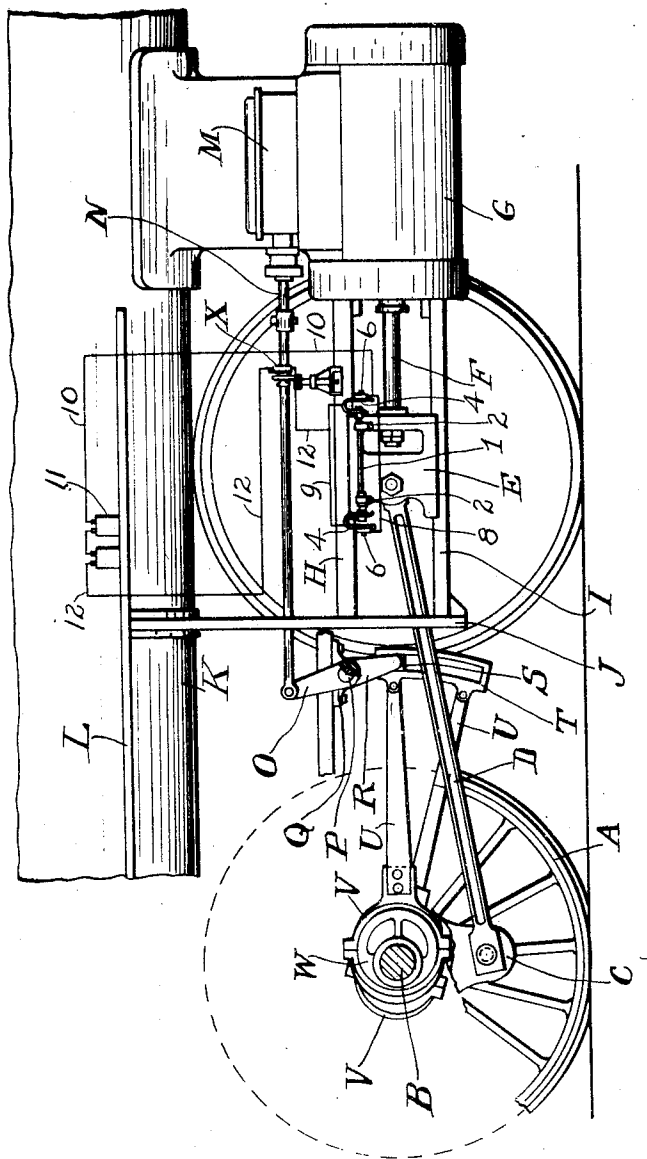


J. B. MICHAEL.
 MAKING RECORDS FOR SETTING SLIDE VALVES.
 APPLICATION FILED OCT. 30, 1908.

942,453.

Patented Dec. 7, 1909.
 4 SHEETS—SHEET 1.

Fig. 1.



Witnesses,
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 W. W. Haley

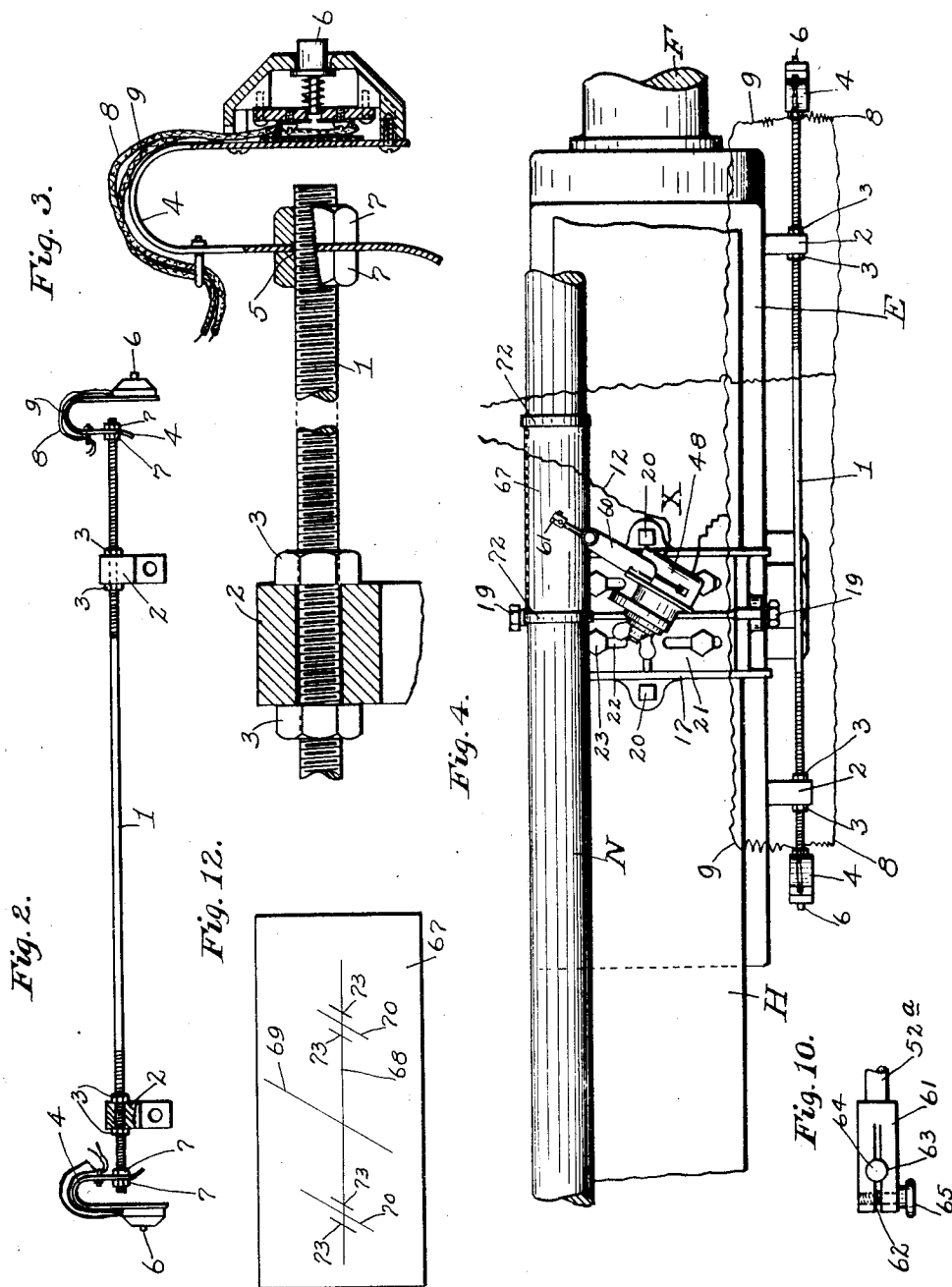
Inventor,
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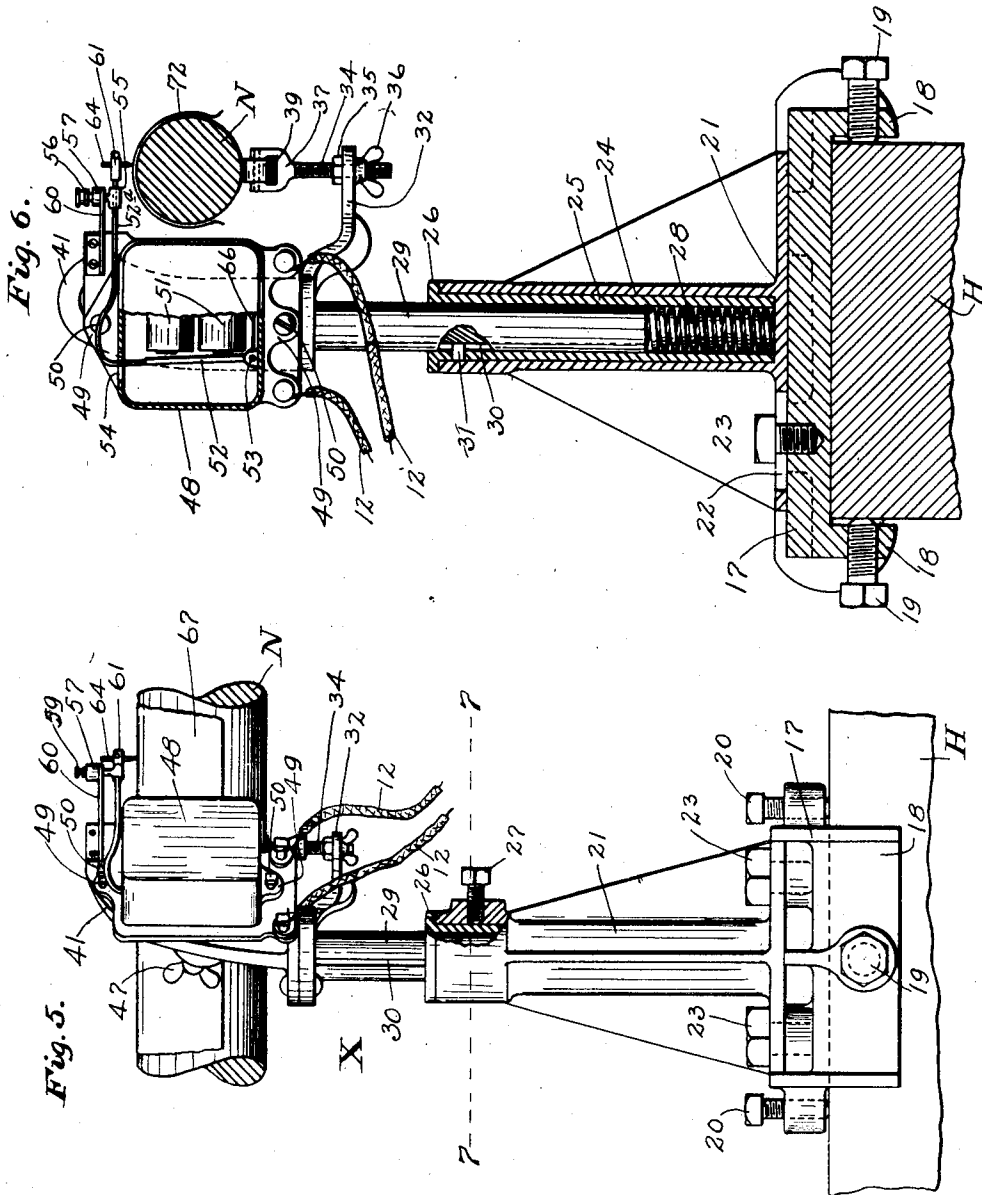
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 4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

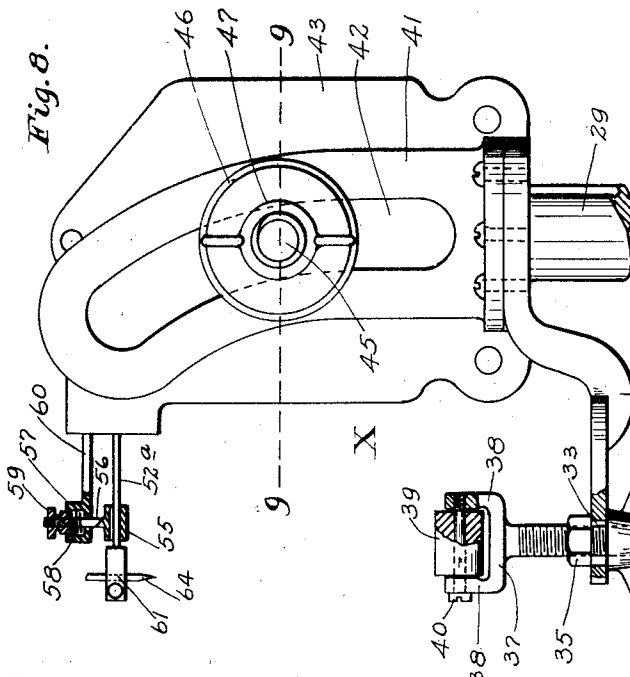
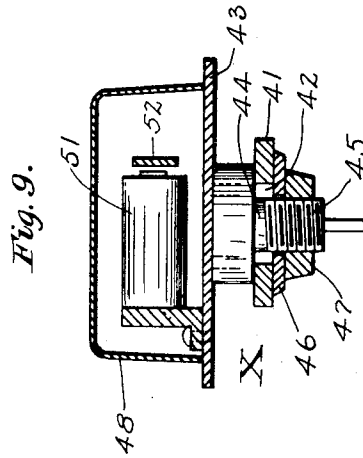
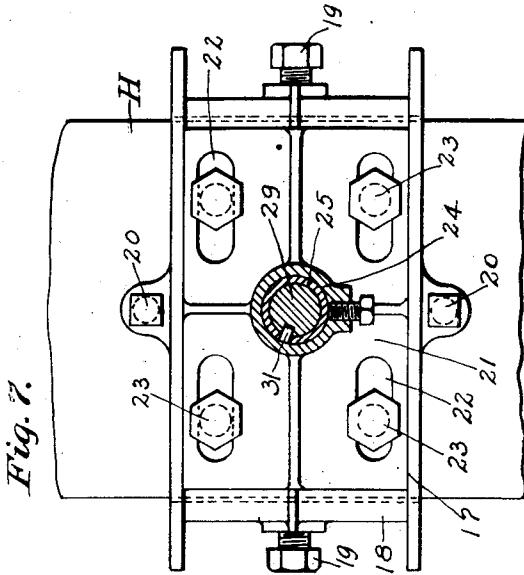
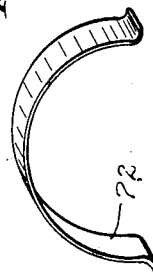


Fig. 11.



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UNITED STATES PATENT OFFICE.

JOHN BAKER, MICHAEL, OF KNOXVILLE, TENNESSEE.

MAKING RECORDS FOR SETTING SLIDE-VALVES.

942,453.

Specification of Letters Patent.

Patented Dec. 7, 1909.

Application filed October 30, 1906. Serial No. 341,310.

To all whom it may concern:

Be it known that I, JOHN BAKER MICHAEL, a citizen of the United States, residing at the city of Knoxville, in the county of Knox and State of Tennessee, have invented certain new and useful Improvements in Apparatus for Making Records for Setting Slide-Valves, of which the following is a specification.

10 This invention relates to means for automatically making a record indicating the relative movements of steam engine pistons and slide valves, the purpose of such record being to afford data for the resetting or adjustment of the eccentrics and eccentric rods which control the valve movements, if such record shows that such adjustment is necessary on account of improper relation between the movements of the pistons and the slide valves.

20 The apparatus is intended to be used on locomotives and other steam engines when they are under steam after the slide valves have been set (according to common practice, while the steam chest covers are raised) and the valve stem marked with what are known as "port marks," one such mark being made with a trammel set in a punch mark on the valve chest or cylinder head when the valve is so set as to barely cover the front port, and the other of said marks being made with the trammel similarly set when the valve barely covers the back port. The first of said marks is termed the "front port mark," while the second is termed the "back port mark." Such marking can be done only when the valve chest is without steam and open, so that the valve can be seen and its position measured. According to established practice, said marks are left permanently upon the valve stem. Hence they are available at any future time for use in making measurements for ascertaining the relative movements of the slide valve and the piston. And they have been so used, but by a method different from my method.

30 For convenience in description, the plane which is transverse to the valve stem and in which the point or stylus of the trammel makes the "port marks" is herein termed the "port mark plane."

50 Usually each valve stem has upon it two sets of "port marks," one representing "forward motion" or "go-ahead," while the other pair of port marks represent "back-

ward motion" or "back-up," one set of said marks being on one side and the other on the other side of a longitudinal line on the valve stem called the "parallel line." According to established practice, if such test and adjustment are to be made, the reversing mechanism being set for "forward motion" or "go-ahead," the drive wheel crank pin is put upon one of its "dead centers," whereby the cross-head and piston are also put on the corresponding "dead center" or end of their stroke. This is accomplished by "pinching" the engine forward with "pinch" bars. The precise point for stopping is indicated by "travel marks" previously put upon the top guide, when the cross-head and associated parts were set accurately upon the dead centers by methods and means well known to persons skilled in this art. When the engine has been thus pinched until one (let us assume the forward) dead center has been reached according to the forward "travel mark" on the top guide, the trammel is applied to the cylinder and the valve stem to make a temporary mark in the "port mark plane" and at one side of the parallel line and adjacent the forward "port mark" on said stem. Then the engine is again "pinched" until it is on the rear "dead center," as indicated by the alignment of the cross-head with the rear "travel mark" on the top guide. Then, by means of the trammel, a mark is made on the valve stem, in the same plane, adjacent the rear "port mark"—which has shifted into or near said plane by the movement of the said stem. The reversing mechanism is then reversed and the engine again brought to the "dead centers" by pinching backward and temporary marks made in said plane and at the other side of the parallel line. Then the port marks and said temporary marks are used, in a manner well known to those skilled in this art, to make an adjustment of the eccentrics and eccentric rods.

100 For the sake of convenience in description, I will herein apply the term, "trial port marks," to the marks made with the trammel upon the valve stem after the engine has been pinched so as to bring the piston, cross-head, etc., to the dead centers as above described.

105 Now the object of my invention is to provide means for making a record comprising these trial port marks while the engine 110

moves forward and backward under its own steam, and without the necessity of slowly and laboriously moving the engine by "pinching" and obtaining the dead centers with a trammel. The course which I propose is desirable, for the reason that locomotives are now made very heavy and "pinching" to a precise position is therefore very difficult, and because when the engine moves forward or backward under its own steam, all the operative parts are under normal temperature (and consequent normal expansion) and under normal relation and strain.

The foundation feature of my invention is the placing of a recording device adjacent the slide valve stem and causing said recording device to place trial port marks upon the valve stem (or upon a card on said stem) when the cross-head and associated parts pass the dead centers, the cross-head or some other part in operative relation with the piston and moving synchronously therewith being used to actuate the recording device. In the form shown by the drawings, the cross-head is used to close an electric circuit upon which the recording device and an electric battery, or its equivalent, are located.

The advantage of my marking or recording apparatus lies in the fact that it operates during the movement of the engine, while the method heretofore practiced requires the engine to be at rest with the piston and cross-head and associated parts in precise positions. In adjusting stationary steam engines, my improvement is in the same manner important, for when engines are large it is difficult to manually move the piston, cross-head, crank, fly wheel, etc., to accurately attain the dead centers.

For the sake of convenience, I prefer to apply to the slide valve stem a card to which the permanent port marks and parallel line of said stem have been transferred, the card being placed upon and secured to said stem in such position as to bring said transferred marks directly above the marks on said stem. Then the trial port marks can be made by a point or stylus which will clearly mark upon the card but could not distinctly mark the surface of the metal stem. But the marking upon such a card placed upon the stem is to be regarded as marking upon the stem.

In the accompanying drawings, Figure 1 is a side elevation of a portion of a locomotive embodying my improvement; Fig. 2 is a side elevation of mechanism mounted upon the piston rod cross-head and embodying portions of a circuit and mechanism adapted for closing said circuit when the piston rod reaches the dead centers; Fig. 3 is an enlarged sectional elevation of the right hand portion of the mechanism shown in Fig. 2;

Fig. 4 is a plan of a portion of the locomotive showing my recording mechanism applied thereto; Fig. 5 is a side elevation of a portion of the top guide and a portion of the valve rod with my stylus supporting and operating mechanism applied thereto; Fig. 6 is a section on the line 6—6 of Fig. 5, looking toward the left; Fig. 7 is a section on the line 7—7 of Fig. 5; Fig. 8 is an enlarged sectional elevation of the upper portion of the stylus supporting and operating mechanism; Fig. 9 is a section on the line 9—9 of Fig. 8; Fig. 10 is a detail of the stylus clamp; Fig. 11 is a perspective of a spring clamp used in securing the record card to the valve rod; Fig. 12 is a view of a record card bearing a record.

Said drawings illustrate only the apparatus applied to the right hand side of a locomotive. Similar mechanism is to be used on the left hand side.

A is one of the drive wheels of the locomotive to which my improvement is applied. B is the shaft or axle of said drive wheel. C is one of the cranks on said axle. D is the main connecting rod applied to said crank. E is the cross-head to which said connecting rod is coupled. F is the piston rod. G is a piston cylinder. H is the top guide for said cross-head. I is the bottom guide for the cross-head. J is the guide yoke supporting the rear ends of said guides. K is a portion of the boiler to which the upper end of said yoke is secured.

L is a run board on the side of the boiler.

M is the valve chest.

N is the valve stem or rod. O is an upper rocker arm to which the rear end of said stem is secured. P is a rock shaft supporting said arm and resting in a bearing, Q. On said shaft is the lower rocker arm, R.

S is the sliding block connected to the lower rocker arm, and T is the link slidable upon said block. U, U are eccentric rods coupled by their forward ends to said link and immovably joined by their rear ends to eccentric straps, V, surrounding eccentrics, W, on the shaft or axle, B.

The parts thus far described are old and may be of any desired specific form and arrangement. In other words, said parts belong to the locomotive and are not my invention. The mechanism constituting a part of my invention is temporarily attached to the parts named.

In the form of my mechanism illustrated by the drawings, a portion of my recording apparatus is applied to the cross-head, E, and another portion is applied to the top guide beside the valve stem. The portion applied to the cross-head is in operative relation with the piston, with reference to which the valve is to be set. The purpose of the mechanism applied to said cross-head is

to close an electric circuit when the crank pins on the drive wheel are on their dead centers and the cross-head reaches each end of its stroke.

5 A horizontal rod, 1, extends loosely through ears, 2, on the side of the cross-head. The portions of said rod adjacent said ears are screw threaded, and at each side of each of said ears nuts, 3, surround said rod and are adapted to be turned against the ear. By this means said rod may be adjusted endwise with accuracy and firmly secured to said ears.

On each end of the rod, 1, is a flexible U-shape member, 4, having in one arm an aperture, 5, through which the adjacent end of the rod, 1, extends and having on its other end a normally open push button, 6, directed horizontally away from the rod, 1. At each side of the arm which surrounds the rod, 1, is a nut, 7, surrounding said rod and adapted to bind against said arm to firmly secure said U-shape member to the rod, 1. And by means of said nuts, said U-shape member may be, to a limited extent, adjusted horizontally along said rod, 1. A wire, 8, and a wire, 9, are joined to opposite sides of the push button, 6; and a wire, 10, leads from the wire, 8, to one side of a battery, 11, seated on the run-board, L, while a wire, 12, leads from the wire, 9, to the recording mechanism, X, and thence to the other side of the battery, 11. The length of the rod, 1, is such as to permit such an adjustment of said bar and the U-shape members, 4, as to cause the forward push button to bear against the adjacent head of the cylinder, G, when the piston and the cross-head reach their forward limit or "dead center" while the rear push button will bear against the adjacent guide yoke, J, when the piston and cross-head reach their rear limit or "dead center", so that the electric circuits on which said push buttons are located will be closed as often as either of the two dead centers is reached.

The forward U-shape member is set away from the head of the cylinder, G, a distance equal to the distance, at the time of such setting, between the cross-head and its forward "travel mark" on the top guide; and the rear U-shape member is set away from the guide yoke, J, a distance equal to the distance, at the time of such setting, between the cross-head and its rear "travel mark" on the top guide. Then, as will now be readily understood, when the cross-head moves forward to the forward travel mark, the forward push button will bear against the cylinder head, and when the cross-head moves backward to the back travel mark, the back push button will bear against the guide yoke, J.

We turn now to the stylus supporting and

operating mechanism, X (see particularly 65 Figs. 5 to 10, inclusive). A flat base, 17, rests horizontally upon the upper face of the top guide, H, and has at each end a depending flange, 18, adapted to extend over the adjacent lateral face of the guide, and 70 each of said flanges is penetrated by a horizontal set-bolt, 19, adapted to bear against the adjacent lateral face of the top guide. For leveling said base, a set-bolt, 20, is screw-threaded downward through each side 75 edge of said base between the flanges, 18, and is adapted to bear upon the upper face of the top guide. By driving either of said bolts downward, said base and the pedestal hereinafter described are correspondingly 80 tilted. Upon said base rests a pedestal, 21, having upright slots, 22, at right angles to the flanges, 18, and said top guide, and binding bolts, 23, extend through said slots into said base. After loosening said bolts, 85 the pedestal may be shifted transversely upon the top guide toward or from the valve stem. Said pedestal has an upright cylindrical cavity, 24, in which rests a tube, 25, having around its upper end an outward-directed flange, 26. Said tube is free to rotate in said cavity, 24, excepting when it is bound by a set-bolt, 27, extending horizontally through the upper portion of the wall of the pedestal (see Fig. 5).

In the lower portion of the tube, 25, and resting by its lower end upon the bottom of the cavity, 24, is an upright expanding coiled spring, 28, which yieldingly supports the upright stem, 29, of the recorder head. 100 Said stem is fitted slidably into said tube and has an upright groove or channel, 30, into which extends a stud, 31, projecting inward from the tube, 25, to prevent said stem from turning, while it is free to slide up 105 and down in said tube. If it is desired to turn said stem, the set-bolt, 27, is loosened. The recorder head supported by said stem comprises a roller adapted to bear against the bottom of the valve stem, a stylus located above the valve stem, an armature for moving said stylus, and a pair of electromagnets for controlling said armature. The upper end of the stem, 29, supports a laterally directed arm, 32, which extends beneath the valve stem (see Figs. 6 and 8). 115 Said arm has in its outer portion a slot, 33, which is upright and transverse to the length of the valve stem. An upright screw-threaded stem, 34, extends through 120 said slot and is surrounded above said arm by a nut, 35, and below said arm by a nut, 36. On the upper end of said stem is a head, 37, having upright ears, 38, between which is supported an anti-friction roller, 39, on 125 an axle, 40, extending through said roller and said ears. The purpose of said roller is to bear against the lower face of the valve

stem during the movements of the latter, so that the stem, 29, will be pressed downward during each downward movement of the valve stem. The spring, 28, bears upward and yieldingly opposes the downward pressure of said stem, 29, through the downward movement of the valve stem, causing said stem, 29, to rise whenever the valve stem rises. Thus the stem, 29, is given an up and down movement which is synchronous and co-extensive with the up and down movement of the valve stem at the point at which said roller, 39, is located. This makes possible the location of the stylus closely above or upon the upper face of the valve stem and maintaining such position relative to said stem without causing the valve stem to strain said stylus or its supporting arm.

The roller, 39, it will be observed, may be adjusted in several ways: (1) the screw-threaded stem, 34, may be partially rotated so as to change the direction of the axis of the roller in the horizontal plane, (2) said stem may be moved horizontally in the slot, 33, so as to change the distance between said roller and the stem, 29, for the purpose of bringing the roller directly under the valve stem, and (3) the stem, 34, may be moved up or down in the slot, 33, to vary the pressure of said roller against the lower face of the valve stem, or, in other words, to vary the strain of the stem, 29, upon the coiled spring, 28. And from the upper portion of the stem, 29, rises an upright plate, 41, which is in a plane transverse to the valve stem and is penetrated by a slot, 42, which is parallel to and approximately concentric with the valve stem.

The back plate, 43, of the electro-magnet housing has a cylindrical wrist, 44, extending into said slot, and on said wrist is a screw-threaded stem, 45, which is surrounded by a washer, 46, and a thumb-nut, 47. By means of said nut and washer, said back plate may be tightly bound to said plate, 41; and on loosening said nut, said plate may be turned on the axis of said wrist, 44, or moved up and down with reference to said slot. Thus a two-fold adjustment of the stylus may be made: (1) up and down, while the stylus does not change position horizontally, and (2) transversely to the length of the valve stem, whereby the stylus may be made to bear upon the valve stem nearer to or farther from the plate, 41. In this manner, the stylus may be made to mark on two lines which are parallel to each other and parallel to the valve stem axis.

Up and down adjustment is made to adapt the elevation of the stylus to the elevation of the roller, 39.

The front member or portion, 48, of the housing is in box form and has above and

below an ear, 49, bearing against the back plate, 43, and screws, 50, extend through said ears into the back plate and bind said front portion to said back plate. Upon said back plate and within said housing are a pair of electro-magnets, 51, adjacent which is an upright armature, 52, hinged by its lower end at 53 and extending through an aperture, 54, in the upper wall of the housing member, 48. Above said housing, said armature has a horizontal arm, 52^a, and said arm extends through a guide block, 55, which is supported by an upright screw-threaded stem, 56, extending loosely through the bottom of a cylindrical cup, 57. In said cup said stem is surrounded by an upright coiled spring, 58, and above said spring said stem is surrounded by an adjusting nut, 59. Thus the guide block, 55, is yieldingly supported by said spring, and by raising and lowering said nut, the adjacent portion of said stylus-supporting arm may be raised or lowered. Said cup is supported by a horizontal arm, 60, which is rigidly secured to the back plate, 43, of the housing.

On the outer end of the armature-supporting arm, 52^a, is a stylus-holding device, 61, and 64 is the stylus or pencil securely held in said holding device. Said holding device is shown by the drawings as being a clamp having an upright slot, 62, parallel to the length of the arm, 52^a, and having an upright aperture, 63, cut by said slot and of proper size to receive the stylus or pencil. A binding screw, 65, extends transversely through said holding device to draw the portions of the latter at opposite sides of said slot toward each other for the binding of the stylus.

The armature is normally held away from the magnets by a spring, 66. When said magnets are energized, the upright portion of the armature moves toward the magnets, whereby the horizontal arm, 52^a, is pushed through the guide block, 55, in the corresponding direction, the stylus holding device, 61, and the stylus or pencil, 64, moving away from said guide block, thus imparting to the stylus or pencil a movement which is transverse to the course of the valve stem but is, on account of the simultaneous movement of said stem, slightly oblique to the latter. By the aid of a standard trammel, the stylus support is so set as to bring the stylus into the "port mark plane." This may be done regardless of the position of the cross-head; hence it may be done regardless of the positions in which the parts of the engine may at the time be resting. The magnets, 51, are placed in circuit with the push buttons, 6, 6, and the battery, 11, by means of the wires 8, 9, 10, and 12, as above described.

In Fig. 12, 67 is a record card. This has a

longitudinal, "parallel" line, 68, and a transverse, diagonal center line, 6. At opposite sides of and equi-distant from the intersection of said lines (which I term the "center" of the card) are two diagonal record lines, 70, which correspond to the permanent "port marks" on the valve stem. Said lines, 70, may be laid upon the card with dividers by measuring on the valve stem from the center between the "port marks" and applying such measurement from the card "center." The lines, 70, are set at the same angle as are the corresponding "port marks" on the valve stem. At any time, regardless of the positions in which the parts of the engine may be resting, said card (if it is used) is to be placed and secured upon the valve stem with the lines, 70, directly over the corresponding "port marks" on said stem. This may be accomplished in several ways. By means of dividers, a mark may be placed upon the valve rod at a distance away from one of the marks on said stem equal to the distance between the corresponding end of the card and the nearer diagonal line, 70—measuring on the "parallel line," 68—and said edge of the card then placed even with the mark so made on said stem. Or the "center" between the "port marks" on the valve stem may be marked on the valve stem and the distance between the card "center" and one of the end edges of the card taken by dividers, and a mark made upon the valve stem at the same distance from the "center" mark on the valve stem, and said edge of the card then placed even with the mark so made on the valve stem. Or a trammel may be so set as to make its point register with one of the "port marks" on the valve stem and the card then moved upon and parallel to the valve stem until the corresponding line, 70, registers with the trammel point. Said card is laid closely against the face of the valve rod and secured to the latter by any suitable means, as by a spring clamp, 72. (See Figs. 4, 6, and 11.)

If the apparatus is used for adjusting the slide valve of a stationary engine, the stylus is so adjusted as to adapt it to make only two trial "port marks", 73, on the card. But if the apparatus is to be used for adjusting slide valves of a locomotive, a double record for each valve is required, one representing forward motion or "go-ahead" and the other representing backward motion or "back-up". Hence the stylus is preferably first so adjusted as to adapt it for making two marks at one side of the "parallel line", 68, and when this is done, readjusted to make two marks at the opposite side of said line. For making the record at the "forward" side of the parallel line, the stylus is set at that side of said line (and in the "port mark plane") and the

locomotive driven forward by its own steam until the two dead centers have been passed, whereby the electric circuit of the apparatus is twice closed, once by the pressing of one of the push buttons and again by the pressing of the other push button. And the closing of the circuit occurs when the valve rod is at its two limits of forward and backward movement, or approximately so, depending upon whether the position of the eccentric sustains its proper relation to the position of the crank upon the drive wheel. But whatever such relation may be, the closing of the circuit causes the stylus to make one trial port mark, 73, which becomes a companion to one of the marks or lines, 70, and when the circuit is again closed, the stylus makes another trial port mark, 73, which becomes a companion to the other mark, 70, on the card, as is the case when the trial port marks are made with the trammel according to the old practice. And for making the record at the opposite or "backward" side of the "parallel" line, the stylus is set at the corresponding side of said line (and in the "port mark plane") and the engine run backward by its own steam until the two dead centers have been passed.

I claim as my invention:

1. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane for movement up and down with the valve stem, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

2. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane in yielding engagement with the valve stem to partake of the up-and-down movement of the latter, and stylus-actuating mechanism adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

3. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane to bear upon one side of the valve in the up and down path of the latter, yielding means for pressing said support against said stem, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

4. In an apparatus for making records on

a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane for movement up and down with the valve stem, and electro-magnetic mechanism adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

5 10 5. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane for movement up and down with the valve stem, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus transversely to said stem when said part is passing the dead centers.

20 6. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane for movement up and down with the valve stem, and electro-magnetic mechanism adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus transversely to said stem when said part is passing the dead centers.

30 7. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane in yielding engagement with the valve stem to partake of the up-and-down movement of the latter, and electro-magnetic mechanism adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

45 8. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to normally hold the stylus in the port mark plane, said support bearing on one side of the valve stem in the up-and-down path of the latter, yielding means for pressing said support against said stem, and electro-magnetic mechanism adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

50 9. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be secured to the top cross-head guide and to engage the valve stem for up-and-down movement with the latter while said support is normally stationary with reference to other directions, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

ton for actuating said stylus when said part is passing the dead centers.

10. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be secured to the top cross-head guide and to engage the valve stem for up-and-down movement with the latter while said support is normally stationary with reference to other directions, and means adapted to be operatively connected with the part of the engine which is in operative relation with the piston for moving the stylus transversely to said stem when said part is passing the dead centers.

11. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be secured to the top cross-head guide and in yielding engagement with the valve stem to adapt it to partake of the up-and-down movement of the latter while it is held against movement in other directions, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

12. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be secured to the top cross-head guide and bear upon one side of the valve stem in the up-and-down path of the latter, yielding means for pressing said support against said stem, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

13. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem, a second member applied to said first member for up-and-down movement and adapted to be engaged by the valve stem to partake of the up-and-down movement of the valve stem, a stylus supported by said second member, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

14. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem, a second member applied to said first member for up-and-down movement and bearing upon one side of the valve stem in the up-and-down path of the latter, yielding means for pressing said second member against said stem, a stylus supported by said second member, and

means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

15. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem, a second member applied to said first member for up-and-down movement and bearing against the lower face of the valve stem, yielding means pressing said second member upward, a stylus supported by said second member, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

16. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem and having an upright cavity, a stylus-supporting recorder head having a stem extending slidably into said cavity, said recorder head being in engagement with the valve stem for moving up and down with the latter, a stylus supported by said recorder head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

17. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem and having an upright cavity, a stylus-supporting recorder head having a stem extending slidably into said cavity, said recorder head being in engagement with the lower face of said valve stem, yielding means for pressing said recorder head upward, a stylus supported by said recorder head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

18. In an apparatus for making records on a slide valve stem, the combination of a member adapted to be secured immovably to the engine adjacent the valve stem and having an upright cavity, a stylus-supporting recorder head having a stem extending slidably into said cavity, said recorder head being in engagement with the valve stem for moving up and down with the latter, adjustable means for engaging said stem against rotation, a stylus supported by said recorder head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating said stylus when said part is passing the dead centers.

19. In an apparatus for making records on a slide valve stem, the combination of a base adapted to be secured immovably to the engine adjacent the valve stem, a pedestal adjustably secured to said base, a stylus-supporting recorder head supported by said pedestal in relation to the valve stem to move up and down with the latter but to be otherwise stationary, a stylus supported by said recorder head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating the stylus when said part is passing the dead centers.

20. In an apparatus for making records on a slide valve stem, the combination of a base adapted to be secured immovably to the engine adjacent the valve stem, a pedestal adjustably secured to said base, a stylus-supporting recorder head bearing upon one side of the valve stem in the up-and-down path of the latter, yielding means for pressing said head against said stem, a stylus supported by said recorder head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating the stylus when said part is passing the dead centers.

21. In an apparatus for making records on a slide valve stem, the combination of a base adapted to be secured immovably to the engine adjacent the valve stem, a pedestal adjustably secured to said base, a stylus-supporting recorder head supported by said pedestal for up and down movement and bearing against the lower face of the valve stem, yielding means pressing said head upward, a stylus supported by said head, and means adapted to be operatively connected with a part of the engine which is in operative relation with the piston for actuating the stylus when said part is passing the dead centers.

22. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including two circuit-controlling devices, one in position to be operated by the cross-head when the latter is at its front center and the other adapted to be operated by the cross-head when the latter is at its back center.

23. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including two circuit-controlling devices mounted upon

the cross-head, one being in position to be actuated by contact with a relatively stationary part when the cross-head is at its front center and the other being in position to be actuated by making contact with a relatively stationary part when the cross-head is at its back center.

24. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including two circuit-controlling devices yieldingly mounted upon the cross-head, one being in position to be actuated by contact with a relatively stationary part when the cross-head is at its front center and the other being in position to be actuated by making contact with a relatively stationary part when the cross-head is at its back center.

25. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including two circuit-controlling devices adjustably mounted upon the cross-head, one being in position to be actuated by contact with a relatively stationary part when the cross-head is at its front center and the other being in position to be actuated by making contact with a relatively stationary part when the cross-head is at its back center.

26. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including two circuit-controlling devices yieldingly and adjustably mounted upon the cross-head, one being in position to be actuated by contact with a relatively stationary part when the cross-head is at its front center and the other being in position to be actuated by making contact with a relatively stationary part when the cross-head is at its back center.

27. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including a bar adapted to be secured to the cross-head horizontally and parallel to the piston rod, a circuit-controlling device secured to the front end of said bar in position to be engaged by a relatively stationary part of

the engine when the cross-head is on one of the dead centers, and another circuit-controlling device secured to the back end of said bar in position to engage a relatively stationary part of the engine when the cross-head is on the other dead center.

28. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including a bar adapted to be adjustably secured to the cross-head horizontally and parallel to the piston rod, a circuit-controlling device secured to the front end of said bar in position to be engaged by a relatively stationary part of the engine when the cross-head is on one of the dead centers, and another circuit-controlling device secured to the back end of said bar in position to engage a relatively stationary part of the engine when the cross-head is on the other dead center.

29. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including a bar adapted to be secured to the cross-head horizontally and parallel to the piston rod, a circuit-controlling device adjustably secured to the front end of said bar in position to be engaged by a relatively stationary part of the engine when the cross-head is on one of the dead centers, and another circuit-controlling device adjustably secured to the back end of said bar in position to engage a relatively stationary part of the engine when the cross-head is on the other dead center.

30. In an apparatus for making records on a slide valve stem, the combination of a stylus, a stylus support adapted to be placed in relation to the valve stem to move up and down with the latter but be otherwise stationary, and electrical mechanism for actuating said stylus, said mechanism including a bar adapted to be secured to the cross-head horizontally and parallel to the piston rod, a circuit-controlling device yieldingly secured to the front end of said bar in position to be engaged by a relatively stationary part of the engine when the cross-head is on one of the dead centers, and another circuit-controlling device yieldingly secured to the back end of said bar in position to engage a relatively stationary part of the engine when the cross-head is on the other dead center.

31. In an apparatus applicable to two approximately parallel members of a steam

engine, namely, the valve stem and the piston cross-head, for indicating the relative movement of the piston and slide valve of such engine, the combination of a stylus, a
5 stylus support adapted to normally hold the stylus in a plane which is transverse to said approximately parallel members and in operative relation with one of said members for marking thereon, and means adapted to
10 be operatively connected with the other of

said members for actuating said stylus when said last mentioned member is passing the dead centers.

In testimony whereof I have signed my name to this specification in the presence of 15 two subscribing witnesses.

JOHN BAKER MICHAEL.

Witnesses:

A. E. ACEE,

C. A. KIRBY.