No. 829,368. PATENTED AUG. 21, 1906.

E. J. CLARKE.

GAGE.

APPLICATION FILED JAN. 16, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

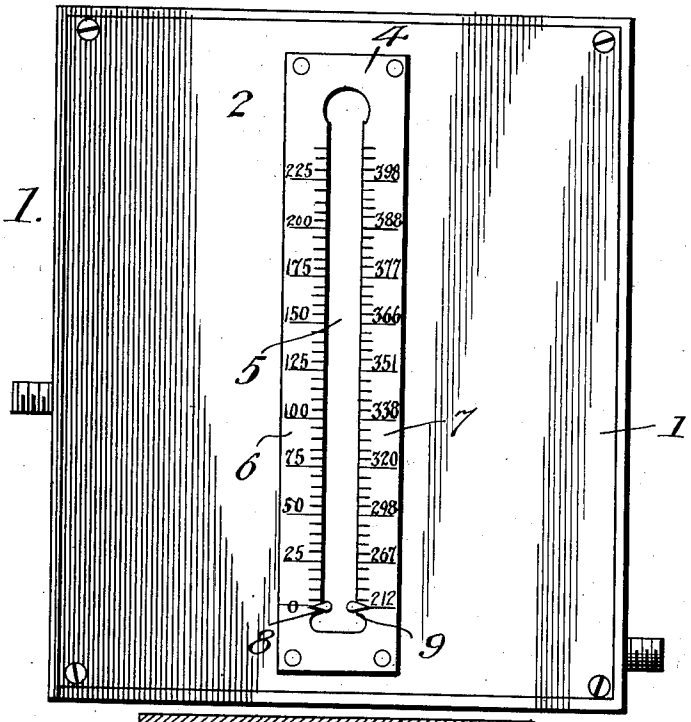
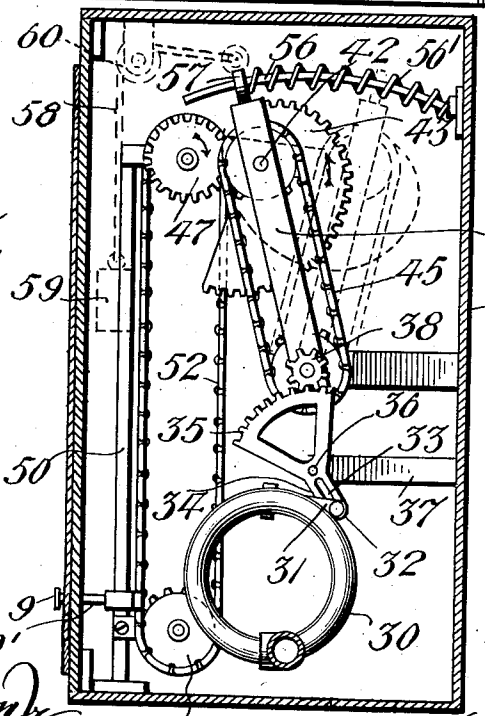


Fig. 3.



Witnesses

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3 SHEETS—SHEET 2.

Fig. 2.

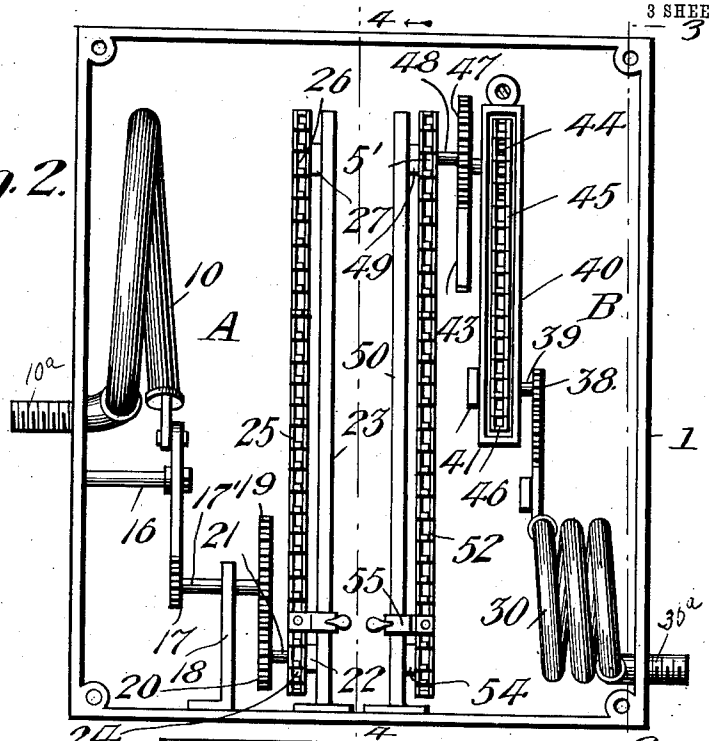
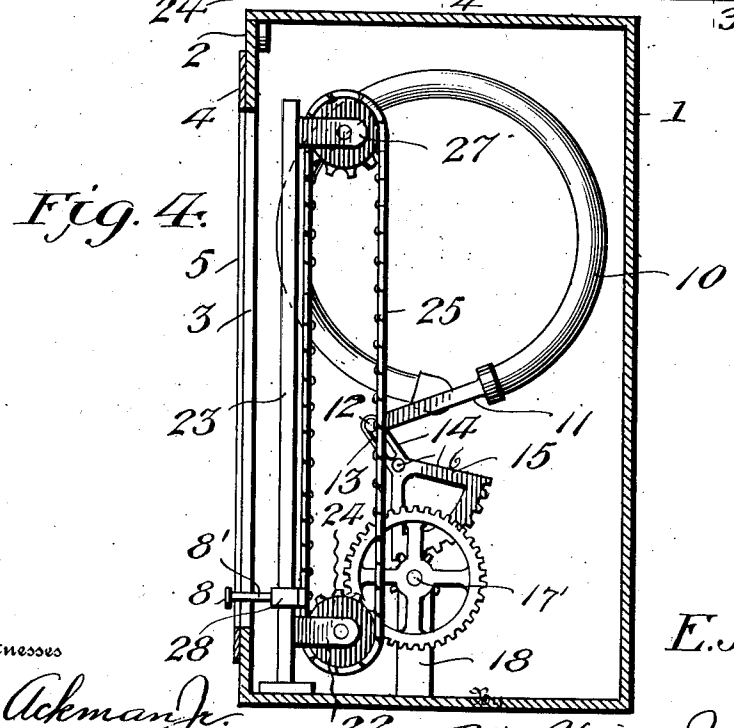


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 5.

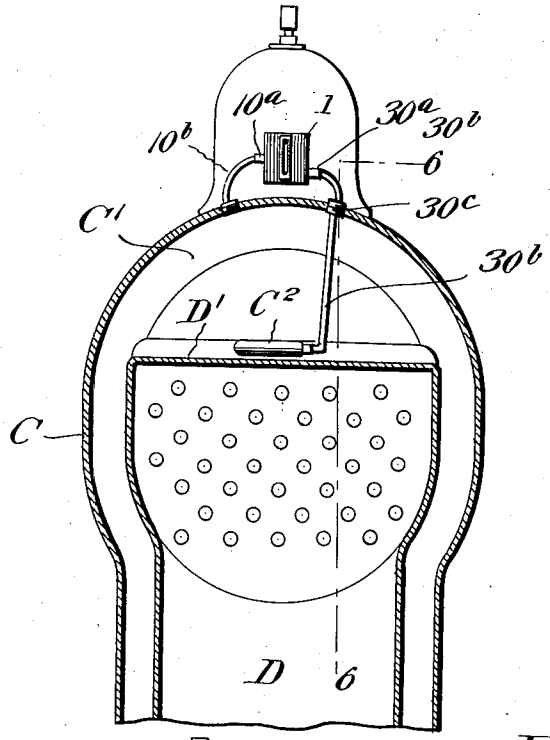

Fig. 6.

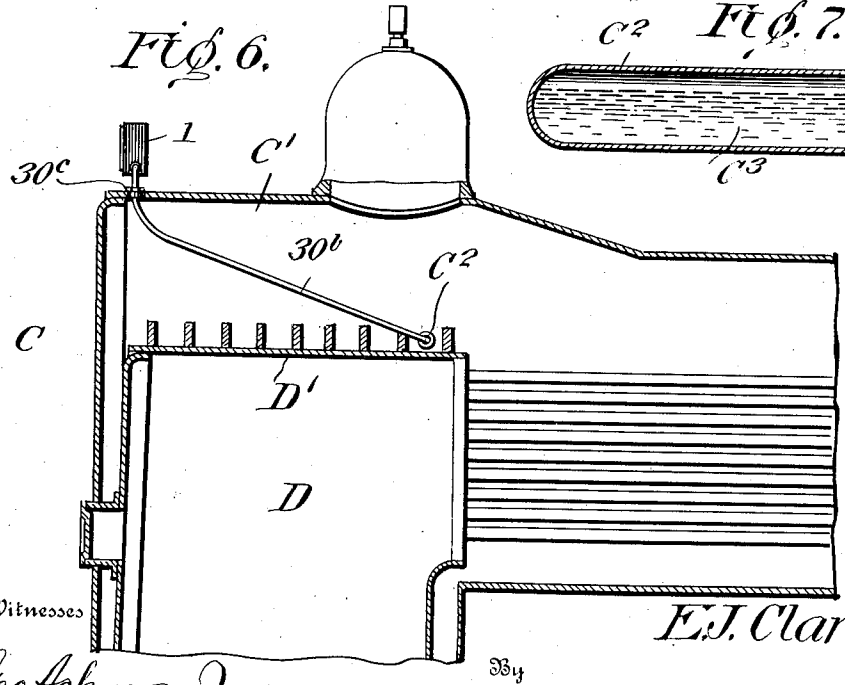

Fig. 7.

Witnesses

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UNITED STATES PATENT OFFICE.

EDWARD J. CLARKE, OF SCRANTON, PENNSYLVANIA.

GAGE.

No. 829,368. Specification of Letters Patent. Patented Aug. 21, 1906.

Application filed January 16, 1905. Serial No. 241,307.

To all whom it may concern:

Be it known that I, EDWARD J. CLARKE, a citizen of the United States, residing at Scranton, in the county of Lackawanna and State of Pennsylvania, have invented new and useful Improvements in Gages, of which the following is a specification.

This invention relates to gages, the object of the invention being to provide a combined pressure and temperature gage for steam-boilers, whereby the pressure of the steam and the temperature within the boiler may be readily and conveniently determined at any time, permitting the engineer or fireman to take measures to prevent an explosion when conditions are such that an explosion is liable to occur.

My invention operates on the principle that a certain temperature should exist with a determined steam-pressure in the boiler and that such temperatures and pressures should always be reasonably consistent; otherwise a condition not indicated by the ordinary gage and of which no warning is given by the indicators now in use is liable under certain phases or instances to ensue, which will cause an explosion notwithstanding the fact that a steam-gage may show that the pressure of steam within the boiler is much less than that which the boiler is designed to stand.

It is well known that a gas does not give a pressure consistent with the temperature under which it has been evolved unless it contains moisture, and a superheated gas is free from moisture, and that the temperature of a steam-boiler may reach such a degree where the water or steam in the boiler will separate into its component gases. When such conditions exist, any sudden change of temperature from the injection of colder feed-water or relief from the opening of a valve produces a recombination, with violence, of the gases and vapor, as a result of which the boiler is subjected to a much greater strain than that indicated by the steam-pressure shown by the gage. Hence an explosion is liable to occur without previous warning and without apparent cause.

My invention provides a device which shows the relative conditions as to pressure and temperature which should exist within a boiler and which indicates when these conditions become inconsistent, as when, for instance, the temperature of the boiler is above that which should occur with a given steam-pressure, thus enabling an engineer or attendant to take steps to restore normal conditions, thereby preventing excessive superheating of the steam and overstrain, without indication, on the boiler.

In the accompanying drawings I have shown certain means for carrying my invention into practical effect, without, however, intending to limit the invention to the particular means which, for the sake of illustration, I have set forth, and in these drawings Figure 1 is a front elevation of a gage embodying the principles of my invention. Fig. 2 is a similar view with the cover of the casing removed. Fig. 3 is a section through the complete gage on a plane indicated by the line 3 3 of Fig. 2. Fig. 4 is a similar view taken on the plane indicated by the line 4 4 of Fig. 2. Fig. 5 is a cross-section through the fire-box and shell of a locomotive-boiler, showing the application of the invention thereto. Fig. 6 is a vertical longitudinal section on line 6 6 of Fig. 5, and Fig. 7 is a longitudinal section of the tube containing the expansive medium.

The numeral 1 in the drawings represents the casing of the gage, which may be of any approved form, size, and material and which, as shown, is provided with a front cover-plate 2, having a central vertical slot 3 and upon the outer side of which is secured a plate 4, having a coinciding slot 5, said slot separating the body portion of the plate to form opposite portions or branches 6 and 7. The face of the portion 6 is suitably graduated to form a pressure-gage, opposite certain lines of which are arranged figures indicating pounds pressure, while the face of the portion 7 is similarly graduated and figured, the figures thereon indicating temperatures. As shown, the sets of lines of graduation and figures are arranged opposite each other or in corresponding registering relation, the line upon the portion 6 indicating the number of pounds of steam generated at a certain temperature being arranged opposite the corresponding line on the portion 7 designating such temperature. The pressure-graduations range from the zero-point to a suitable limit, in the present instance two hundred and twenty-five pounds, while the temperature-graduations range from 212°, Fahrenheit, the point at which steam is evolved, to 398°, at which temperature the pressure limit noted above is produced under normal conditions. For convenience I shall herein-

after term the part 6 and its graduations a "pressure-scale" and the part 7 and its graduations a "temperature-scale," which, in effect, they form. Coöperating with these scales are suitable pointers or indicators 8 and 9, carried by stems 8′ and 9′, which move vertically in the slots 3 and 5. These pointers are actuated, respectively, by the operating elements A and B, constituting, with the scale-plates and pointers, steam-pressure and temperature gages.

The operating mechanism A of the steam-pressure gage comprises a pressure expansion-coil 10, connected by a coupling 10^a with a steam-conducting pipe 10^b, leading into the steam-space C′ of the boiler C, said coil 10 being provided at its free extremity with a shank 11, carrying a pin 12, which is adjustable to vary its range of movement under a given amount of movement of the tube in a longitudinal slot 13, formed in an arm 14 of a toothed quadrant or rack 15. This quadrant is fulcrumed to swing upon a suitable supporting-rod 16 and stands at an angle to the vertical, as shown in Fig. 4, and its toothed portion meshes with a pinion 17, rigidly mounted upon one end of a shaft 17′, journaled in a bracket 18, fixed to the casing 1, said shaft carrying at its opposite end a rigid gear-wheel 19, which meshes with a pinion 20, fixed to a shaft 21. The shaft 21 is journaled in a bearing-block or bracket 22 upon the lower end of a vertical standard 23 and has also fixed thereto a sprocket-wheel 24, around which passes an endless sprocket-chain or carrier 25. The sprocket-chain also passes around a guide or direction sprocket-wheel 26, journaled in a bearing-block or bracket 27 at the upper end of the standard 23. The stem 8′ of the pointer or indicator 8 is connected to a block 28, which is fastened to the forward stretch of the chain 25 and is mounted to slide upon the standard 23, thereby guiding the hand or pointer 8 and the said forward stretch of the chain in true vertical paths. When the tube or coil 10 is expanded to a greater or less extent, its shank 11 is projected correspondingly, and the pin 12 communicates corresponding motion to the arm 14 and swings the toothed segment or quadrant 15 in the direction of the arrow in Fig. 4, thereby imparting motion to the train of gears before described to turn the bottom sprocket-wheel 24 to the right in Fig. 4 and actuating the chain, so that its front stretch will move upward, thereby causing the pointer 8 to also move upward on the pressure-scale 6 and indicate, in connection with the figures or lines of graduations thereof, the amount of pounds pressure in the boiler.

The temperature-scale indicating mechanism B comprises an expansion tube or coil 30, which in practice is connected by a coupling 30^a with a pipe 30^b, extending through a stuffing-box or plug 30^c in the boiler-shell and communicating therein with a tube or casing c^2, arranged at the water-line inside the boiler and containing an expansive medium c^3. The free end or extremity of this coil has an arm or shank 31 carrying a pin 32, which is adjustable to vary its range of movement under a given amount of movement of the tube in a slot 33 in the arm 34 of a toothed quadrant or rack 35, pivoted at 36 upon a suitable bracket 37, fixed to the rear of the casing 1. The toothed face of this quadrant or segment is directed upward and meshes with a pinion 38 on a shaft 39, journaled in the walls and at the lower end of an oblong rectangular frame 40 and also in a bracket 41 fixed to the casing 1.

Mounted in the upper portion of the frame 40 is a shaft 42, which extends at one end laterally therefrom and has fixed thereto a cam gear-wheel 43. On the shaft 42 is a sprocket-wheel 44, which is driven by a sprocket-chain 45, passing therearound and around a sprocket-wheel 46 on the shaft 39, whereby when the quadrant 35 is actuated motion will be transmitted to the cam-gear 43 in a manner readily understood. The cam-gear is adapted to mesh with a spur-wheel or pinion 47, mounted upon a shaft 48, journaled in a bearing-block or bracket 49, fixed to the upper end of a standard 50. On said shaft 48 is also a sprocket-wheel 51, over which passes a sprocket-chain 52, which also passes around a sprocket-wheel 53, mounted on a suitable stub-shaft journaled in a bearing-block or bracket 54, fixed to the lower end of the standard 50. The chain 52 is thus arranged vertically, and its front stretch is disposed just in rear of the standard 50 and in line with the vertical stretch of the chain 25 of the mechanism A. The stem 9′ of the pointer 9 is carried by a block 55, which is suitably fastened to the forward stretch of the chain 52 and is fitted to slide vertically on the standard 50, thereby causing the said vertical stretch of said chain and the pointer 9 to move in true vertical paths. The pointers 8 and 9 are so connected to the forward stretchers of the chains 25 and 52 that they lie opposite each other when the parts of the gage are in normal position, as shown in Figs. 1 and 2.

When the coil 30 expands to a greater or less extent, the gear 35 is swung to the right in Fig. 3 in an obvious manner and through its connection with the chain 45 communicates motion to said chain and thence to the cam-gear 43, which turns to the left or forwardly in the direction of the arrow shown in Fig. 3 and meshes with the pinion 47, thereby communicating motion to the chain 52, causing the vertical stretch thereof to travel upward and carry with it the pointer 9, which coöperates with the figures and lines of graduation on the temperature-scale 7 to indicate the temperature of the boiler's contents. In-

asmuch as the ratio of movement of the gearing of the pointer 9 must be increased with respect to that of the pointer 8, for reasons hereinafter stated, the cam-gear 43 is employed, which gives the necessary amount of toothed or motion-transmitting surface to actuate the chain 52 to the desired degree, and as on this account provision must be made for compensating for a variation in the arrangement of parts owing to the toothed portions of said cam-gear being at different points from its axis the frame 40, carrying the gear, is mounted to swing at its lower end upon the shaft 39, so that said frame may move rearwardly as its toothed surface meshing with the pinion 47 increases its distance from the shaft 42 and to correspondingly permit said frame to swing forward when the direction of movement of the cam-gear is reversed. The cam-gear is normally mounted in engagement with the pinion 47 by the weight or pressure exerted by the parts when the frame is in its normal position or inclined forward of the vertical line of the shaft 37 and is maintained in such position by the use of suitable retaining means, which must be of such a nature as to permit the frame 40 to have free swinging movement. The retaining means shown in the present instance consist of a curved or arcuate guide 56, fixed at one end to the rear wall of the casing 1 and projecting upwardly therefrom. To the upper end of the frame 40 is secured an eye 57, through which the guide 56 passes and which slides on said guide as the frame 40 swings in one direction or the other.

Surrounding the guide is a coil-spring 56′, which bears upon said eye and exerts a resistance to the rearward movement of the frame 40, thus requiring it to be positively swung rearwardly by the action of the cam-gear 43. When positive movement is exerted, the guide 57 will slide along the guide 56 against the resistance of spring 56′ in a manner readily understood, and when the coil 30 reacts or contracts and the motion of the parts is reversed the action of the quadrant 35 in returning to its normal position, as well as the weight of the frame 40 and attached parts and the pressure of the spring 56′ will swing the frame 40 forward to its normal position, thus again bringing the cam-gear 43 into mesh with the pinion 47.

If desired, another form of resisting and retracting device—such as a cord or chain 58 and a weight 59, as shown in dotted lines in Fig. 3—may be used in place of the spring 56′. The weight 59 will be attached to one end of the cord, which will pass upwardly and rearwardly over a direction-pulley 60 and be attached at its upper or opposite end to the eye 57 or directly to the upper end of the frame 40, as desired.

In the operation of the apparatus it is assumed, as before described, that the pointers 8 and 9 should always be arranged opposite each other or in registering relation when the pressure and temperature in the boiler are consistent—that is to say, when the temperature accords with the gage-line or numeral on the gage 7 coinciding with that on the gage 6 which indicates the amount of steam-pressure which the boiler should contain under such temperature. Thus if the pointer 8 has been moved upward on the scale 6 to coöperate with the numeral "100" thereon, indicating that the pressure in the boiler is at one hundred pounds, the pointer 9 should lie opposite the same and indicate that the boiler temperature is approximately 338°. If the corresponding indications as shown by the gage are, on the contrary, inconsistent with each other—that is to say, if when the pointer 8 is at "100" on the gage 6 and the pointer 9 instead of registering with the numeral "338" on the gage 7 has passed upwardly beyond said numeral—then the gage as a whole will indicate that an inconsistency between the steam-pressure and the boiler temperature exists and that attention to the boiler is required. As before stated, it is well known that a gas does not give a pressure consistent with the temperature under which it has been evolved unless it contains moisture, and a superheated gas is free from moisture, and that the temperature of a steam-boiler may reach such a degree where the water or steam in the boiler will separate into its component gases. When such conditions exist, the boiler is apt to be subjected to a much greater strain than that indicated by the steam-pressure shown by the gage, as when, for instance, a violent recombination of the gases and vapor is caused by a sudden reduction of temperature produced by the injection of colder feed-water or the quick relief afforded by the quick opening of a valve. Hence an explosion is liable to occur without previous warning and without apparent cause. If the pointer 9, coöperating with the gage 7, shows that the temperature within the boiler is much greater than that which should accord with the steam-pressure indicated on the gage 6 by the pointer 8, the engineer, fireman, or other attendant will know at once that an abnormal condition exists and that proper measures should be taken to reduce the temperature. My invention therefore provides a simple and effective combination-gage which shows the relative conditions as to pressure and temperature which should exist within a boiler under any degree of any steam-pressure and which indicates when these conditions become inconsistent, thus enabling normal conditions to be quickly restored to obviate any liability of an explosion.

The tube C^2, containing the expansive fluid C^3, is placed in practice in the boiler at the point first influenced by a change of temper-

ature. In the type of boiler shown the said tube is supported above the inner end of the fire-box D and out of contact with the crown-sheet D′ to prevent fluctuations from the influence of heat by conduction of the metal, yet close enough to said sheet to be uniformly influenced by the evolved heat. It will thus be understood that while the tube C^2 will be arranged at a definite point in the boiler such point will vary according to the type of boiler to which the gage is applied. The expansive medium C^3 may consist of any volatile liquid capable of responding rapidly to temperature variations, oil of turpentine, however, being preferably employed, as this volatile agent is rapidly and uniformly responsive to temperature changes. The quantity of turpentine employed in practice is sufficient to occupy approximately two-thirds of the total containing capacity of the casing C^2, pipe 30^b, and coil 30. This agent is vaporized, and as the vapor expands and contracts or its tension varies under variations in the boiler temperature the coil 30 will be expanded and contracted to a proportionate degree. I employ oil of turpentine or some other similar highly-volatile agent in preference to water, as an inclosed body of the latter is not sufficiently responsive to temperature changes.

Owing to the fact that the advancing ratio of temperature is different from that of pressure, as will be apparent by reference to the temperature and pressure scales, from which it will be seen that the degrees of temperature vary irregularly between regular periods of pressure progression, it is clear that in order to enable the temperature-graduations on the scale 7 to be arranged opposite the graduations on the scale 6, setting forth the pressures normally produced under such temperatures, some means must be provided to vary the ratio of movement of the gearing of the temperature-scale with respect to the gearing of the pressure-scale in order that the pointers 8 and 9 may have the same degree of movement notwithstanding necessary variations in the construction of the coils 10 and 30 and different degrees of movement imparted thereto under the relatively different pressures acting thereon as long as the temperature and pressures are consistent. This varying ratio of movement of the two sets of gearing is secured by the use of the cam-gear 43; but any other equivalent means for producing the same result may be employed.

It will be apparent that in this particular my invention differs radically from all prior pressure and temperature gages. I am aware that the use of a gage having opposite pressure and temperature scales and hands or pointers coöperating therewith to indicate at the same time the pressure and temperature has been suggested, such a device being shown in the United States patent to Seyferth, No. 301,397, dated July 1, 1884. In this patent the hands are operated by similar pressure-expanded spring tubes or coils, from which it will be apparent that the extent of movement of the hands will be dependent wholly upon the degrees of pressure exerted upon the coils, and as such degrees vary even when the pressure is consistent with the temperature under which it is produced the inoperativeness of such a structure to secure corresponding movements of the hands when a consistency of pressure and temperature is maintained will be obvious.

An important and desirable advantage which my invention provides over the patented device is that by causing the hands or pointers to operate in timed accord or to have the same degree of movement at all times when the generation of steam is progressing under normal conditions the degrees on the pressure-scale 7 may be arranged opposite the degrees on the scale indicating the temperatures under which such pressures are normally produced, thus enabling the engineer or fireman to determine by visual observation and without the necessity of memorizing or referring to a table whether or not the pressures and temperatures indicated by the hands or pointers are consistent or inconsistent.

I am also aware of the prior United States patent to Lyman, No. 6,955, dated December 18, 1849, disclosing a combined steam-pressure gage and low-water indicator and alarm, wherein two companion mercury-gages are used and provided with corresponding pressure indications, one of the gages being adapted when the mercury therein expands to a certain degree to sound a low-water-alarm whistle. While it is true that the mercury in the low-water gage of this device is operated by the pressure of steam generated from a body of water inclosed in a vessel disposed in the boiler at the point first influenced by a variation of temperature, it is nevertheless a fact that the primal purpose of this construction is to secure increased pressure when the water falls below the normal level to sound an alarm and not to indicate the maximum interior temperature of the boiler. It is furthermore apparent that while the temperature of the boiler may be determined by inspection of the pressure indications on the alarm-scale such determination would involve either expert mental calculation or the use of a pressure and temperature table for consultation, as the scale indications are not arranged or intended to indicate the degrees of temperature under which the pressures are produced. Moreover, the patentee's construction clearly does not show a scale having temperature and pressure graduations arranged in corresponding registering relation, each pressure graduation being disposed opposite the graduation indicating the temperature

under which said pressure is normally produced, indicators coöperating with the respective graduations and sets of gearing or equivalent means for operating the respective indicators, said sets of gearing having a differential ratio of movement to compensate for the difference between the advancing ratio of temperature and that of pressure. The radical differences between the purposes, functions, and results of Lyman's gage and my gage will therefore be readily understood.

By the use of the word "consistent" as herein applied to pressures and temperatures I mean the relative conditions as to temperature and pressure which should exist within a boiler when the pressure evolved is produced by the degree of temperature under which it should normally be evolved. By the use of the word "inconsistent" is meant a condition which exists when the pressure indicated is less than that which should be produced under the indicated temperature.

It is to be understood that the scale may show that an inconsistency between pressure and temperature exists when the danger of an explosion is remote, as when the boiler contains a large amount of impurities, so that the scale will indicate in either event that the boiler requires attention.

From the foregoing description, taken in connection with the accompanying drawings, the construction and mode of operation of the invention will be apparent without a further extended description. Changes in the form, proportions, and minor details of construction and additions may be made within the scope of the invention without departing from the spirit or sacrificing any of the advantages thereof.

Having thus described the invention, what is claimed as new is—

1. In a gage, an endless carrier, an indicator actuated thereby, an expansion device, a swinging rack actuated by said expansion device, and means for communicating motion from the rack to the endless carrier.

2. In a gage, an endless carrier, an indicator actuated thereby, an expansion element, a cam-gear, means actuated by said gear for imparting movement to the carrier, operating connections between the expansion element and cam-gear, and means for compensating for the movement of said cam-gear.

3. In a gage, an endless carrier, an indicator operated thereby, an expansion element, a cam-gear, means for imparting motion from the expansion element to the cam-gear, means for imparting motion from the cam-gear to the carrier, a movable support for the cam-gear, and means for normally holding the cam-gear in operative position.

4. In a gage, an endless carrier, an indicator attached to said endless carrier, an expansion device, a swinging element actuated by said expansion device, and means for communicating motion from said swinging element to the endless carrier.

5. In a gage, a standard, an endless carrier supported by said standard, an indicator guided by the standard and connected to the carrier, an expansion device, a swinging element actuated by said expansion device, and means for imparting motion from the swinging element to the carrier.

6. In a gage, an endless carrier, an indicator actuated thereby, an expansion device, a train of gears for operating the endless carrier, and a swinging rack actuated by the expansion device and engaging one of the gears of the train.

7. In a gage, an endless carrier, an indicator actuated thereby, a gear for driving the endless carrier, an expansion device, a cam-gear operated by the expansion device and meshing with said driving-gear, and a swinging support for the cam-gear.

8. In a gage, the combination of an endless carrier, an indicator actuated thereby, a gear for driving the endless carrier, a cam-gear for operating said driving-gear, a swinging support for the cam-gear, an expansion device, operating connections between the expansion device and cam-gear, and means for resisting rearward movement of the swinging support and returning the same to its normal position when the cam-gear moves out of engagement with the driving-gear.

9. In a gage, an endless carrier, an indicator operated thereby, a gear for driving the endless carrier, a swinging frame, sprocket-gearing carried by said frame, a cam-gear operated by said sprocket-gearing and meshing with the driving-gear, an expansion device, and means for operating the sprocket-gearing from the expansion device.

10. In a gage, an endless carrier, an indicator operated thereby, a gear for driving the endless carrier, a swinging support, sprocket-gearing carried by said swinging support, a cam-gear also carried by the swinging support and driven by the sprocket-gearing and adapted to mesh with and drive the aforesaid drive-gear, an expansion device, means for operating the sprocket-gearing from the said expansion device, and means for resisting rearward movement of the swinging support when the cam-gear meshes with the drive-gear and returning the same to its normal position when the cam-gear moves out of mesh with the drive-gear.

11. In a gage, an endless carrier, an indicator operated thereby, a gear for driving the endless carrier, a swinging support, a cam-gear carried by said support and adapted to mesh with the driving-gear to operate the endless carrier, a swinging support, a cam-gear carried by said support and adapted to mesh with the driving-gear to operate the endless carrier, sprocket-gearing carried by

the support for operating the cam-gear, an expansion device, a swinging rack operated by said expansion device and operatively connected with the said sprocket-gearing, and means for resisting the rearward movement of the swinging support when the cam-gear meshes with the drive-gear and returning the same to its normal position when the cam-gear moves out of mesh with the drive-gear, substantially as described.

12. A gage for indicating the temperatures and pressures within a steam-boiler, comprising temperature and pressure scales having graduations arranged in corresponding registering relation, each pressure graduation being disposed opposite the graduation indicating the temperature under which said pressure is normally produced, pointers cooperating with said scales, and means embodying sets of pressure-controlled gearing, one having a regulated variable ratio of movement with respect to the other, for operating the respective pointers, whereby the sets of gearing are adapted to compensate for irregularities in the degrees of temperature progression between regular periods of pressure progression to move the pointers at like ratio when the temperatures and pressures are consistent.

13. A gage for indicating the temperature and pressure within a steam-boiler, comprising temperature and pressure scales provided with graduations arranged in corresponding registering relation, each pressure-graduation being disposed opposite the graduation indicating the temperature under which said pressure is normally produced, pointers cooperating with said scales, pressure-influenced expansion devices, operating connections between the respective pointers and expansion devices, and means for definitely varying the ratio of movement of one connection with respect to the other connection to compensate for variations in the advancing range of pressure and temperature in the generation of steam to adapt the temperature-pointer to move in timed accordance with the pressure pointer when the boiler-pressure and the temperature under which it is produced are consistent, substantially as described.

14. An apparatus for indicating the temperatures and pressures within a steam-boiler, comprising temperature and pressure scales having graduations arranged in corresponding registering relation, each pressure graduation being disposed opposite the graduation indicating the temperature under which said pressure is normally produced, pointers coöperating with the respective scales, traveling carriers for actuating the pointers, pressure-controlled expansion devices, sets of gearing for actuating the carriers from the respective expansion devices, and means forming part of the temperature-pointer-operating gearing for definitely varying the ratio of movement of said gearing with respect to the pressure-pointer-operating gearing to compensate for variations in the advancing range of pressure and temperature in the generation of steam to adapt the temperature-pointer to move in timed accordance with the pressure-pointer when the boiler-pressure and the temperature under which it is produced are consistent, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD J. CLARKE.

Witnesses:
WILLIAM W. SCHANK,
HORTON E. KIMBLE.