Sept. 24, 1940. J. C. HOLDMAN 2,215,503

VALVE SETTING CALCULATOR

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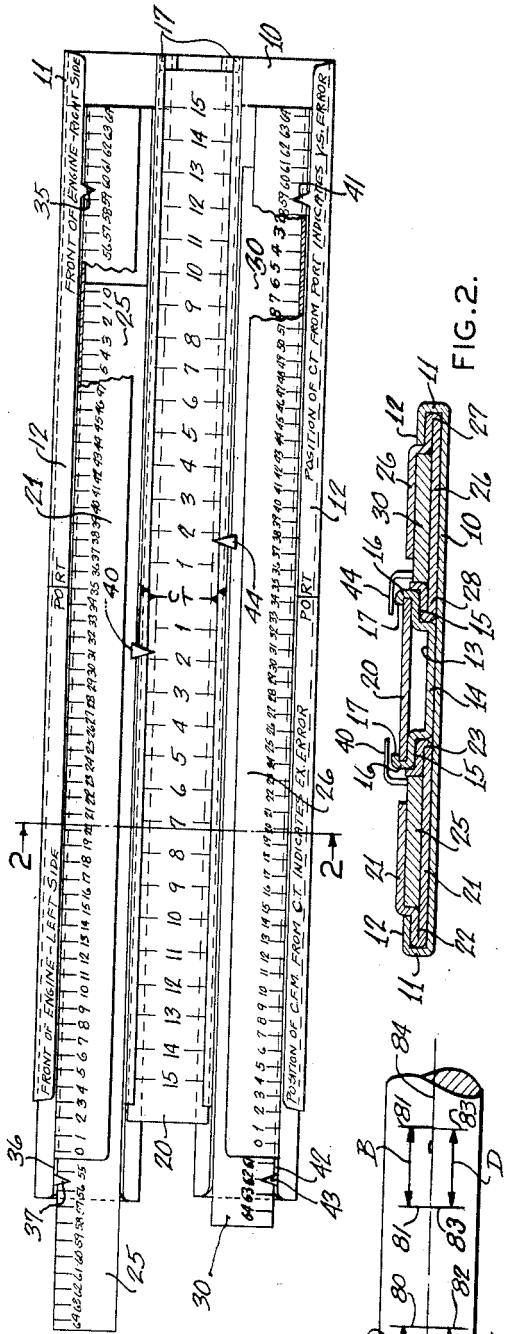

FIG. 1.

FIG. 2.

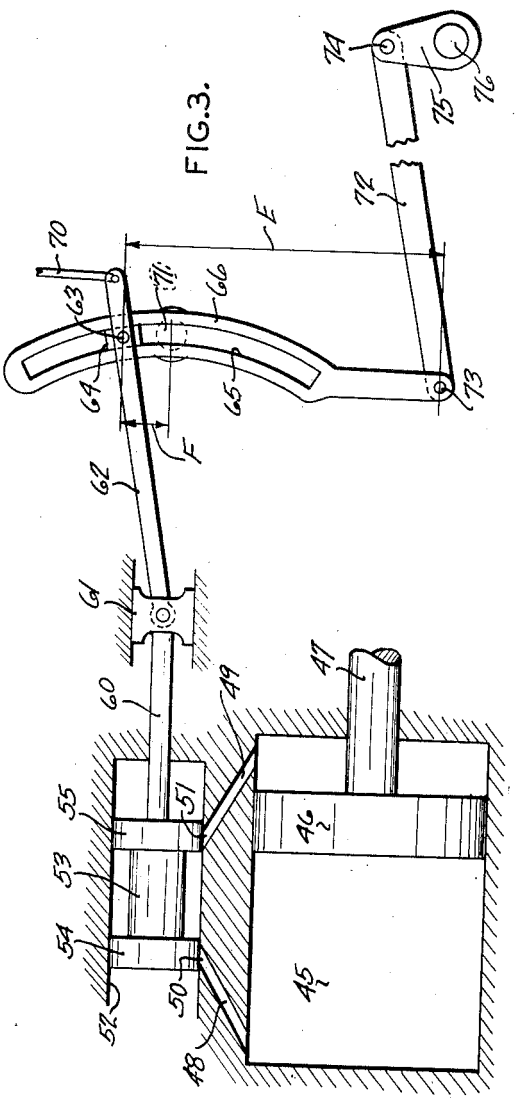

FIG. 3.

FIG. 4.

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VALVE SETTING CALCULATOR

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10 Claims. (Cl. 235—70)

This invention relates to valve setting calculators, and particularly to calculating devices for aid in synchronizing or equalizing the slide valve mechanism of steam engines, and is utilized to great advantage in servicing the valves and valve gear of steam locomotives.

It has heretofore been necessary at intervals, usually incident to the routine servicing of steam locomotives, to check, and usually to readjust the position of each of the steam valves as to its timed or operative relation to the piston of the corresponding cylinder. Usually the adjustments include, to insure optimum valve positioning, two more or less separate, and yet related changes in the valve operating mechanism. The first of these consists in effecting any necessary change in the spacing, say of a piston type valve, and the valve crosshead by which it is operated; otherwise expressed in the manner usually employed, this change involves a variation in absolute length of the valve stem or valve-operating rod by or through which the valve is connected to its crosshead. The second adjustment is cared for in usual practice with steam locomotives, by changing, if and as necessary, the length of the eccentric rod which serves as one of the connecting elements between the reverse and cutoff link, and the valve actuating crank or eccentric. The procedure heretofore resorted to is well known to the skilled railroad mechanic and need not be herein described in detail. It is sufficient for the present to note that because of the plurality of careful measurements involved, and ensuing arithmetical calculations, the process is usually time-consuming and fraught with possibility of error.

The present invention has as its principal object, an improved device by which certain values, easily arrived at by measurement, may be set up on the device which is in the nature of a calculator of slide rule type, and which is further so designed as to enable deriving by direct reading, any change necessary to be made in the length of valve stem, and also so designed that the device provides, when fully set up, a value which, through an easy conversion factor, will give with certainty any necessary change in length of the eccentric rod. From this fact and the following more detailed description it will appear that the valve setting device of the present invention obviates all of the protracted arithmetical processes heretofore required incident to the synchronization of steam locomotive valves, for example, with the sole exception of a single simple multiplying operation hereinafter explained.

Yet another object of the invention is attained in a simple, compact, easily readable, low-cost calculating device for the purpose noted.

Yet another object of the invention is attained in a valve-setting calculator particularly adapted for the purpose noted, and which is so designed, and provided with indicia such that the device in use bears a definite, physical fore-and-aft relation to the locomotive or other steam engine of slide valve type, such as positively to indicate to the user whether the reading indicating a change in the valve mechanism is either an increment or decrement, and further such that there is obviated any confusion between the results obtained with respect to the two valve gears on opposite sides of the locomotives.

The foregoing and numerous other objects and advantages will hereinafter appear from the following description of a presently preferred embodiment of the invention, considered in connection with the accompanying drawing, in which:

Fig. 1 is a plan or top elevation of a calculating device for the setting of stem engine valves, and constructed in accordance with the present invention; Fig. 2 is a transverse section through the device of Fig. 1, as viewed along line 2—2 thereof; Fig. 3 is a schematic or diagrammatic view of a simplified form of valve linkage to illustrate the manner of usage of the device of the present invention, and Fig. 4 is an enlarged fragmentary side elevation of a valve stem to which port and travel marks have been applied, incident to the usage of the calculator to be described.

Referring now by characters of reference to the drawing, and first to the structure of a calculating device through which the desired results are accomplished, it is preferred to utilize a base or frame of formed sheet metal, indicated generally at 10, as a guiding holder for the several slide elements. The channeled base 10 is formed, as best appears in the section of Fig. 2, with a planar bottom portion and upstanding margins 11, the latter being turned inwardly to form guiding flanges or lips 12, the portions 11 and 12 being similar on the top and bottom margins of the base except of course that the portions 12 are oppositely inturned. Disposed along the central median portion of the base structure is a second fixed channel element indicated generally at 13, and having a planar bottom 14 secured as by welding or riveting to the base of the structure 10.

The member 14 is of channel shape, and so designed as to present laterally undercut guide portions 15 on its opposite sides, for a purpose later more clearly appearing. It results from the portions 15 that the upper part of element 14 provides a guiding seat of channel form, characterized by upstanding margins 16 and inturned lips or flanges 17. The latter serve guidingly to receive a central slide element 20.

The slide 20 as well as the portions 10, 14 and other major elements of structure are, for economy of production, preferably formed of sheet metal—say of stainless sheet steel or other corrosion-resisting material. It is however to be understood that the invention is not restricted in embodiment to the use of any particular metal or even to the use of the die-formed sheet metal parts as shown and for convenience hereinafter referred to in description. Obviously some or all of these elements may be formed of suitable grades of wood, composition, plastics, or the like.

As will best appear from Fig. 2, the intermediate guide structure 14 serves with the upstanding portions 11 and flanges 12, to form guide grooves which for convenience, may be described as lying above and below the central slide 20. One such slide is shown at 21 as consisting of top and bottom planar portions formed by folding a suitable strip of metal upon itself. This arrangement, due to the fold portions, provides flanged extensions 22 and 23 along the upper and lower margins of the slide 21, the former portion being guided by and along parts 11 and 12 at the top of the base, and by the part 15 of the intermediate guide 14, at the opposite margin of the slide 21. The resulting spaced parallel portions of this slide serve slidably and guidingly to receive therebetween, a companion or coacting slide element 25.

The arrangement of slides below the central slide 20 and the guide structure 13, 14, 16 for the slide 30, is substantially the same along the lower portion of the calculator as that heretofore described in the upper portion. A slide 26 includes spaced parallel top and bottom elements similar to the corresponding parts of slide 21; extended fold portions 27 and 28 correspond respectively to those indicated at 22 and 23 on slide 21, so that the guiding extensions 27 and 28 operate in and along the grooves constituted by parts 11 and 12 and in the guide seat or channel 15.

Disposed between the spaced parallel top and bottom portions of slide 26, is a companion or cooperating slide element 30, it being understood that the slide 30 cooperates with the slide 26, although being movable independently thereof, in the same manner that slide 25 is carried by and cooperates with the slide 21. It is understood of course that the ends of the channels in the base structure 13 and in the member 13, 14, are open, so as to permit the extension of any of the various slide elements endwise beyond the base or frame structure proper.

As essential to the particular purpose and usage of the calculator selected for present illustration of the invention, reference is now made to the several indicia provided on the base and slides as well as the indicator elements cooperating therewith. It may first be noted (Fig. 1) that the uppermost flange 12 of the base is provided at its left hand end (Fig. 1) with the legend "front of engine—left side," and near its right hand end (Fig. 1) with a corresponding legend "front of engine—right side." These indicia are employed to enable placement of the calculator in the indicated relation to a steam engine or locomotive with which it is employed for the purposes of synchronizing the valves, in a manner more clearly hereinafter appearing.

It is further to be noted that the flanges 12, both at the top and bottom marginal portions of the calculator, are each provided substantially centrally of the base, with a score mark or base mark identified with the legend "port," these being port reference marks utilized in setting up certain readings on the device as will clearly appear from an exemplary or illustrative usage thereof hereinafter included. More accurately expressed, these reference marks indicate a midpoint of valve travel between beginning-port-opening positions.

Referring now to the scheme of graduation of the several slides, it will appear from Fig. 1 that the graduations on each of the five slides 21, 25, 26, 26 and 30, are arithmetic in nature, in distinction from the logarithmic graduations often employed on slide rules of other types utilized for general calculation. It is further noted from Fig. 1 that the spacing of the unit markings of the slides 21, 25, 26 and 30 are uniform on each slide. The exact value of this spacing is immaterial, so long as the spacing is the same on all four of the last noted slide elements. The readings, as hereinafter will appear, are set up on the several slides of the calculator and the results taken therefrom, according to prevailing American practice, in sixty-fourths of an inch, although it is not necessary that the spacing of the units on the four slides last named, actually be of this small value.

It is a great preference that the graduations on the central slide 20 be such that the units are spaced at twice the value of the corresponding markings on the remaining four slides of the calculator; for example, if the spacing of the score marks on slides 21, 25, 26 and 30 be one-thirty-second of an inch, the spacing of the unit markings on slide 20 is one-sixteenth of an inch, the exact values against being noted as arbitrary.

Considering further the companion or cooperating slides 21 and 25, it is seen that the former thereof is graduated from left to right as it appears to the operator when in use, while the score marks and numbering forming the scale on slide 25 are disposed to read from right to left. This same relation prevails with respect to slide elements 26 and 30, the former being graduated from left to right, and the latter correspondingly graduated but reading from right to left. The central slide element 20 differs from any of the four slides last described in that it is graduated from a central zero mark designated as CT (Fig. 1) indicating to the user a point of center of travel of the valve, slide 20 being graduated symmetrically from left to right, to the right of the CT mark, and in an opposite direction, viz., from right to left, on that portion lying to the left of the CT mark.

Further describing the base marks and reference indicia as preferably utilized on the calculator, there is noted near the right hand upper margin of the frame or base 10 and secured thereto, a fixed pointer or indicator overlying the ruled margin of slide 21, this indicator being designated at 35. It is with respect to this indicator that slide 21 is set up, as will later appear. It will be seen that a substantial economy in dimensions is attained by reason of the nested relation of slides 25 and 21, so that one slide lies partly within the other and is carried thereby, the same

relation prevailing between slides 26 and 30. Slide 21 is provided with an extension 36 at its left hand end and upper margin, which extension terminates in a pointer or reference element 37, with respect to which the slide 25 is set up, when the desired value (hereinafter described) is applied thereto. The slide 25 is also provided with a depending pointer or reference element 40 which overlies and forms a base or reference marker with which cooperate the graduations or score marks on slide 20.

The structure of the companion slide elements 30 and 26 corresponds to that of slides 25 and 21 respectively, except that, of course, the latter pair of slides are relatively reversely formed and their indicia relatively inverted for ease in reading. Similar to pointer or reference element 35 there is provided, projecting upwardly from the lower margin 12 of the base frame, a pointer 41 with reference to which the slide 26 is set. Likewise, slide 26 is provided with a terminal projection 42 at its left hand lower margin, this projection terminating in a pointer 43. The inner slide 30 of this pair, is set up with respect to pointer 43, and is provided with a pointer or reference element 44, corresponding in purpose and position on the slide, to pointer 40 on element 25.

Proceeding now to a description of a typical mode of usage of the calculator for the purpose of synchronizing or equalizing the valve setting on a steam railway locomotive, there is shown by Figs. 3 and 4 a schematic representation, including only the portions necessary for present purposes, of a modified and simplified type of Walschaert valve gear; it being understood of course that the principles underlying the device may be applied to other types of valve gear on steam locomotives, as well as to the relatively more simple types of slide valve gear on stationary engines. It will be apparent to those skilled in the art, from the following description, how the calculator is employed in connection with other and prevailing types of gear.

Referring to Fig. 3, there is indicated by the numeral 45, a steam cylinder in which reciprocates a piston 46 which may be of any usual or suitable type, and to which is operatively connected the piston rod 47, operatively related to the usual crosshead (not shown), and therethrough to the rods and drivers (not shown). Port passages 48 and 49 serve to connect the cylinder 45 respectively with ports 50 and 51 of the valve chest 52, in which is reciprocally disposed a piston type slide valve 53 of inside-admission type, provided with heads 54 and 55, the valve structure being connected to the valve stem or rod 60, and the latter being in turn connected to the valve crosshead 61. The crosshead is pivotally connected to and actuated by the radius bar 62, which has its outer end portion pivotally connected as at 63, to a slide 64 operating in an arcuate slot 65 of link 66. The free end portion of radius bar 62 is provided with a control rod 70 which leads to the reverse and cutoff control accessible to the engineer.

In accordance with known practice the link 66 is provided with a fixed pivot structure 71, about which the link is arranged to reciprocate under the influence of the valve-actuating crank or eccentric, this motion being imparted to the link through the eccentric rod 72, pivotally connected as at 73 to the link 66, and pivotally connected at its opposite end as at 74, to the crank (or eccentric) 75, driven by rotary shaft 76 in well known manner. The valve gear thus described is diagrammatic in nature, and is described in present form for brevity of description of the method of usage of the calculator, as will hereinafter appear.

The structure shown by Fig. 4 consists solely of an enlarged fragmentary portion of the valve stem 60, being a portion exterior to the valve chest and so accessible for the purpose of inscribing port marks incident to the operation of valve setting or timing by the use of the calculator.

Proceeding now to the preferred method of correcting or synchronizing the timed setting of each of the valves such as 53, it is presumed that the method of exact synchronization, using the calculator of the present invention, will in nearly all cases be practiced with an engine which has been in recent service, and the condition of which is such that each valve assembly is at substantially correct leads; hence the condition is such that the object is attained in a final accurate valve setting or synchronization. If however for any reason the valve gear is entirely out of correct setting it is necessary, in accordance with known and prevailing practice, to approximate a condition of equal leads prior to the synchronization of the valve gear involving a determination of correctness of valve stem length and eccentric rod length.

Assuming that the valve setting is a matter of equalizing valve operation in forward and reverse directions of operation, one routine of synchronization to which the calculator is adapted will generally be conducted as follows: With the eccentric rod of Fig. 3 disconnected, the piston type valve 53 is manually moved to a position so that one of the steam edges of the valve is in registry with the edge of the adjacent steam port, and so that this edge is just beginning to admit steam to the corresponding end of the cylinders. A scratch or score mark is then made on the upper portion of the valve stem 60, as by the use of trammels. This operation is conducted with respect to both of the heads of the valve and both ports, as a result of which there are obtained the two port marks on the upper half of the valve stem as indicated by Fig. 4, these score marks indicating the valve positions in which the steam edges of the valve, respectively, are just beginning to uncover the steam ports. The following step is to connect the eccentric rod and valve gear in operative relation; the locomotive is then pulled for a sufficient distance to operate the valve gear through a complete cycle of valve operation, the limits of the valve travel being indicated by additional punch or score marks, designated as travel marks, it being a preference and suggestion for uniformity in practice that the port marks and travel marks thus far derived, say in respect to the forward motion of the locomotive, be disposed above the center line of the valve stem. The movable radius bar 62 of Fig. 3 for example, is then shifted to a position on the opposite side of the fixed link pivot 71, and located the same distance from such pivot as before, but the radius bar being now positioned so that the valve gear is in reverse setting. With the parts thus positioned, the locomotive is again pulled for a distance, or otherwise actuated again to operate the valve through a complete cycle, and score marks representing port opening positions and the limits of valve travel are now scored on the stem, but below the center line thereof. At this stage, the markings on the stem will appear somewhat in the manner represented

by Fig. 4, wherein the two outside score marks indicated at 80 and 81, define the limits of valve travel, and the two inside marks 80 and 81 respectively indicate the limits between the beginning opening movements of the valve head, corresponding to forward engine operation; the corresponding marks for reverse setting being correspondingly arranged and shown at 82 and 83, the reverse marks being below the valve stem center line 84, and the markings attained for forward engine operation located thereabove.

From the spacing of the port and travel marks 80, 81, 82 and 83 as they appear in Fig. 4 for example, may readily be derived four values indicated respectively as dimension A between marks 83, dimension B between marks 81, dimension C between marks 82, and dimension D between marks 83. It is a preference, as being in keeping with the heretofore prevailing practice incident to a calculated determination for purposes of synchronization, that the dimensions A, B, C and D be determined, by direct and careful measurement, in sixty-fourths of an inch. These values having been thus determined, they may now be "set up" on, or applied to the upper and lower pairs of companion slide elements of the calculator.

Dimension A is applied to slide 25 by moving this slide to such position that the reading A in sixty-fourths, is brought directly under or in register with pointer 37, while dimension B is similarly set up on slide element 21 by bringing the value of B in sixty-fourths, under pointer 35. It will be seen from the fact of identical digit spacings on slides 21 and 25 that in case there is any difference in dimensions A and B, this difference will result in a movement of pointer 40 on slide 25 to the right or to the left of the port mark lines located centrally of the base of the calculator.

Dimensions C and D are applied in much the same manner, respectively, to slides 30 and 26, dimension C being applied to slide 30 by shifting this element so as to bring the reading thereon corresponding to dimension C, opposite to or in register with the pointer 43, and moving slide 26 (with slide 30) so as to bring the value D thereon under the pointer 41. Similarly to slides 21 and 25, if the values of C and D are the same, the pointer 44 on slide 30 will remain in line with the port marks centrally of the calculator. Unless the valve is perfectly synchronized, the result will be that the pointer 44 on slide 30 is moved to the right or the left (Fig. 1) of the port marks on the flanges 12 of the base or frame of the calculator. For purposes of illustration, the result may, for example, be of the order depicted by the arrangement of parts in Fig. 1, wherein pointers 40 and 44 are displaced on opposite sides of the port line or lines of the calculator, although in very many instances these pointers may be brought on the same side of the port marks, either to right or left thereof. It will have appeared from the foregoing description as a preference to set up the port mark dimensions obtained by valve movement corresponding to the forward engine operation, on the upper pair of cooperating slide elements 21 and 25, and corresponding values attained for valve operation in a reverse direction, on the lower cooperating pair of slide elements 26 and 30.

Following the settings above described, the center slide 20 is now shifted in such manner that its zero or center point indicated by the legend CT, is located midway between the pointers 40 and 44, and with the slide 20 so adjusted, the horizontal distance from the line CT of slide 20, to the line of the port marks on flanges 12, provides a direct reading in sixty-fourths of an inch to indicate the necessary change to be made in length of the valve stem. This change in length may be effected either by adjustment, where provided, between the valve head 53 and stem 60, or by lengthening or shortening the stem 60.

It is to be noted that in using the calculator, the operator either actually or supposedly locates the calculator with respect to the engine in such manner that the operator is facing the side of the engine to be affected by the calculation or determination; i. e., in synchronizing the valve gear on the left of the engine the calculator is located with its left hand end positioned, actually or supposedly, toward the front of the engine, while it is oppositely positioned on the opposite or right side of the engine, incident to correction of valve setting on that side. To assist in the correct position of the calculator with respect to the engine, there are provided the two legends at the ends of the upper flange 12 of the base of the calculator, heretofore referred to. With the calculator thus positioned for left side of engine, in accordance with the legends at the end margins thereof, it is noted that in case the CT point on slide 20 lies to the left of the port marks, the adjustment needed is a shortening, or decrement in total length of valve stem and valve. The opposite is true in case the CT point lies to the right of the port lines or marks. The converse is true with respect to the right side of the engine. There thus exists a definite physical relation between placement of the calculator and engine, in indicating whether the readings are to be applied positively or negatively to the parts affected. The legend on the lower right hand part of the base flange (Fig. 1) is provided by way of suitable direction as to valve stem error.

There remains, incident to full synchronization, a determination of any necessary change in relation of the eccentric or crank 75 to the valve proper, as affected by length of eccentric rod 72. With the calculator set up as heretofore described, the change in eccentric rod length is arrived at by determining, by direct reading, the horizontal distance from the center or CT line of slide 20, to the pointer 40 on slide 25. This reading provides a value which, when multiplied by a factor to be described, gives a result expressed, say in sixty-fourths of an inch, indicating the change to be made for example, in absolute length of the eccentric rod 72. This factor arises from the inherent motion-multiplying effect of the long and short arms of the levers either on the same or opposite sides of the fixed link-pivot 71. This factor represents the ratio of dimension E to dimension F (Fig. 3), so that for example, if this ratio be 3:1, the last described reading on slide 20 would require to be multiplied by three, and if this reading be, for example, two sixty-fourths, would require a change in length of the eccentric rod of six sixty-fourths inch in order correctly to equalize or compensate. Whether the value just arrived at is to be applied as an increase or as a decrease in eccentric rod length, is determined in the general manner outlined in respect to valve stem changes; for example, if the line CT falls to the right of pointer 40 on the left side of the engine, there is indicated a decrease or decrement in length of this rod, and an increase in length in case the line CT falls to the left of

pointer 40 incident to a check or test of the valve gear on the left side of the engine. It will thus appear that there exists a definite physical relation resulting from the actual or hypothetical placement of the calculator with respect to the locomotive or other engine, in accordance with the directions provided by the legends on the upper end and marginal portions of the calculator. The legend at the lower left hand margin of the base flanges, viz., "Position of C. F. M. from C. T. indicates E. X. error," refers to the position of the C. T. legend with respect to pointer 40 of the present drawing, and thus refers to the nature of alteration in eccentric rod length, as above discussed. It may be noted for completeness that the legend C. F. M., last referred to, denotes center of forward motion, i. e., center of valve travel when operating in forward setting of the engine, this center being indicated by the position of pointer 40 when the calculator is set up. Similarly, the position of pointer 44, when the calculator is set up, indicates a C. R. M. or center of reverse motion. Since the CT mark on slide 20 may be regarded as a physical division point, it is apparent that an adjustment of the eccentric rod length such as would bring the C. F. M. to the C. T. point, will serve to equalize the forward and reverse valve motions.

The foregoing has constituted for brevity, only a description of one preferred manner of usage of the calculating device, but it will be apparent therefrom that the same principles of usage prevail with respect to other known types of locomotive valve gear, as well as the slide valve mechanism of other steam engines. It is further to be noted that, although the device has been disclosed as containing slide elements of linear form, movable linearly along the base or holder, the same principles are applicable to slide rules of so-called circular or disc type, or other types utilizing any reasonable range of equivalents within the scope of the claims hereunto appended.

I claim as my invention:

1. In a calculating device of slide rule type for use in steam-locomotive slide valve setting, a base or holder provided with reference indicia including port reference markings, a pair of coacting, relatively slidable elements arranged for movement selectively as a unit, and individually with respect to each other, said elements bearing arithmetical graduations arranged in relatively reverse order on the elements whereby the elements are adapted to be set up to indicate a mean algebraic increment corresponding to the optimum change in relation of valve to valve operating elements, and separate indicia means carried by the base or holder for establishing different physical relations of the device to the locomotive, such as to establish the positive or negative nature of said algebraic increment respectively for the opposite cylinders of the locomotive.

2. In a calculating device for use in physical combination with a valve gear for setting the slide valves of reversible steam engines, a frame or holder, a pair of reversely graduated scale-bearing elements movable on the frame, a pointer on the frame, a pointer on one of the graduated elements; a second pair of reversely graduated scale-bearing elements movable with respect to the frame and the aforesaid pair of elements, another element movable on the frame and coacting with said pairs of elements to provide a reading indicative of optimum change in valve setting, with respect to the valve operating mechanism, the last named movable element being graduated or scaled to provide readings in opposite directions from an intermediate center point thereon, the several graduated elements being arithmetically scaled, and the frame or holder carrying indicator means coacting with the engine valve gear for establishing as positive or negative, the values derived from the readings of the graduated elements.

3. In a calculating device for use as an engine accessory in setting the slide valves of reversible steam engines, a holder, a pair of reversely-graduated scale-bearing elements movable on the holder, a second pair of reversely-graduated scale-bearing elements movable with respect to the holder and the first said pair of elements, pointers on the holder, pointers on the paired graduated elements, and another element movable on the holder and coacting with said pairs of elements to provide a reading indicative of optimum change in setting of a valve with respect to the valve operating mechanism, the last named movable element being graduated or scaled to provide readings in opposite directions from an intermediate center point thereon, the units of graduation on said last named movable element being characterized by a spacing substantially twice that of the units of graduation on the several said paired scale-bearing elements and indicia means on the holder, arranged to establish a physical relation between the device and the engine valve gear such as to impart an algebraic significance to the values derived from the readings on the device.

4. In a calculating device for use as an engine accessory or attachment in steam-engine slide-valve setting, a base or holder, a graduated scale structure carried by and movable over the holder, the graduations on the scale structure being arithmetically spaced, a second graduated scale structures may be brought into positions graduated arithmetically, port reference indicia on the frame or holder such that the graduated scale structures may be brought into positions relative to each other and to the holder, to provide a direct reading of desired change in valve setting with respect to valve actuating elements, and indicia means provided on the holder to establish a physical relation between the calculating device and the engine, such as to indicate whether the numerical reading provided by the calculating device represents an increment or decrement in valve stem length or equivalent adjustment in valve mechanism.

5. In a calculating device for use as a physical engine adjunct in steam-engine valve setting, a frame or holder, a graduated structure movably carried by the holder and adapted to be set up to indicate an optimum setting of a slide valve with respect to its valve stem, in one direction of engine operation; a second graduated structure adapted correspondingly to be set up with respect to the holder to indicate an optimum setting of the valve with respect to its stem, in reverse operation of the engine, a graduated element movably associated with the holder and coacting with each of the structures aforesaid, to provide a value from which may be derived by a known factor, a desired change in effective length of eccentric rod, and means for establishing, when the device is in use, a physical relation between the device and the engine, said means coacting with the engine and device to establish said rod change as an increment or a decrement.

6. In a calculating device for use as a physical

adjunct to a steam-engine for purposes of valve-setting, a holder, a graduated structure movably carried by the holder and adapted to be set up to indicate an optimum setting of a slide valve with respect to its valve stem, in one direction of engine operation; a second graduated structure adapted correspondingly to be set up with respect to the holder to indicate an optimum setting of the valve with respect to its stem, in reverse operation of the engine, a graduated element movably associated with the holder and coacting with each of the structures aforesaid, to provide a value from which may be derived by a known factor, a desired change in effective length of eccentric rod, and indicia means carried by the holder for defining, when the device is in use, a physical relation of the calculator to the engine such that the readings on the calculator serve to indicate direction of adjustment of the valve with respect to its valve stem, and the nature of change in length of the eccentric rod necessary to attain the optimum setting of valve gear.

7. A calculator of slide rule type for the purpose described, including a longitudinally channeled frame or holder having upstanding and inturned flanges along its opposite longitudinal margins, a pair of coacting graduated slide elements guidingly engaged by one of said margins of the holder, a second channel structure arranged parallel to and carried by the holder between its margins, and coacting with one thereof for guidingly engaging said graduated slide members, and a third graduated slide member carried in the said second channel structure, and movable with respect to the holder in positions contiguous to the slide members first aforesaid, the holder and slides being provided with reference pointers through which the slide members cooperate with the holder to provide direct readings of desired changes in valve setting.

8. A calculator device of the type and for the purpose described, including a holder or frame of formed sheet metal characterized by upstanding margins and inturned flanges thereon along the opposite longitudinal margins of the holder, a channel member disposed longitudinally and medially of the holder, a graduated slide element carried by said channel member, a pair of coacting nested graduated scale elements movably and guidedly retained in the holder, by and between one of its flanged margins and said channel member, an additional pair of graduated scale elements movably and guidedly retained between the opposite margin of the holder and the channel member, the holder and slide elements being provided with reference indicia in addition to their graduations, such that the slide elements of each of said pairs are adapted to cooperate with each other and with the slide element carried by said channel member to provide readings from which may be derived optimum settings of a slide valve with respect to its actuating mechanism, and changes in relation of valve-operating eccentric, to the associated valve gear.

9. A calculating device for use in setting slide valves of steam-engines and as an adjunct to the engine and valve gear, the device including a base or holder, means establishing a useful physical relation of the base to the valve gear, five independently movable, graduated slide elements, together with port markings on the holder, and reference indicators on each of the slide elements, the aforesaid means indicating a physical relation of the device to the engine such that the readings derived from the slide elements will indicate whether such values are to be applied as increments or decrements in changing the relation of the valve and elements of the valve gear.

10. A calculating device as set forth in claim 9, characterized in that two of the slide elements are nested, so as to keep them in close physical adjacence, are graduated oppositely to each other, and arranged along one side of a single central slide element graduated in both directions from a mid-point, and the remaining two slide elements are similarly nested and movably located for cooperative use each with the other and on the opposite side of the said central slide element.

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