and integrating mechanisms effect on the one hand the recording of the products of the variable volume and pressures of steam—viz., the weights of the amounts of steam passing through the conduit as ordinates of a diagram—and on the other hand

in the summing up of the said products on a counter of an integrator to obtain the weight of steam passing during any given period of time. As the scale for the diagrams of the recording mechanism, there is assumed either a steam-consumption in kilograms per hour or per minute, and the unit of the counter of the integrator will also be one kilogram of steam, while the scale itself and the relation of the wheel gearing between the planimeter-wheel and the counter will in every case be selected to correspond with the results of the gaging of the measuring-valve.

The determination of the steam-weights in the manner hereinbefore described is chiefly intended for measuring quantities of steam for heating purposes which are not subject to continuously and suddenly increasing and decreasing variations in volume and pressure in the steam pipes or conduits leading from the steam-generator to the place of consumption, as in the case in steam-conduits for steam-engines.

As is well known, steam-engines receive the amounts of steam for the partial charges of the cylinder only intermittently, for which reason a measuring-valve inserted in the steam-conduit and a multiplying, recording, and integrating mechanism connected therewith would at every piston-stroke of the steam-engine be subjected to suddenly increasing and diminishing variations in volume and pressure which the various mechanisms would not be able to follow up quick enough by reason of their inertia.

Now in view of the fact that the governor determines the variable amounts of admission to the cylinder of the steam-engine the governor is very suitable for use as an apparatus for measuring the volume of steam in place of the steam-measuring valve.

As shown in Fig. 14, the lever $a'$ or the rod $b'$, leading to the valve-gear of the adjusting mechanism $c'$ of the governor, is connected by the wire $e'$ $e^2$ by way of the guide-pulleys $F^2$ and $F^3$ with the multiplying, recording, and integrating mechanism.

Now, as is well known, the intervals between the movements of the lever $a'$, connected to the adjusting mechanism $c'$, are not proportional to the various amounts of admission to the engine-cylinder; but it is necessary that the proportionality of the amounts of admission to the engine-cylinder shall be transmitted to the recording and integrating apparatus. Therefore the wire $e'$ $e^2$, which passes otherwise directly over the guide-pulleys $F^2$ and $F^3$, is divided into two parts, of which the first part $e'$ is attached at one end to the governor-lever $a'$ and at the other end at $g'$ to the periphery of a grooved cam F', while the part $e^2$ is attached at one end at $h'$ to the guide-pulley $F^2$, which is connected to the cam F' and at the other end to the slide-piece O, which guides the multiplying-lever S. The cam F' is constructed in such a manner that when rotated through three-fourths of a revolution it will transmit the non-proportionate movements of the governor-lever by means of the two wire arrangements in a proportional manner—that is to say, at equal intervals corresponding to the amounts of admission to the engine-cylinder to the multiplier or to the recording and integrating apparatus.

The recording and integrating apparatus, together with the mechanisms appertaining thereto for determining the weights of steam admitted to the engine-cylinder in steam-engines, is in principle and construction essentially the same as in the steam-meter for recording and integrating the weight of steam passing through pipe-conduits, but with the modification that the pressure of the steam admitted to the cylinder is transmitted to the indicator I from the steam-engine by means of a steam-pipe H' from the side valve-chest or from the steam-space between the steam-cylinder and its steam-jacket.

In this mode of measuring the weight of steam it is more advantageous to determine the weight of steam admitted for each two strokes of the piston rather than the weight of the steam admitted during certain regular intervals of time, this being effected by replacing the clockwork of the recording-drum and that for driving the plane disk $i$ of the integrator by a common ratchet mechanism which can be driven by a stroke or revolution counter mounted on the distributing-shaft or on the fly-wheel shaft of the steam-engine. This ratchet mechanism is indicated in elevation in the integrator shown in Fig. 14 and consists of the ratchet-wheel $r$, lever S, pawl $t$, and wire $e^3$, which passes over one or more guide-pulleys $F^4$ to the operating-lever of the stroke or revolution counter. The recording-drum L of the recording apparatus is driven by wheel-gearing connected with the shaft of the disk $i$, said wheel-gearing not being shown in Fig. 14.

The operation of this steam-meter for steam-engines is analogous to that of the steam-meter for steam-conduits. When the steam-engine is at rest, the governor-lever $a'$ is in the lowest position, corresponding to the greatest amount of admission to the cylinder; but the multiplying-lever S is in the position shown in Fig. 14, the movable pivot $d$ of the same being at zero-pressure. Now as soon as steam is admitted to the engine the multiplying mechanism will move correspondingly to the pressure in the slide-valve chest or in the steam-jacket, as will also be the case with the pencil Z and the planimeter-wheel $k$; but only after the engine has started will the variable admissions to the cylinder be registered and integrated, the weights of the amounts of steam entering the cylinder at every stroke of the piston being transmitted to the recording and integrating apparatus, as products of the volume of steam proportional to the amounts of admission and the pressure or density on one hand by means of the posi-

tions of the governor and on the other hand by means of the indicator and the multiplying mechanism. The scale for the diagrams of the recording apparatus may be graduated, also, in this case to a steam consumption in kilograms per hour or per minute, the unit of the counting mechanism of the integrator being one kilogram, and the scale, as also the relations of the gearing between the planimeter-wheel and the counting mechanism, are determined for each steam-engine with reference to the piston area and piston-stroke by calculation and by gaging the steam consumption of the same at various admissions to the cylinder and various pressures of admission. The arrangement described with reference to Fig. 14 for the determination of the steam consumption of a steam-engine can also be employed on substantially the same principle, and the same construction for the recording and integration of the average steam-pressure in atmospheres or of the work done by steam-engines in indicated and effective horse-power. Assuming that a steam-engine has a prompt governing action—that is to say, that the number of revolutions of the same can be assumed to be constant—then in the case of varying loads with reference to the work done by a steam-engine, the only variable factors in determining the work done are the so-called "mean" or "average" steam-pressures corresponding to the admissions of the cylinder, because the numerical values of the piston-area, the piston-stroke, and the number of revolutions of the engine can be taken as being constant. To every amount of work done by the steam-engine there corresponds, therefore, a certain average steam-pressure which, as is well known, can be calculated from a diagram taken from the engine by means of an indicator. This average steam-pressure, however, can be found from a series of diagrams, according as the boiler-pressure or admission-pressure and the corresponding cylinder-admission vary, the load remaining the same. The cylinder-admissions are therefore directly dependent on the admission-pressures, and every admission to the cylinder has a corresponding position of the governor. If now a series of indicator-diagrams be taken from the steam-engine at varying loads and varying boiler-pressures and admission-pressures, and the average steam-pressures be calculated from the series of diagrams and the corresponding positions of the governor and indicator be considered in connection therewith—that is to say, the corresponding positions of the governor at the various admission-pressures be made into a scale—then for every engine a corresponding diagram can be made, according to which the transmission of the positions of the governor to the multiplying mechanism is arranged in such a manner that the variable amounts of work done by the engine are corrected proportionally by the simultaneous co-operation of the indicator I—that is to say, are transmitted at equal intervals to the recording and integrating apparatus.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an apparatus for measuring the quantity of steam passing through a conduit in a given time, the combination, with a valve in the conduit through which the steam to be measured passes, of a swinging and lateral-movable lever connected with said valve, a marker on said lever, a movable sheet on which the lever can trace marks, a steam-pressure indicator, and means for shifting the pivotal support of the above-mentioned lever carrying the marker from said pressure-indicator, substantially as set forth.

2. In an apparatus for measuring the quantity of steam passing through a conduit in a given time, the combination, with a valve in the conduit through which the steam to be measured passes, of a reciprocating support, a lever pivoted to said reciprocating support and carrying a marker, means for raising or lowering said lever from the valve in the above-mentioned conduit, a rod connected with said reciprocating support, cams acting on said rod, and a steam-pressure indicator actuating said cams, substantially as set forth.

3. In an apparatus for measuring the quantity of steam passing through a conduit in a given time, the combination, with a valve in the conduit through which the steam to be measured passes, of a sliding support, a lever pivoted on said sliding support and operated from the valve, a marker on said lever, a sheet upon which the marker can trace the lines, a reciprocating rod connected with the movable support for said lever, two opposite cams acting on said rod, a pinion on the shaft of said cams, a rack engaging said pinion, and a steam-pressure indicator for actuating said rack, substantially as set forth.

4. In an apparatus for measuring the quantity of steam passing through a conduit in a given time, the combination, with a valve in the conduit through which the steam to be measured passes, a reciprocating support, a lever pivoted to said support, means for raising and lowering said lever from the above-mentioned valve, a steam-pressure indicator, and means on the same for reciprocating the support, a marker on said lever, and adding mechanism connected with and operated from said marker, substantially as set forth.

5. In an apparatus for measuring the quantity of steam passing through a conduit in a given time, the combination, with a valve in the conduit, through which the steam to be measured passes, of a swinging and sliding lever, a marker on said lever, a sliding carriage connected with said swinging and sliding lever, a counting mechanism on said carriage, a wheel for operating said counting mechanism, a disk in contact with said wheel

for operating the counting mechanism, and means for rotating said disk, substantially as set forth.

6. In an apparatus for measuring the quantity of steam passing through a conduit at a given time, the combination, with a sliding support, a swinging lever pivoted on the same, which lever carries a marker, a sheet on which the marker can act, a rod connected with the sliding support, cams acting on said rod, a steam-pressure indicator for operating the cams, and means controlled by the steam to be measured for moving said swinging lever that carries the marker up or down, substantially as set forth.

In testimony whereof I hereunto sign my my name, in the presence of two subscribing witnesses, this 27th day of February, 1892.

FRANZ SEILER.

Witnesses:
M. HORSTMANN,
SIGMUND WAGNER.