N° 23,363 A.D. 1904

Date of Application, 29th Oct., 1904
Complete Specification Left, 28th July, 1905—Accepted, 14th Sept., 1905

PROVISIONAL SPECIFICATION.

"Improvements in Calculating Apparatus."

I, OLIVER LEOPOLD PEARD, of 1ª Clifton Road, South Norwood, in the County of Surrey, Electrical Engineer, do hereby declare the nature of this invention to be as follows:—

The invention relates to improved and simplified forms of calculating apparatus applicable for readily making rapid calculations based on observed data chiefly in connection with practical central station work, the object of the invention being to facilitate economies by providing a simple and clear form of calculating apparatus graduated and marked off to read directly in the system of units concerned, and having a degree of accuracy at least equal to the correctness of the observations concerned. By its means rapid estimates may be frequently made of the values of different sources of loss incidental to the various operative methods employed for the transformation of energy to the desired form. The apparatus may be graduated and marked off either to read the desired result in terms of the units concerned, the loss sustained in units or percentages, or the percentage efficiency of the transformation, and where desirable the reading off scale may be graduated to give a combination of these values. The scales of the apparatus below described may be graduated and arranged for a great variety of purposes but has been primarily designed for clear and rapid calculations of the following nature:—

(*a*). To determine the efficiency of, or loss in combustion from the known composition and temperature of the resultant flue gases.

(*b*). To determine the efficiency of, or loss in a combination of furnace and boiler from the known quantity and calorific value of the fuel consumed and the thermal capacity and quantity of liquid used and the steam or gas produced therefrom.

(*c*). To determine the efficiency of, or loss in a steam or other engine from the known quantity and thermal capacity of the steam, gas or liquid used for the production of a known amount of power.

(*d*). To determine the efficiency, or loss in the combination of an engine and electric generator from the quantity and thermal capacity of the material used for the production of a known amount of electric energy; or the commercial efficiency of the combination from the indicated horse power of the engine and the rate of generation of electric power.

(*e*). To determine the consumption of fuel, gas, liquid, or steam used per unit of electric energy produced from the known rate of consumption of the material concerned and the quantity of power derived therefrom, such as the steam or coal consumed per unit of energy produced.

(*f*). To determine the quantity of electric energy, produced by an electric generator from the observed current and voltage, combined in the case of alternate currents with the power factor of the circuit.

The apparatus is arranged on the same principles as a slide rule the scales being graduated in proportion to the logarithmic values of the terms or units employed and the construction admits of it being used without error by workmen without special training or knowledge of the principles involved in operating the ordinary forms of slide rules. The essential parts of the

[*Price* 8*d*.]

apparatus are three scales and an index pointer and the arrangement preferred is as follows:—

A scale A called the setting scale, and an adjustable scale B, both graduated in terms of the known values, are arranged so that the known values may be set together such operation causing an index pointer C to indicate on a third scale D the required result either directly in the terms of the system of units employed or as a percentage value.

In actuating the apparatus the known values on scales A and B are set together and the desired result read off on the scale D opposite the index pointer C. The details of construction of the apparatus may be somewhat modified to meet the requirements of each special case, such as the relative lengths and degree of subdivision of the sets of scales desired for the particular purpose for which it is employed, but I prefer to adopt one or other of the two following methods of construction.

In one form the apparatus consists of a disc made up of an annular ring or rim fitted with a movable circular centre, on the front side of the disc is marked the setting scales A and B one being on the ring and the other on the movable centre, and on the back of the disc is marked the reading scale D and the index pointer C one being on the ring and the other on the movable centre. This form of the calculator may be advantageously adopted where the various scales approach the same length and may be applied for determining the efficiency of or loss in combustion in which case the parts may be arranged as follows:—

Three scales and an index pointer are provided; the scale A, is a logarithmic scale of the thermal capacity of flue gases containing various percentages of carbonic acid gas, scale B is a logarithmic scale of flue gas temperatures, and D is a logarithmic scale of losses resulting from combustion expressed either as a percentage efficiency or loss, or in British thermal units, but preferably as a percentage of the fuel value lost and in British thermal units, combined.

The front of the outer ring may be graduated to scale B in the terms of the flue temperatures, and the back of outer ring may be graduated to scale D in terms of the efficiency or loss. The front of the movable centre is graduated to scale A in terms of the percentage of carbonic acid gas present in flue gases, and the back of the movable centre is provided with the index pointer C. To actuate the apparatus the movable centre is revolved until the known percentage of carbonic acid gas is opposite the known rise of flue gas temperature, then the index pointer on the back of the centre portion will indicate the resulting loss or efficiency on scale D on the back of the outer ring. The movable centre is held in the annular ring by either the centre or the ring being grooved to receive a feather on the other, or both the centre and the ring may be grooved to receive a bent flat spring or springs.

In another form of the apparatus, applicable when the scale A is relatively short as compared to scales B and D, the apparatus is of the following construction:—

A plate E having two openings F and G is mounted over a movable band H. Along one side of the opening F is fixed the log scale A and on the side of the other opening G is fixed the index pointer C. The movable band is graduated with two log scales B on the portion passing under the opening F and therefore capable of being set to scales A and D passing under the opening G and therefore being read at the index pointer C. In operating this form of the apparatus the known values on scales A and B are set together by moving the band H and the required value is then indicated on the scale D by the index pointer C. In this form of the apparatus the plate E may form the cover of a box in which the band H may be coiled and kept in tension on rollers, either in the form of an endless band or terminated on two rollers the movement being controlled by a milled head or lever outside the case. In

a modification of this form the band may be a rigid lath on which the plate E is free to move, in which case the scales A and B may be arranged on the front, and the scale D and index C on the back, of the band or lath.

This form of the calculator may be employed for determining the combined boiler and furnace efficiency or loss in which case the scale A would be a log scale of the thermal capacity of the feed water at the various temperatures denoted, scale B would be the log scale of the thermal capacity of various quantities of steam generated for a known consumption of fuel, and the scale D would be a log scale of the total thermal capacity of the quantity of steam produced expressed either as a percentage of the calorific value of fuel consumed, or in British thermal units absorbed or lost in the generation of the steam.

This form of the apparatus is also the most suitable for calculating the quantity of electric energy produced by an electric generator in which scale A would be a log scale of the voltage, scale B a log scale of the current and scale D a log scale of the kilowatts; for correcting the calculation to the power factor of an alternate current dynamo the log scale A or the index pointer may be made adjustable to a subsidiary log scale on the side of the plate E.

Dated this 28th day of October 1904.

OLIVER. LEOPOLD. PEARD.

COMPLETE SPECIFICATION.

"Improvements in Calculating Apparatus."

I, Oliver Leopold Peard, of 1ª Clifton Road, South Norwood, in the County of Surrey, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

The invention relates to improved and simplified forms of calculating apparatus applicable for readily making rapid calculations based on observed data chiefly in connection with practical central station work, the object of the invention being to facilitate economies by providing a simple and clear form of calculating apparatus graduated and marked off to read directly in the system of units concerned, and having a degree of accuracy at least equal to the correctness of the observations. By its means rapid estimates may be frequently made of the values of different sources of loss incidental to the various operative methods employed for the transformation of energy to the desired form. The apparatus may be graduated and marked off either to read the desired result in terms of the units concerned, the loss sustained in units or percentages, or the percentage efficiency of the transformation, and where desirable the reading off scale may be graduated to give a combination of these values. The scales of the apparatus below described may be graduated and arranged for a great variety of purposes but have been primarily designed for clear and rapid calculations of the following nature:—

(*a*). To determine the efficiency of or loss in combustion from the known composition and temperature of the resultant flue gases.

(*b*). To determine the efficiency of or loss in a combination of furnace and boiler from the known quantity and calorific value of the fuel consumed and the thermal capacity and quantity of liquid used and the steam or gas produced therefrom.

(*c*). To determine the efficiency of or loss in a steam or other engine from the known quantity and thermal capacity of the steam, gas or liquid used for the production of a known amount of power.

(*d*). To determine the efficiency or loss in the combination of an engine and

electric generator from the quantity and thermal capacity of the material used for the production of a known amount of electric energy; or the commercial efficiency of the combination from the indicated horse power of the engine and the rate of generation of electric power.

(*e*). To determine the consumption of fuel, gas, liquid, or steam used per unit of electric energy produced from the known rate of consumption of the material concerned and the quantity of power derived therefrom, such as the steam or coal consumed per unit of energy produced.

(*f*). To determine the quantity of electric energy, produced by an electric generator from the observed current and voltage, combined in the case of alternate currents with the power factor of the circuit.

The apparatus is arranged on the same principles as a slide rule the scales being graduated in proportion to the logarithmic values of the terms or units employed and as the various physical constants and data connected with each calculation are directly embodied in the graduations and subdivisions of the different scales the operator is enabled to arrive at the desired result without reference to the data or knowledge of the methods by which the result is determined and the construction admits of it being used without error by workmen without special training or knowledge of the principles involved in operating the ordinary forms of slide rules. The essential parts of the apparatus are three scales and an index pointer and the arrangement preferred is as follows:—

A scale A called the setting scale, and an adjustable scale B, both graduated in terms of the known values, are arranged so that the known values may be set together such operation causing an index pointer C to indicate on a third scale D the required result either directly in the terms of the system of units employed or as a percentage value.

In actuating the apparatus the known values on scales A and B are set together and the desired result read off on the scale D opposite the index pointer C. The details of construction of the apparatus may be somewhat modified to meet the requirements of each special case, such as the relative lengths and degree of subdivision of the sets of scales desired for the particular purpose for which it is employed, but I prefer to adopt one or other of the following methods of construction.

Figure 1 is a front view, Figure 2 a back view and Figure 3 a transverse section of one form of the apparatus. It consists of a disc *a* made up of an annular ring or rim fitted with a moveable circular centre, on the front side of the disc is marked the setting scales A and B one being on the ring and the other on the moveable centre, and on the back of the disc is marked the reading scale D and the index pointer C one being on the ring and the other on the moveable centre. This form of the calculator may be advantageously adopted where the various scales approach the same length and may be applied for determining the efficiency of or loss in combustion in which case the parts may be arranged as follows:—

Three scales and an index pointer are provided; the scale A is a logarithmic scale of the thermal capacity of flue gases containing various percentages of carbonic acid gas, scale B is a logarithmic scale of flue gas temperatures, and D is a logarithmic scale of losses resulting from combustion expressed either as a percentage efficiency or loss, or in British thermal units, but preferably as a percentage of the fuel value lost and in British thermal units combined.

The front of the outer ring may be graduated to scale B in the terms of the flue temperatures, and the back of outer ring may be graduated to scale D in terms of the efficiency or loss. The front of the moveable centre is graduated to scale A in terms of the percentage of carbonic acid gas present in flue gases, and the back of the moveable centre is provided with the index pointer C. To actuate the apparatus the moveable centre is revolved until the

known percentage of carbonic acid gas is opposite the known rise of flue gas temperature, then the index pointer on the back of the centre portion will indicate the resulting loss or efficiency on scale D on the back of the outer ring. The moveable centre is held in the annular ring by either the centre or the ring being grooved to receive a feather on the other, or both the centre and the ring may be grooved to receive a bent flat spring or springs.

The construction of this form of the apparatus may be modified as follows the arrangement of the parts and the graduation of the scales being exactly as in the preceding case. Figure 4 shows a transverse section along the diameter of the disc in which the annular ring B. D. and the moveable centre A. C. are held in the desired position by covers E. E^1. of any transparent material such as celluloid glass, mica, talc, such transparent covers being secured at their outer edges by a rim J or ring of metal or other suitable material. The moveable centre A. C. is fixed to one of the transparent covers E which is free to turn in the metal rim while the annular ring B. D, the metal rim and the other transparent cover E^1 are fixed together. The apparatus is actuated by turning the moveable transparent cover E which carries with it the moveable centre A. C. with the setting scale A and the index pointer C graduated thereon.

Figures 5, 6, 7 and 8 show modifications of the same apparatus in which the setting scales, the reading scales and the index pointers are arranged all on one side of the disc. The scales are engraved as concentric rings with suitable intervening spaces and distinctive separatory lines. The disc is provided with a transparent cover held to, but free to revolve on the disc, by the outer rim of metal or other suitable material and where desired the transparent cover may also be pivoted to the disc by a pin passing through the centre. To the transparent cover is affixed the moveable scale A and the index pointer C.

In Figure 5 the apparatus is engraved with three scales the innermost scale B which is one of the setting scales is engraved on the disc in terms of the flue gas temperatures and the outermost scale D also engraved on the disc is graduated for reading the desired result in terms of the loss by chimney gases expressed as a percentage of the coal burnt. The inner and outer scales on the disc are separated from each other by a wide space and the transparent cover, which is secured to the disc by a central pivot and also by an outer rim of metal, has engraved on or attached to the underside the moveable setting scale A graduated in terms of the percentage of carbon dioxide in the flue gases. This scale A is arranged on transparent cover so that it travels over the space between the inner and outermost scales B and D on the disc and is capable of being set to the scale B. An index pointer is also attached to or engraved on the transparent cover and indicates the desired result on the outer scale D on the disc. The apparatus is actuated by revolving the transparent cover on the disc so that the known values on the moveable scale A attached thereto are set to the known value on the central or innermost scale B on the disc, the result then being indicated by the index C on the scale D situated at the outer edge of the disc.

Figure 6 shows a slight modification of this arrangement as regards the relative position of the various scales of the apparatus. The moveable scale A which is carried by the transparent cover forms the innermost of a series of concentric scales and is graduated in terms of the percentage of carbon dioxide contained in the flue gases. The other setting scale B graduated in terms of the flue gas temperature forms the second concentric scale and is marked on the disc in the manner shown so that the moveable scale A on the cover may be set to it. The reading scales D are on the disc and are separated from the setting scale B by a suitable space and distinctive separating lines. In the apparatus shown two reading scales are shown the outermost scale being graduated to read the thermal units lost by chimney gases per pound of coal

burnt and second outer scale is graduated to read the percentage loss of coal burnt of known calorific value. The apparatus is actuated as in the preceding case.

Figure 7 is in mechanical construction similar to Figure 6. In this case however the inner moveable scale A carried on the moveable central disc is graduated for setting the known feed water temperature to the second inner scale B on the annular rim and graduated in terms of the pounds of water evaporated per pound of coal burnt. The central moveable scale is also provided with two auxiliary indices which indicate on the second scale B the equivalent number of pounds of water evaporated at 165 lbs. per square inch absolute press from feed water at 212° Fahrenheit and also the equivalent evaporation from and at 212° Fahrenheit, such figures being the usual basis on which comparisons of actual results are compared. The two outermost scales D on the annular ring form the reading scales proper of the apparatus and are separated from the setting scale B by suitable distinctive separating lines. Two reading scales D are shown, the outermost scale is graduated to read the thermal units transmitted to water and steam in the boiler per pound of coal burnt and the second outer scale is graduated to read the thermal efficiency of evaporation when burning coal of 14,000 Brit: thermal units calorific value. These two scales are separated by a space over which the index pointer C attached to or marked on the transparent cover travels.

Figure 8 shows a section of a double calculator in which the top side of the apparatus may be used for one purpose and the bottom side for another purpose, as shown the top side is arranged as a calculator for determining the efficiency of combustion, the scales being as described and illustrated in Figure 6. The bottom side of the apparatus is similarly constructed as an independent calculator for determining the combined boiler and furnace efficiency and the heat units utilised for evaporative purposes per pound of coal burnt. The apparatus shown by section No. 8 consists of:—

A transparent cover E fixed to the top metal rim J. The moveable central disc F fixed to and carried by the top transparent cover E. An outer annular disc ring G fixed to the bottom metal rim J^1. A bottom transparent cover E^1 fixed to the moveable central disc F and enclosed at the outer edge but free to move in the bottom metal rim J^1. The two outer rims are free to revolve on each other but are keyed or otherwise held together:—the drawing shows screws J^2 in the top rim running in a groove cut in the edge of the bottom rim. The top side of the calculator is arranged and graduated as shown and described by Figure 6.

The arrangement of scales on the bottom side of the calculator is shown by Figure 7.

The apparatus is actuated by turning one of the metal rims on the other thus causing the transparent covers, the central moveable disc and the index pointers to move relatively to the annular disc to which the other scales are fixed.

Another form of the apparatus shown at Figures 9 and 10 which is applicable when the scale A is relatively short as compared to scale B and D is of the following constructions:—

A plate E having two openings F and G is mounted over a moveable band H. Along one side of the opening F is fixed the log scale A and on the side of the other opening G is fixed the index pointer C. The moveable band is graduated with two log scales B on the portion passing under the opening F and therefore capable of being set to scale A and D passing under the opening G and therefore being read at the index pointer C. In operating this form of the apparatus the known values on scales A and B are set together by moving the band H and the required value is then indicated on the scale D by the index pointer C. In this form of the apparatus the plate E may form the cover of a box in which the band H may be coiled and kept in tension on rollers, either

in the form of an endless band or terminated on two rollers the movement being controlled by a milled head or lever outside the case.

Figures 11 and 12 show another way of carrying out this form of the apparatus.

The designs are particularly applicable to central station switchboard calculators for calculations of the energy output from the known current and pressure, in which case the pressure scale is relatively short as compared to the current setting scale and the kilowatt reading scale.

Figures 9 and 10 show a form of the apparatus in which the moveable scales are graduated on a flexible band coiled and kept in tension round suitable rollers enclosed in a case or box immediately below the plate E carrying the setting scale A and the index pointer C.

Figure 9 is a perspective view of the apparatus showing the external milled head F^1 by which the moveable band is actuated.

Figure 10 is a longitudinal section of the apparatus showing the moveable band H coiled round the rollers G one or more of which may be connected to the external controlling milled head. The roller *i* is kept in tension against the band.

Figure 13 shows a portion of the scales on the moveable band B graduated to read in amperes and capable of setting to the pressure scale A on the plate E, while D is graduated to read in kilowatt, the desired result being indicated by the index pointer C which is also on the plate E.

Figure 14 shows the plate E with the setting scale of pressures A along one side and the index pointer C on the other.

Figures 11 and 12 show a similar arrangement of parts in which the place of the flexible band is taken by a wheel the moveable scales being graduated on the periphery.

Figure 11 shows a transverse section of the apparatus and Figure 12 a longitudinal section. The moveable wheel J is mounted on a spindle K the scales on the periphery being immediately below or level with the plate E, the whole being mounted and enclosed in a case L of which the cover to plate E may form a part. An external wheel N attached to the spindle K allows of a coarse adjustment of the moveable scales while a means of making fine adjustments may be provided by actuating the wheel with the fingers through an opening or openings M in the side of the outer case. The arrangement of scales is similar to that described for Figure 9 the graduations being varied to meet the specific purpose for which the calculator may be required.

In modification of this form of the apparatus shown at Figures 15 and 16, the band may be a rigid lath on which the plate E is free to move, in which case the scales A and B may be arranged on the front and the scale D and index C on the back of the apparatus.

This form of the calculator may be employed for determining the combined boiler and furnace efficiency or loss in which case the scale A would be a log scale of the thermal capacity of the feed water at the various temperatures denoted, scale B would be the log scale of the thermal capacity of various quantities of steam generated for a known consumption of fuel, and the scale D would be a log scale of the total thermal capacity of the quantity of steam produced expressed either as a percentage of the calorific value of fuel consumed, or in Brit: thermal units absorbed or lost in the generation of the steam.

This form of the apparatus is also the most suitable for calculating the quantity of electric energy produced by an electric generator in which scale A would be a log scale of the voltage, scale B a log scale of the current and scale D a log scale of the kilowatts; for correcting the calculation to the power factor of an alternate current dynamo the log scale A or the index pointer may be made adjustable to a subsidiary log scale on the side of the plate E.

Figure 15 is a front view and Figure 16 a back view in which the rigid lath or band O having the setting scale B graduated on the front and the reading

scale D on the back is free to move between the plates E and E¹. Along one side of the opening in the plate E passing over the front side of the lath O is graduated the setting scale A and along the side of the back plate E¹ is fixed the index pointer C. The plates E and E¹ are held together at the sides.

Figure 17 shows a similar form of calculator in which the whole of the scales are arranged on one side of the apparatus, the back being available for directions or other printed matter.

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

1. Calculating apparatus in which the scales are graduated to read directly in terms of the system of units employed and consist of two scales of known values which when set together cause an index pointer to indicate on a third scale, or set of scales, the required result in any suitable terms, substantially as described.

2. The construction of calculating apparatus substantially in the manner and for the purposes described.

Dated this 14th day of July 1905.

OLIVER LEOPOLD PEARD.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1905.

A.D. 1904. Oct. 29. N° 23,363.
PEARD'S COMPLETE SPECIFICATION.

[8 SHEETS; SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 2.

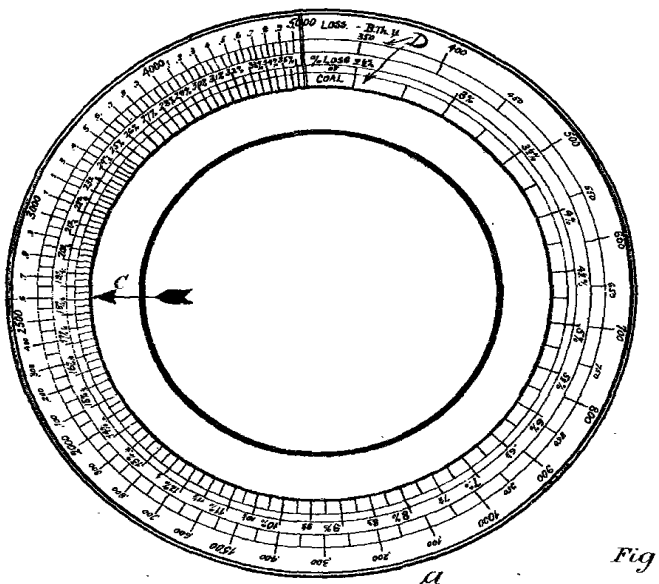

Fig. 1.

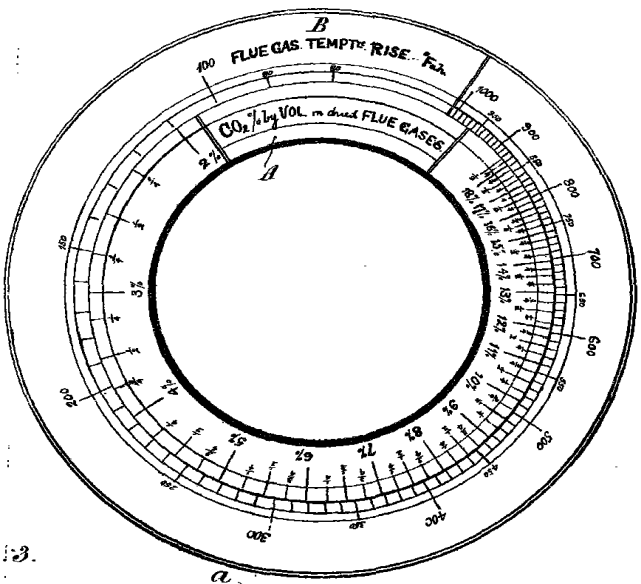

Fig. 3.

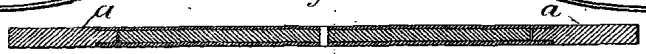

Fig. 4.

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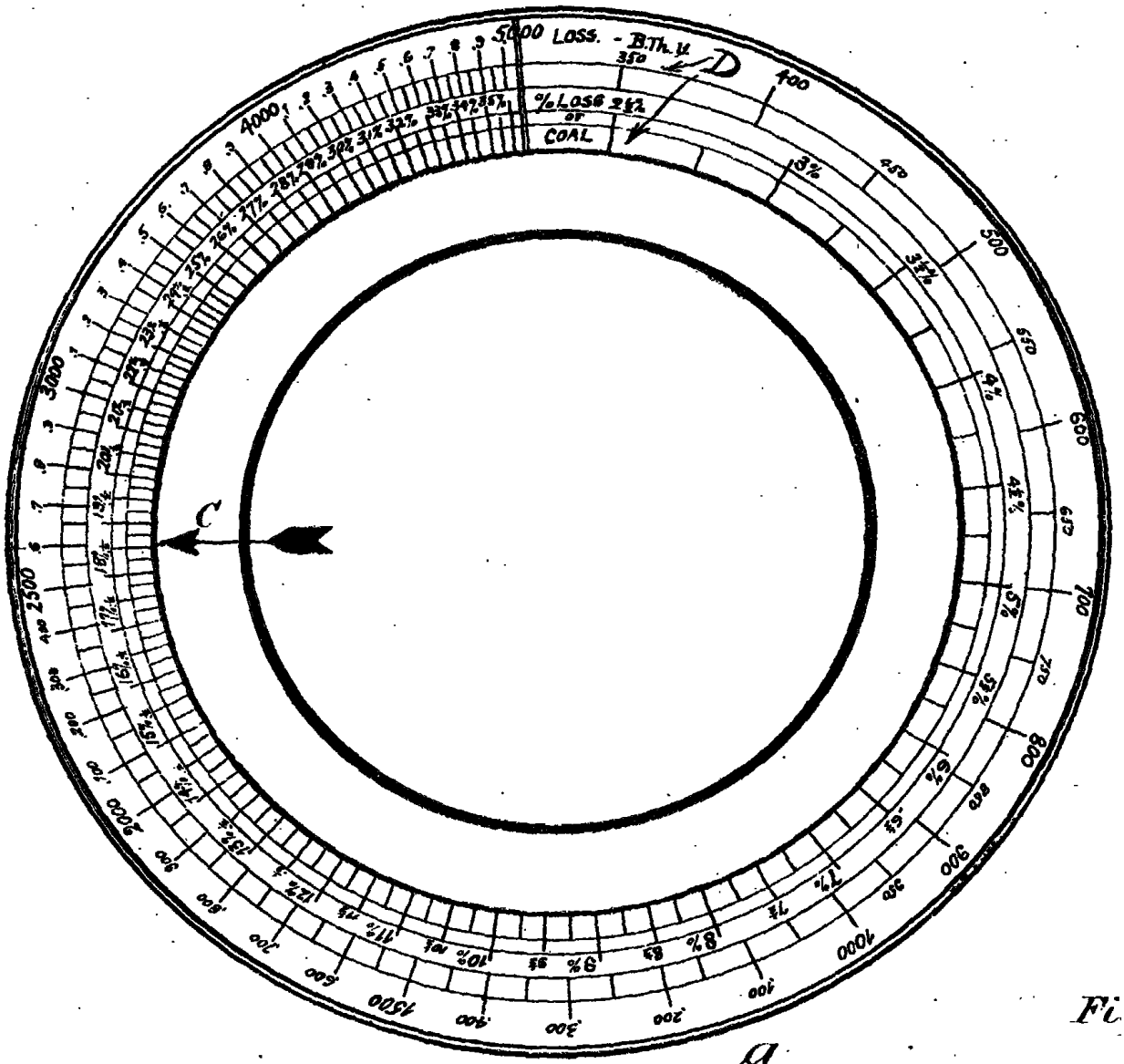
Fig. 2.



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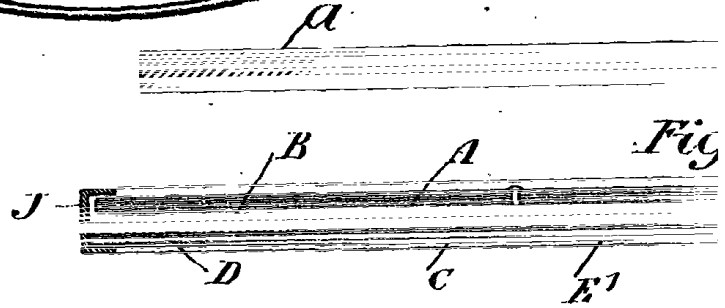

Fig

Fig. 1.

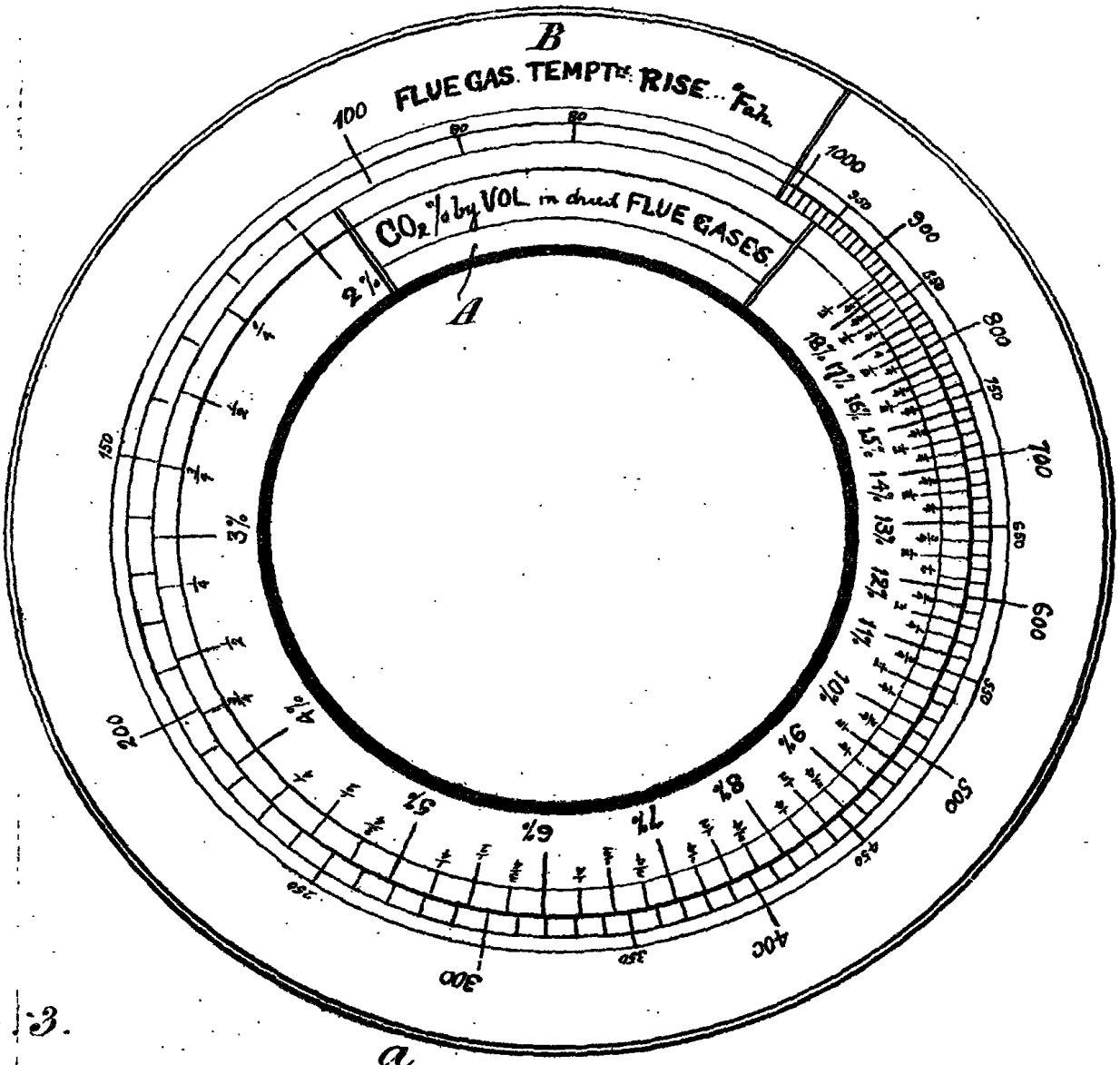

Fig. 3.

Fig. 4.

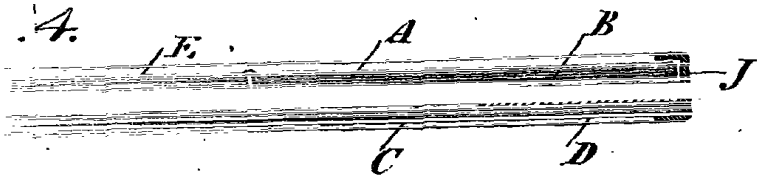

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Fig. 5.

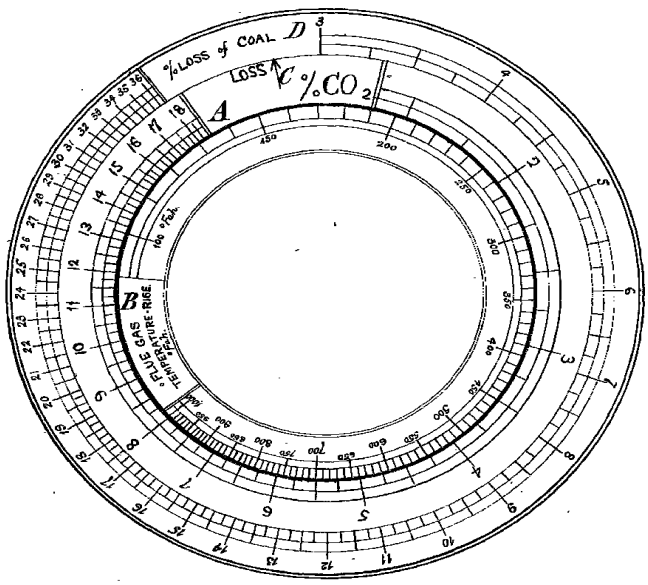

Fig. 6.

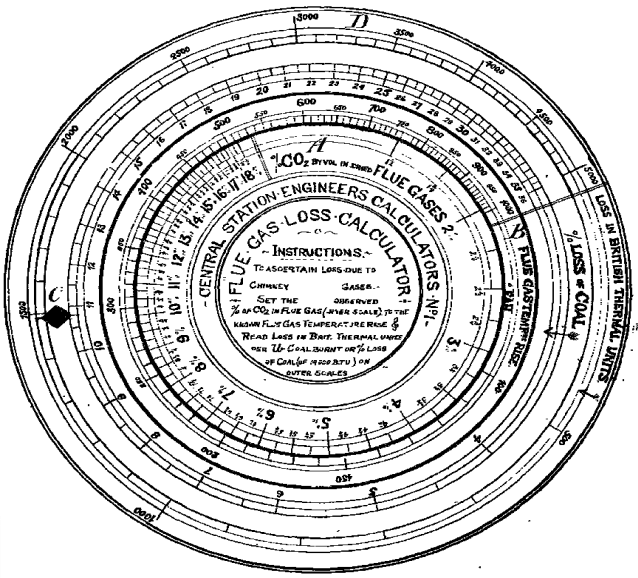

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Fig. 5.

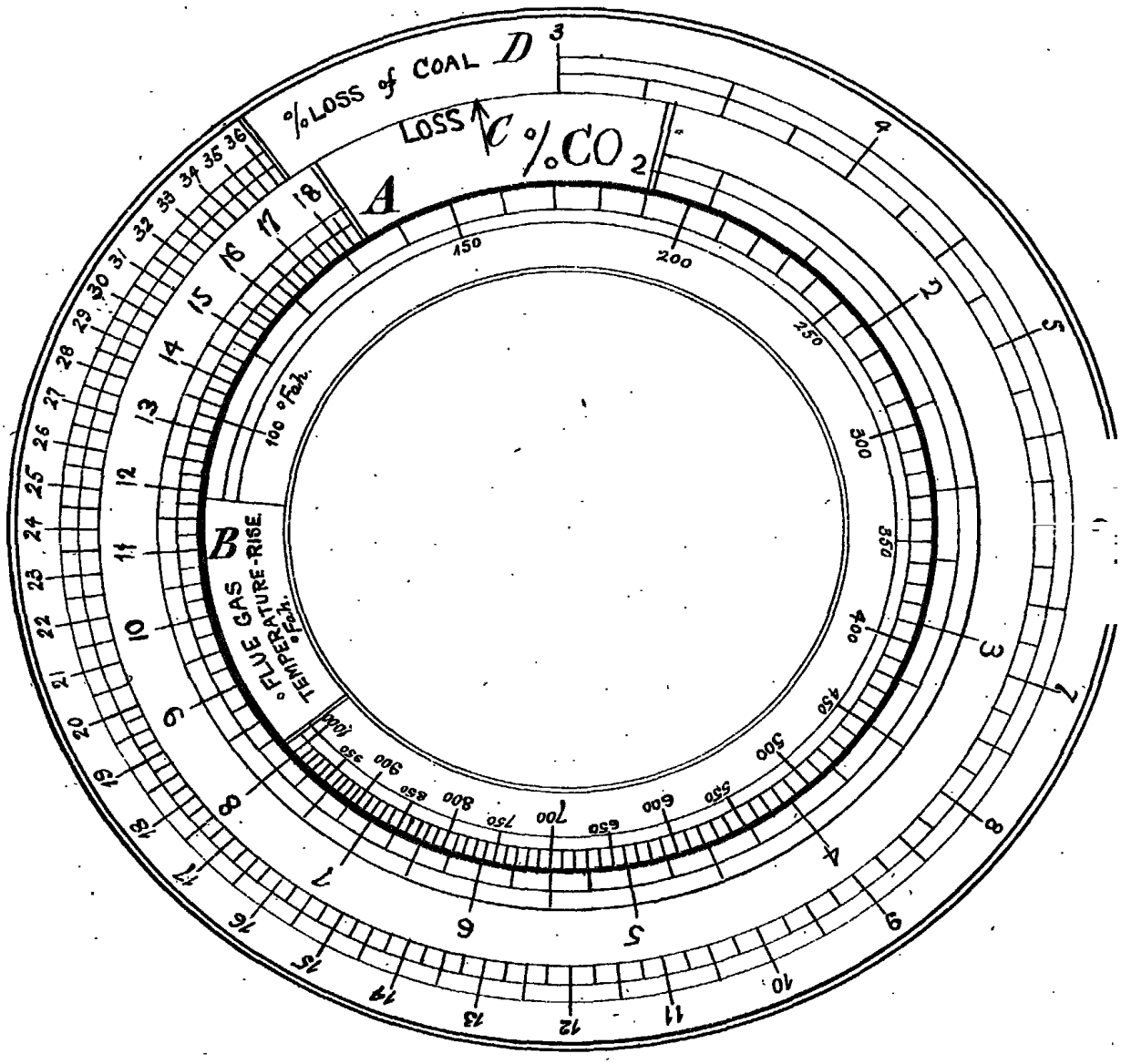

Fig. 6.

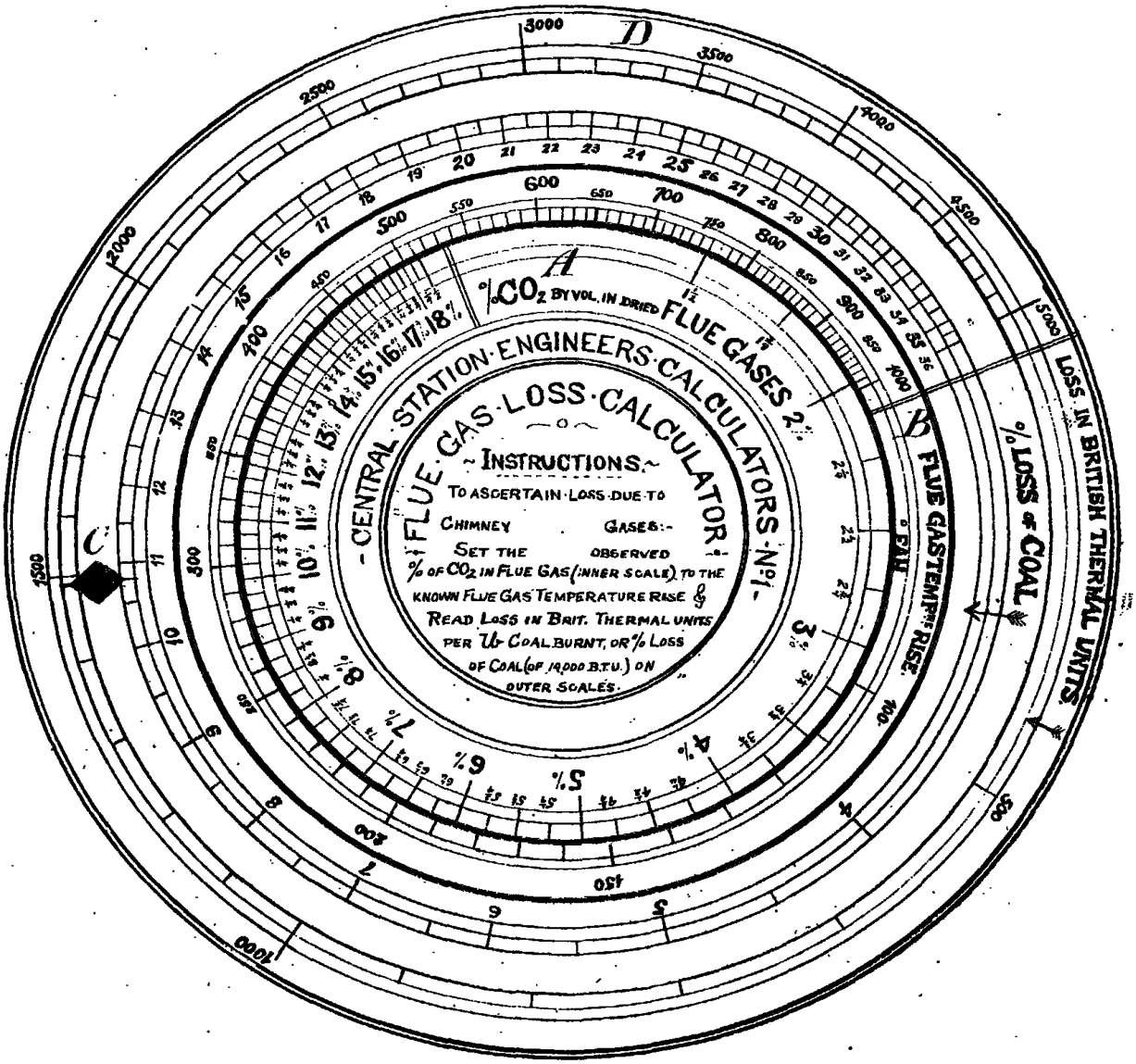

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Fig. 7.

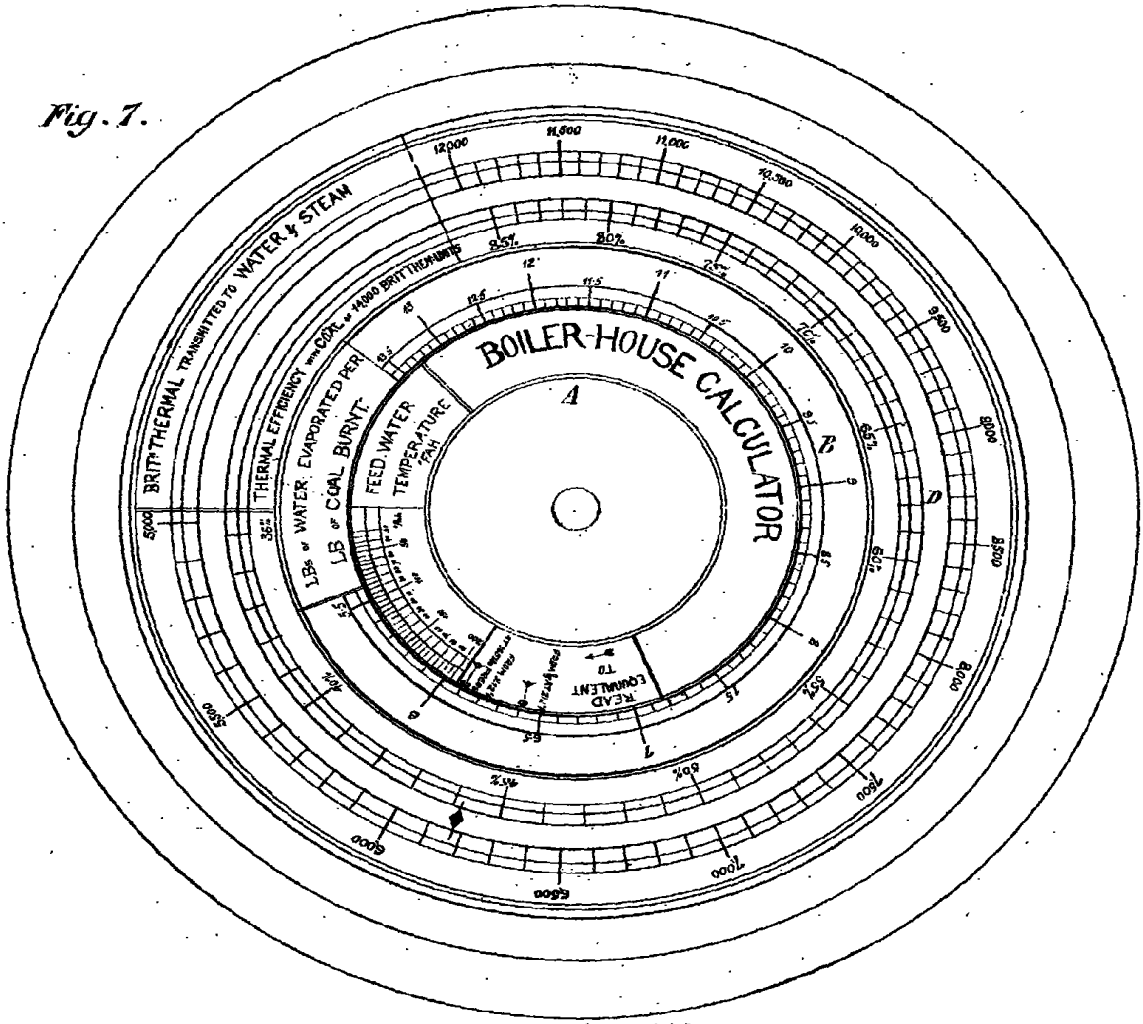

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Fig. 8.

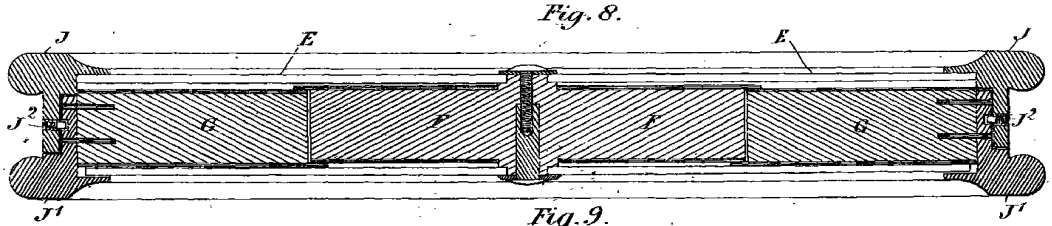


Fig. 9.

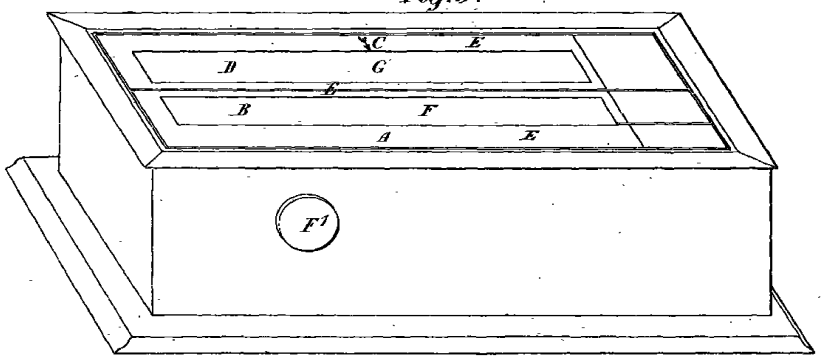
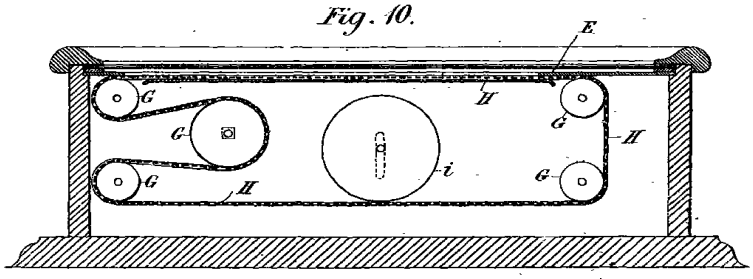


Fig. 10.



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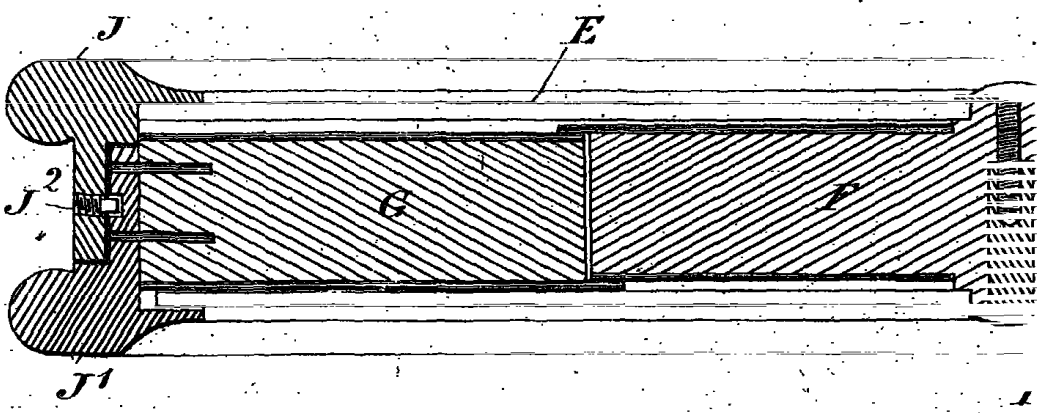

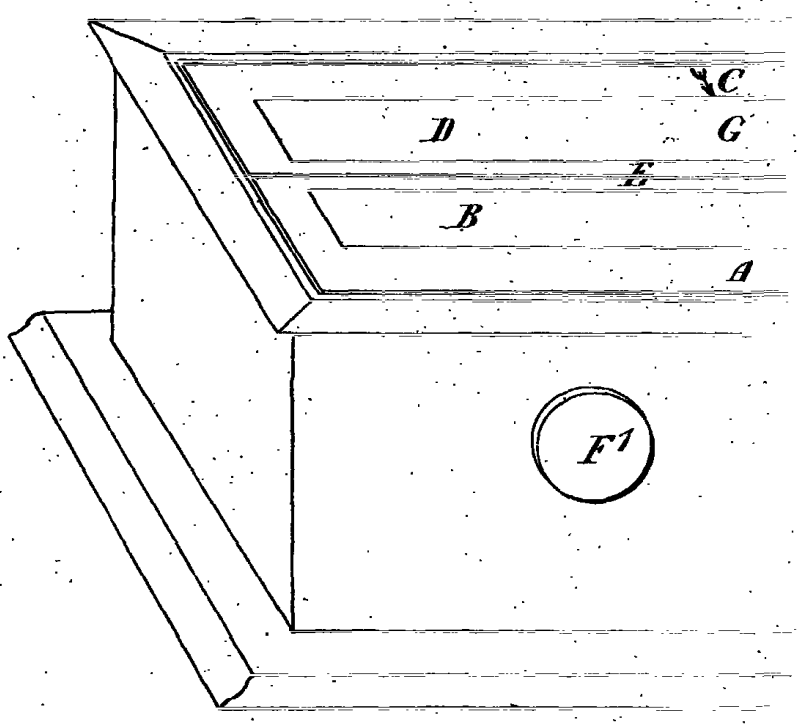

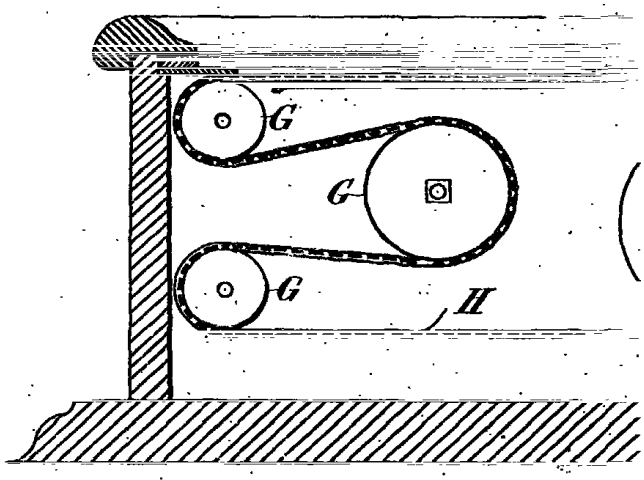

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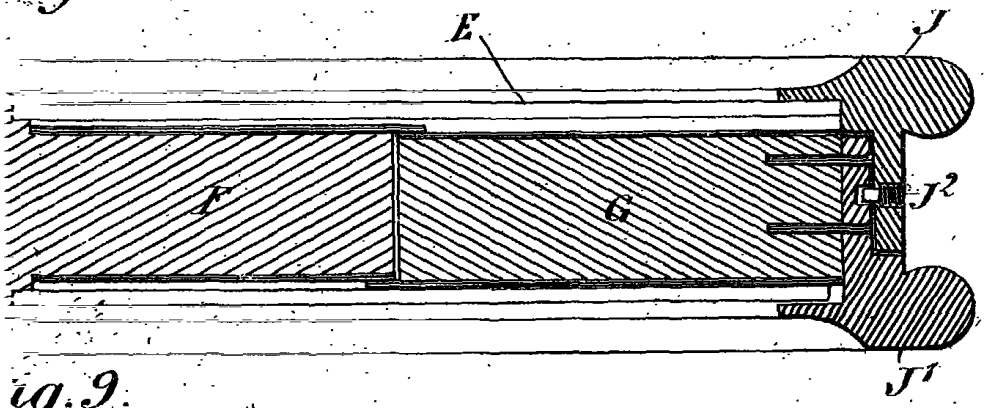

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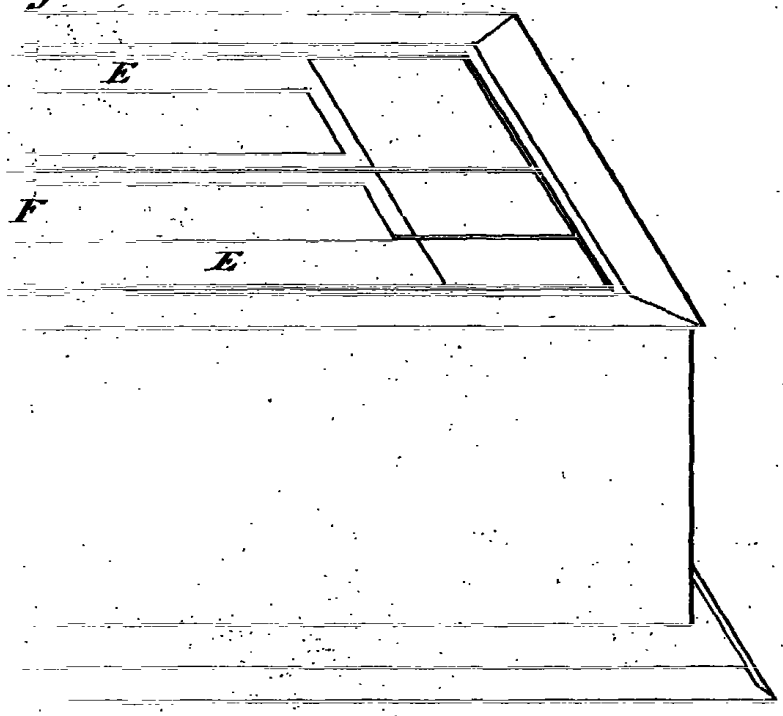

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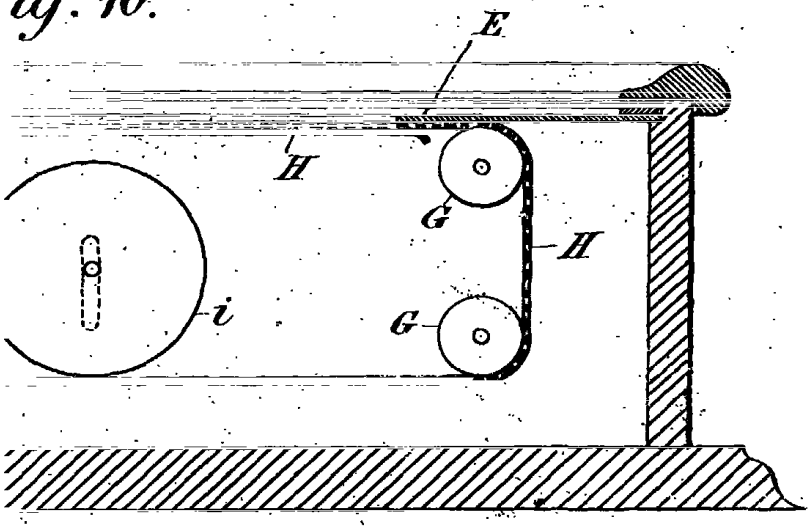

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Fig. 12.

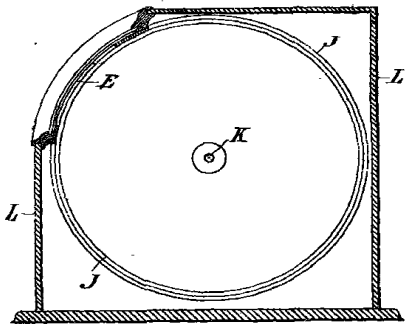
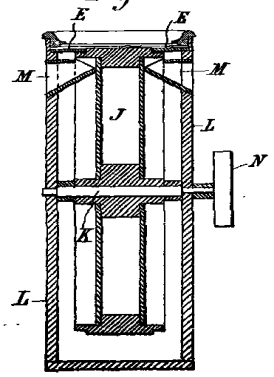


Fig. 11.



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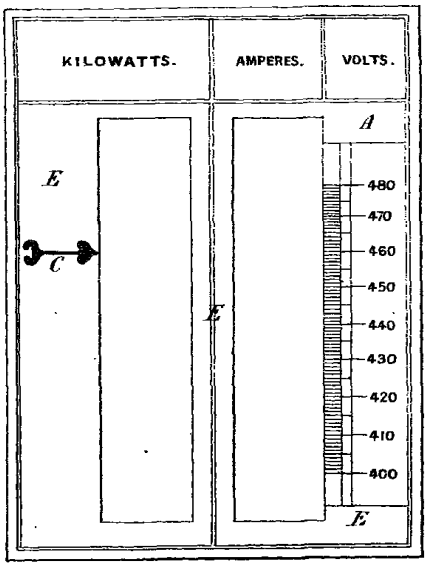

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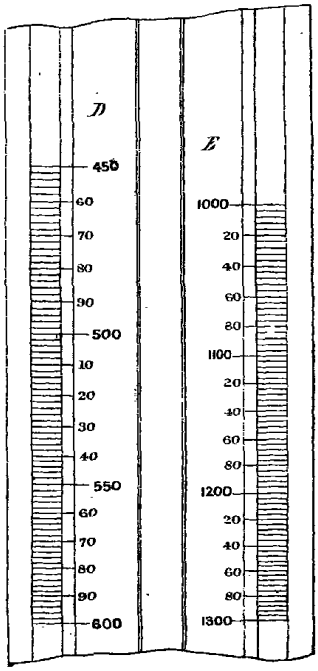

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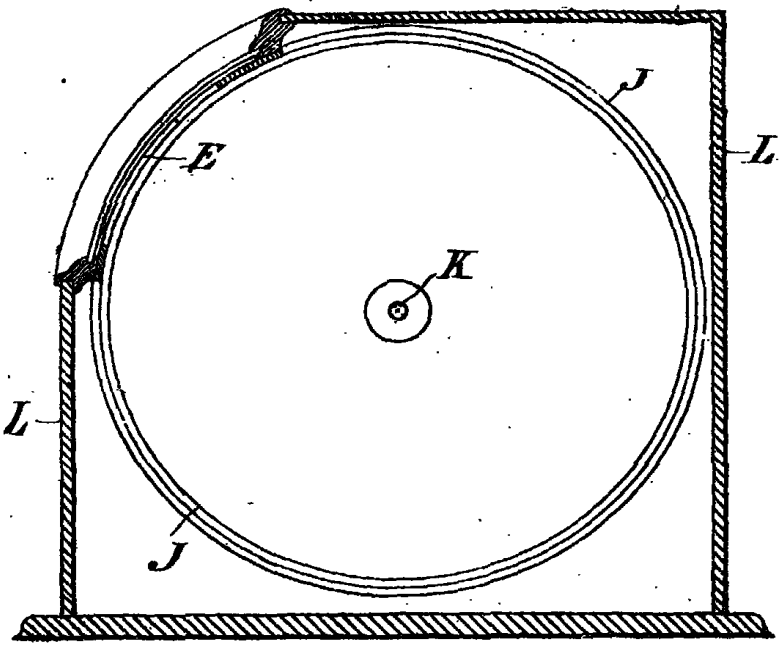

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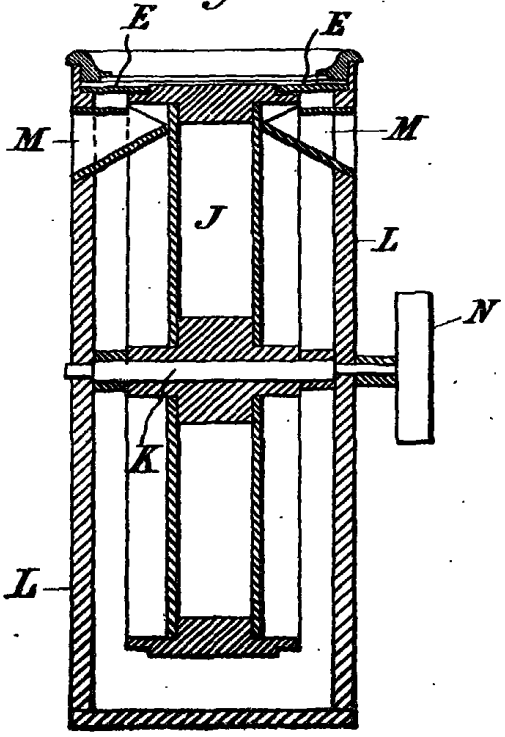

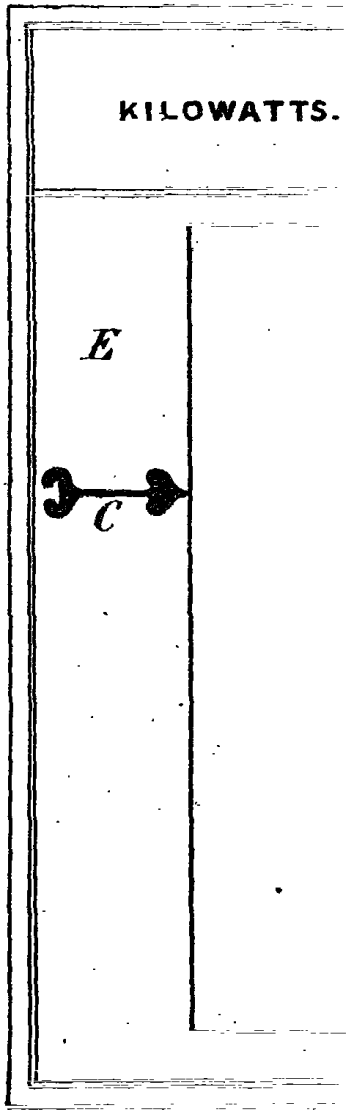

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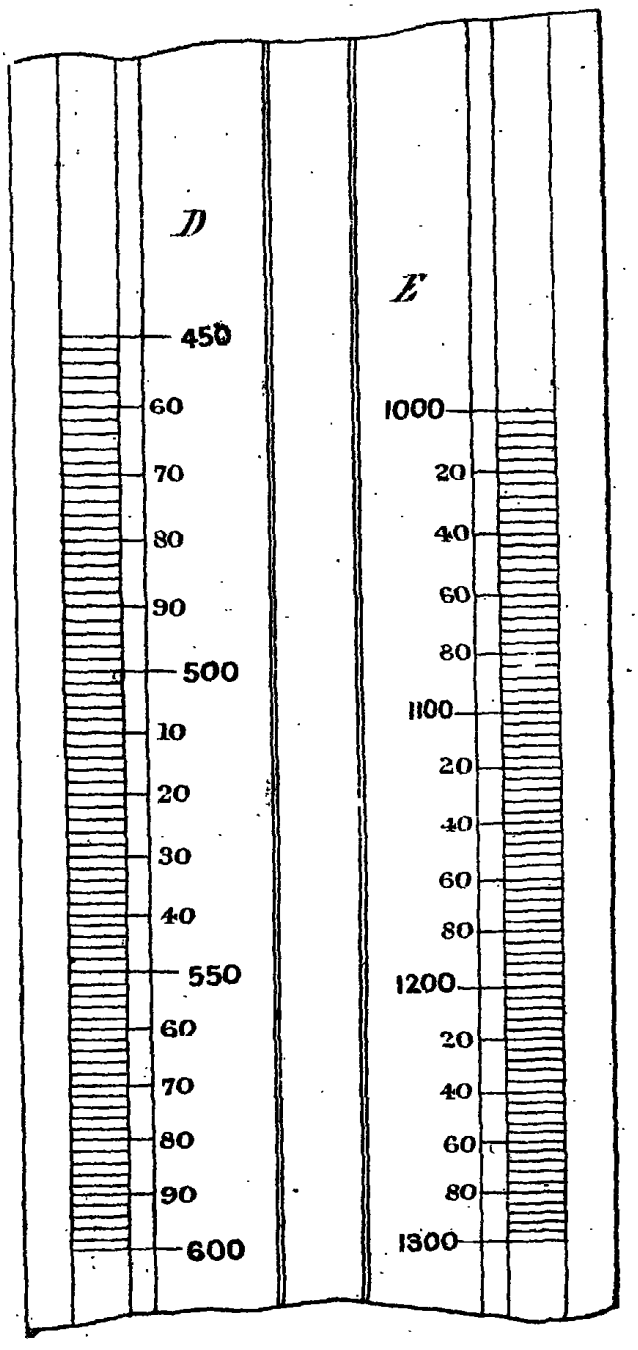

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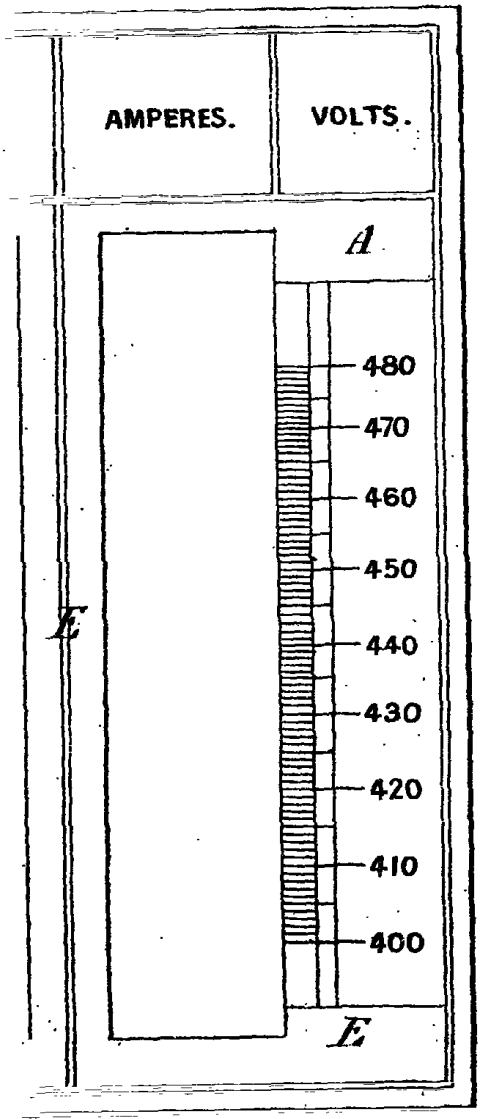


A.D. 1904. Oct. 29. N° 23,363.

PEARD'S COMPLETE SPECIFICATION.

8 SHEETS: SHEET 8

[This Drawing is a reproduction of the Original on a reduced scale.]

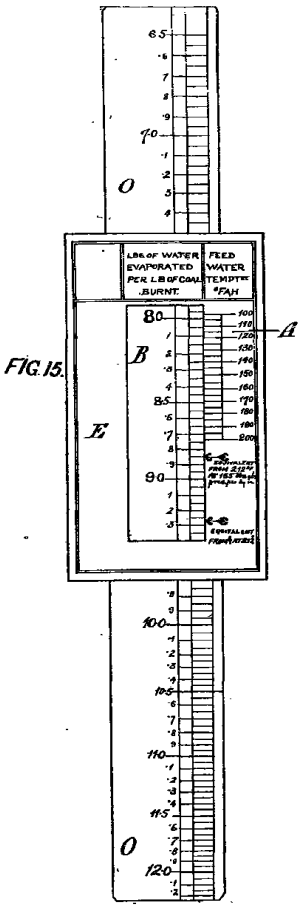


FIG. 15.

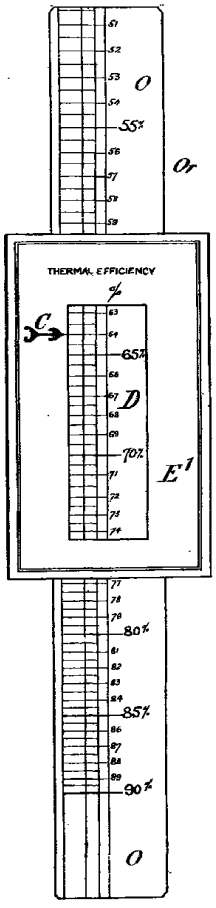
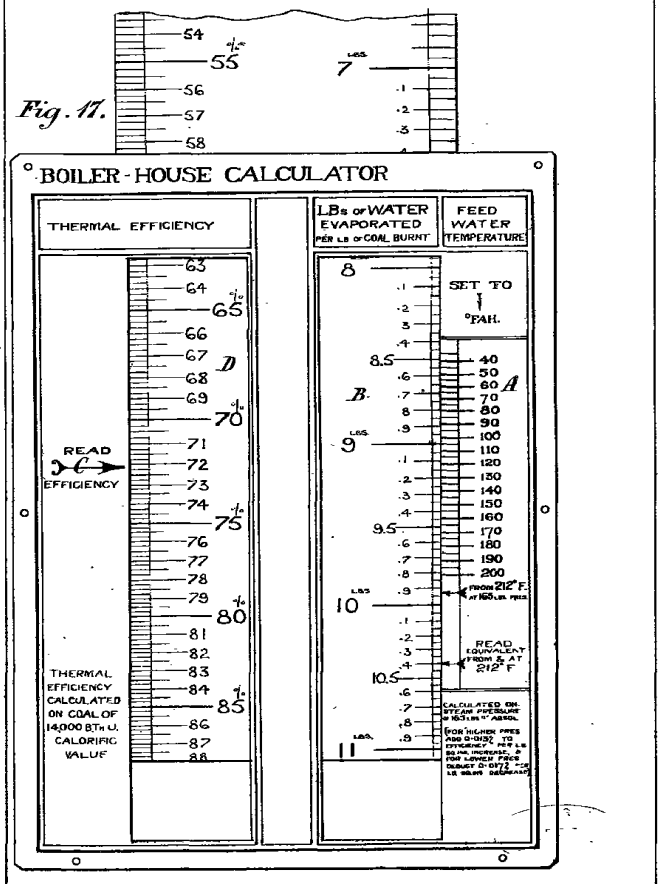


FIG. 16.

Fig. 17.



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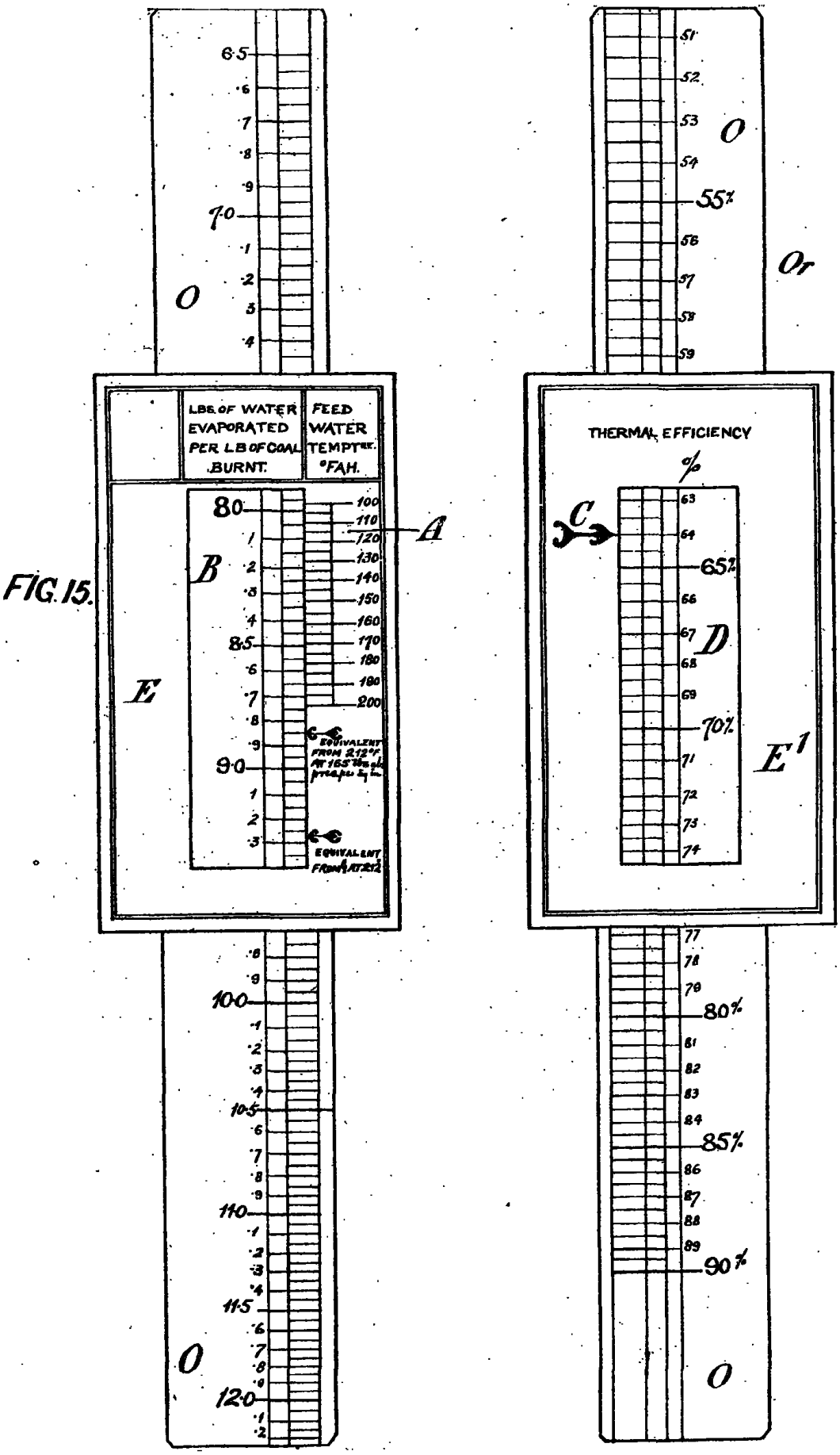
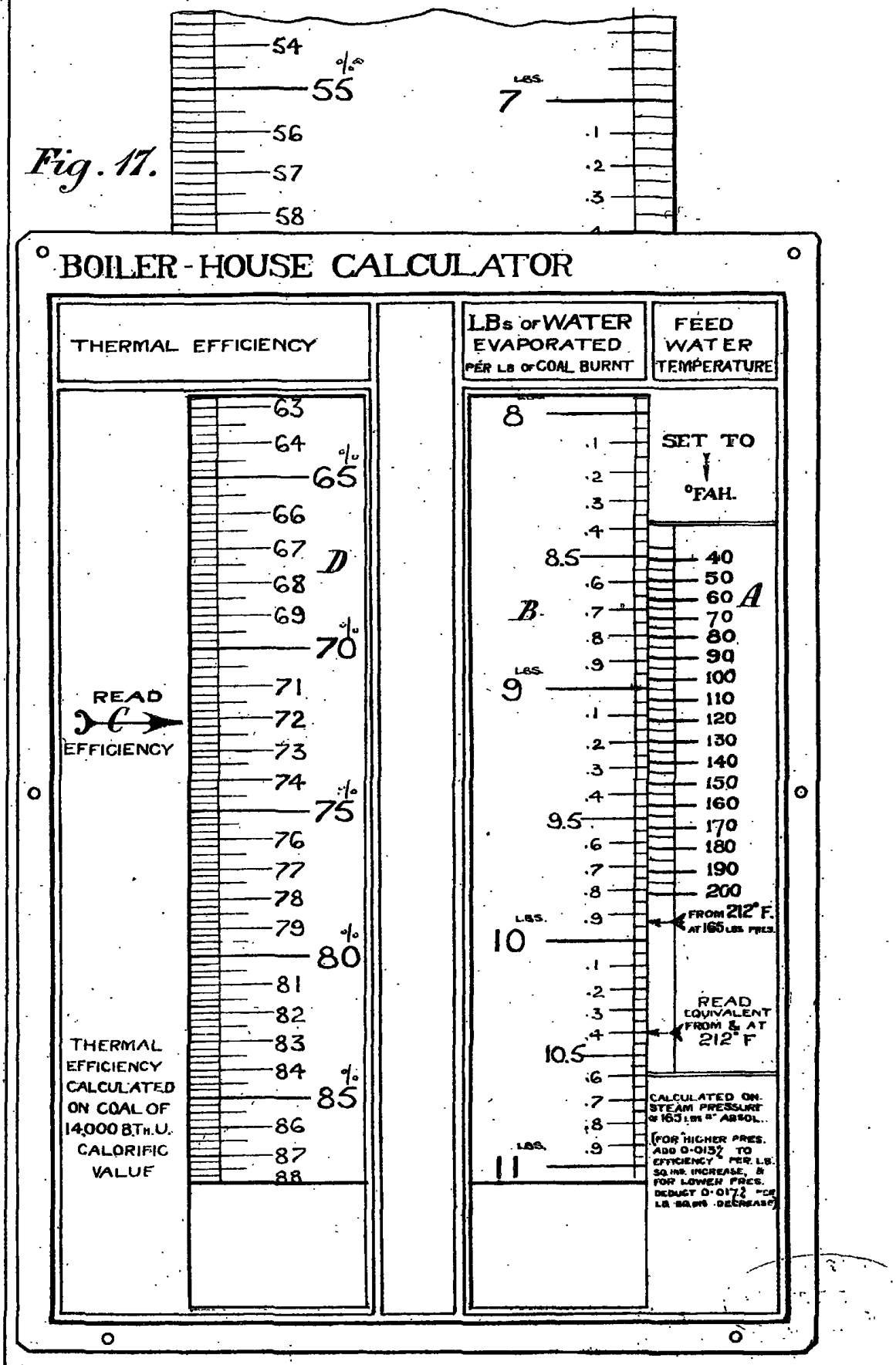


FIG. 15.

FIG.

16.

Fig. 17.



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