No. 677,665. Patented July 2, 1901.

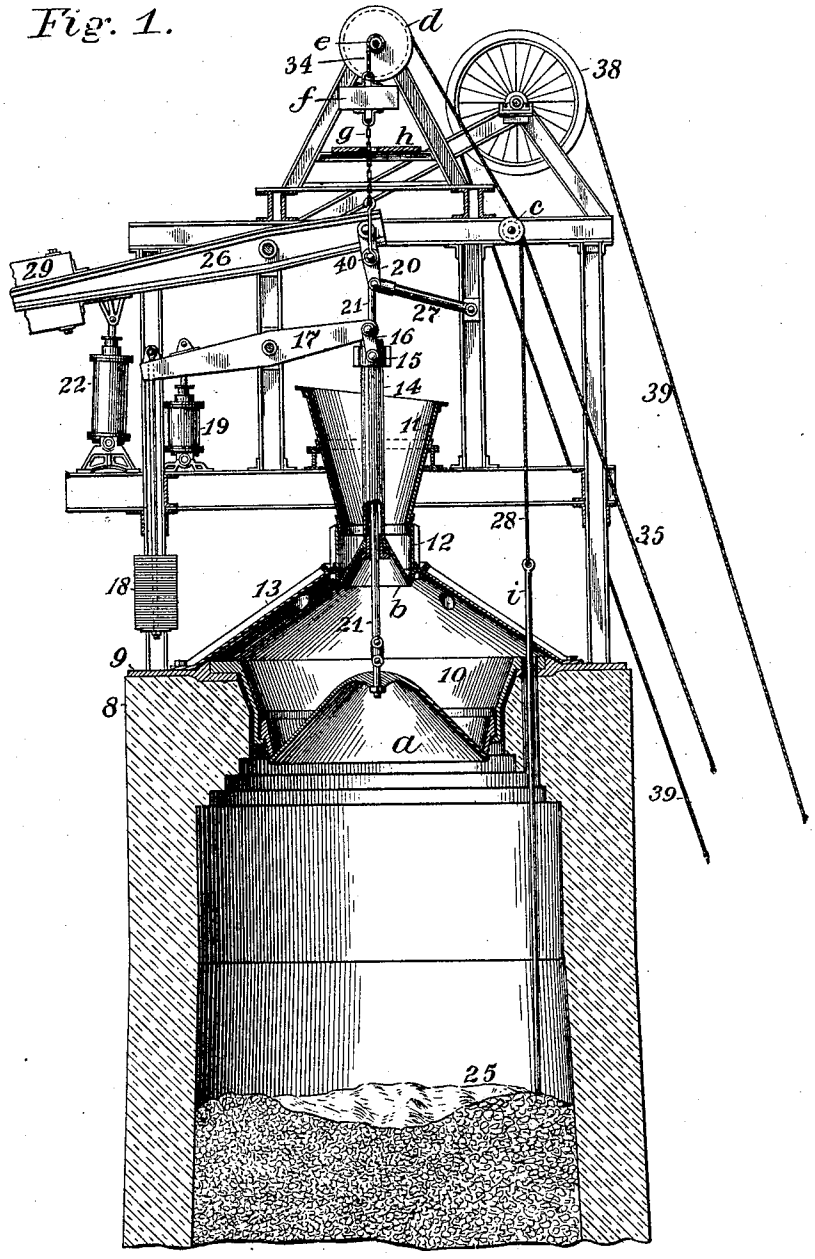
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STOCK LINE RECORDER FOR BLAST FURNACES.

(Application filed Jan. 16, 1901.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



Witnesses

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STOCK LINE RECORDER FOR BLAST FURNACES.

(No Model.) (Application filed Jan. 16, 1901.) 4 Sheets—Sheet 2.

Fig. 2.

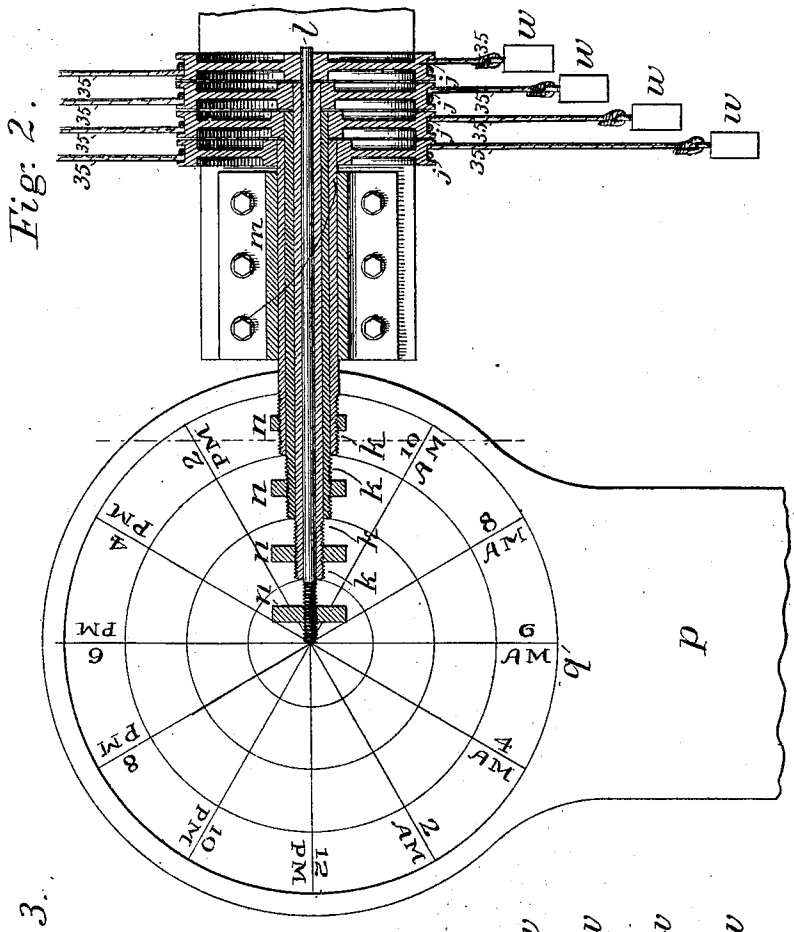
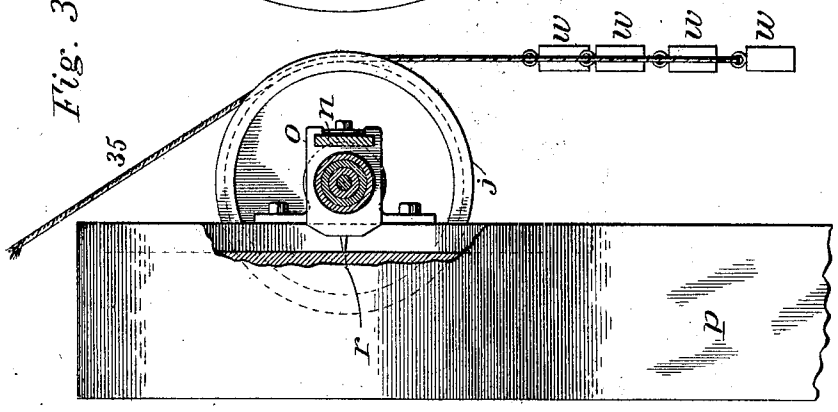


Fig. 3.



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Fig. 5.

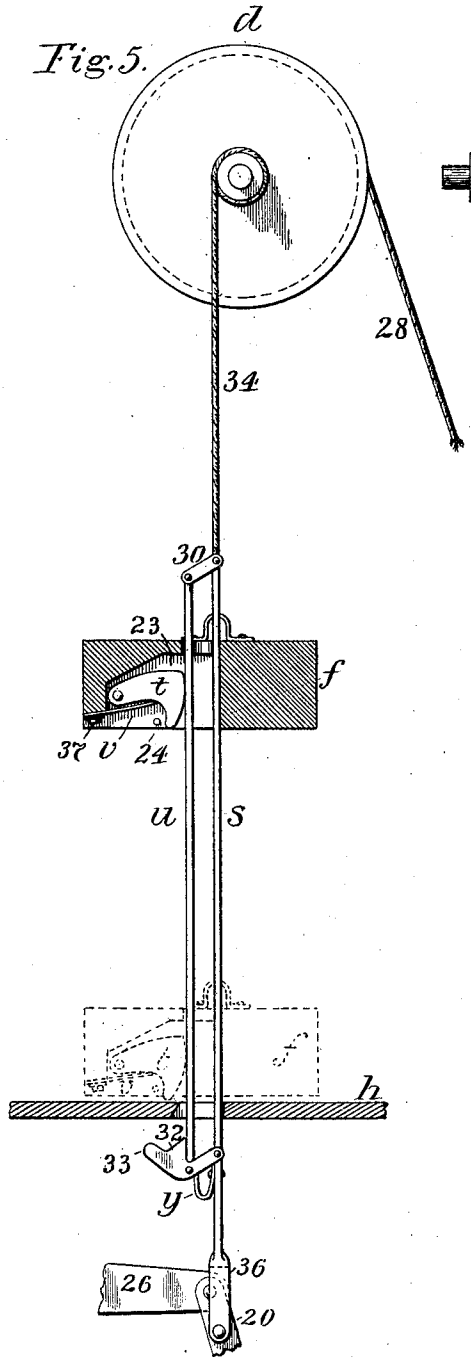


Fig. 4.

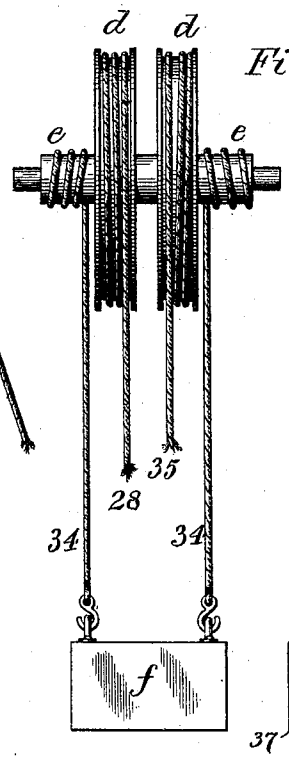
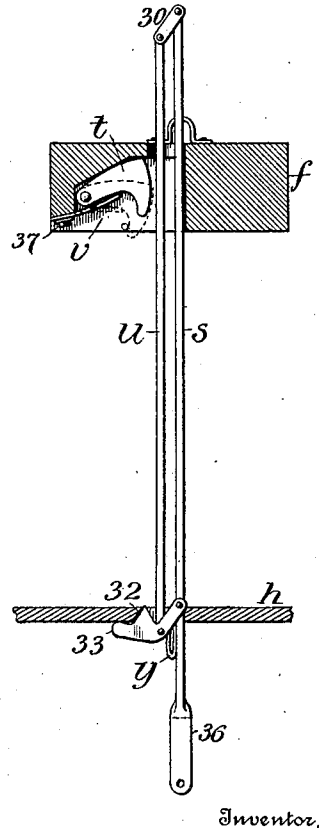


Fig. 6.



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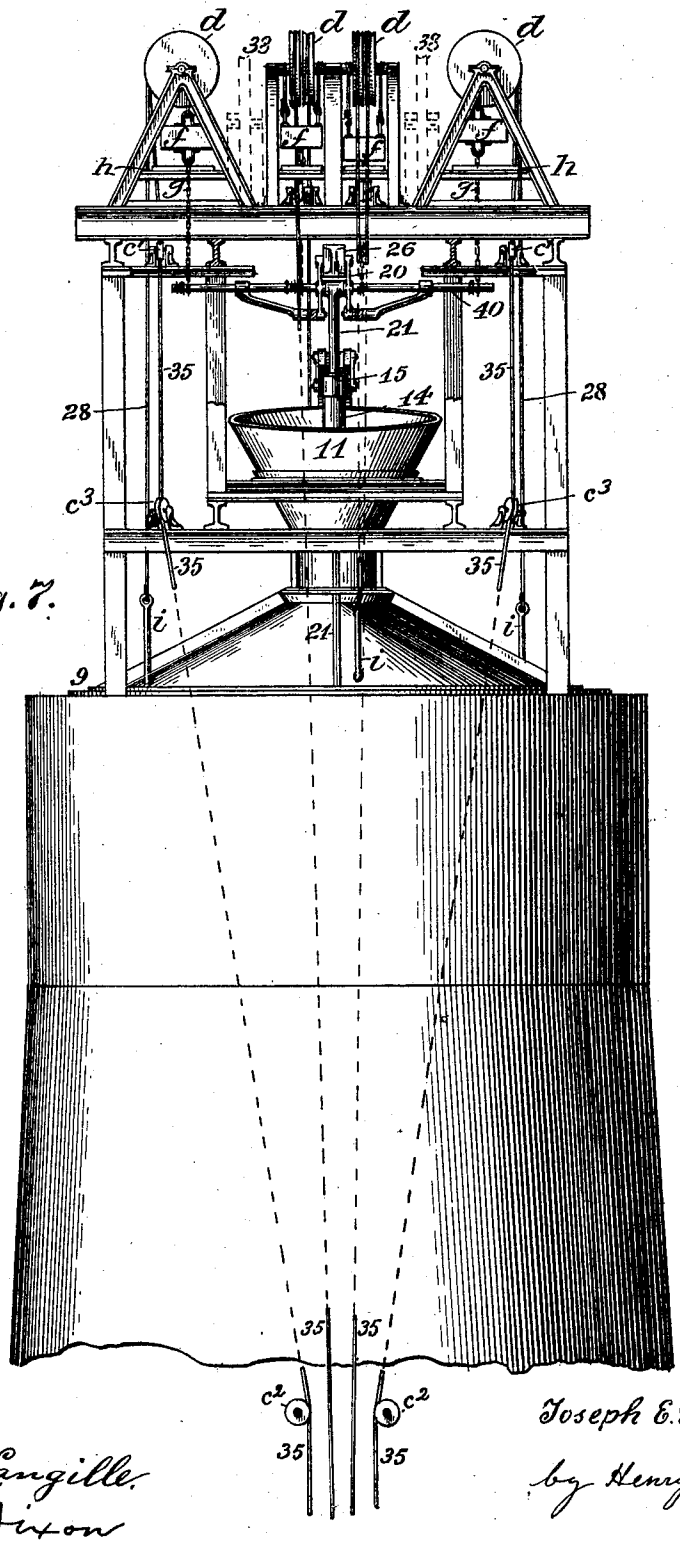
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(No Model.) (Application filed Jan. 16, 1901.) 4 Sheets—Sheet 4.

Fig. 7.



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UNITED STATES PATENT OFFICE.

JOSEPH ESREY JOHNSON, JR., OF PITTSBURG, PENNSYLVANIA.

STOCK-LINE RECORDER FOR BLAST-FURNACES.

SPECIFICATION forming part of Letters Patent No. 677,665, dated July 2, 1901.

Application filed January 16, 1901. Serial No. 43,539. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH ESREY JOHNSON, Jr., a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Stock-Line Recorders for Blast-Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to stock-line recorders for blast-furnaces, and has for its object the furnishing of a continuous record of the height and contour of the upper surface of the stock or material fed into the top of a blast-furnace or similar apparatus, showing the rate and nature of the descent of the stock at all times and the length of the time intervals occurring between successive charges.

The essential features of the invention are a test rod or rods which rest upon the stock when the main bell is closed and indicate the position and movements of its upper surface, but which when the bell is opened are automatically withdrawn to be out of the way of the entering charge, preferably by means actuated by the movements of the bell itself, and are again restored and allowed to rest upon the stock when the bell is replaced, the movements and position of which test-rods both as to time and extent are indicated and recorded by a suitable recording apparatus conveniently located for inspection, preferably at the main operating-line of the furnace.

It has long been customary to use a metal rod passing through a hole or holes in the hopper or other place of access to determine by hand-test from time to time the distance of the stock below the top of the furnace, and such rods have also more recently been connected with graduated indicating means, whereby the position assumed at the time of testing could be more accurately read and measured for each observation. Furthermore, a means for recording the times of movement of the charging-bell of the furnace and the extent of movement thereof has been proposed from which might roughly be inferred the position of the stock-line at such times of opening; but under the modern conditions of blast-furnace operation, involving much higher pressures than formerly and much finer ores, something far more accurate and reliable than an occasional gaging of the stock-time or a record of the times of dumping each charge of stock is required. The tendency of the stock to stick in the furnace and settle by jumps of greater or less magnitude at very varying intervals of time is vastly increased, making it of great importance that the furnace-man should be forewarned of these conditions, and especially if the time-interval since the stock last settled is of undue duration, so that he may take precautionary measures to prevent a "slip" of too great severity, from which serious damage has frequently resulted. It is also very desirable to have a record, inaccessible to the "fillers," of the regularity with which the stock has been charged into the furnace, affording an infallible check upon their operations. To supply such a want is the object of the present invention.

In the drawings forming a part of this specification, Figure 1 is an elevation, mainly in section, of the upper portion of a blast-furnace of modern construction using a double-skip hoist supplied with my improvement. Fig. 2 is a vertical longitudinal sectional view of the recording apparatus, with a front view of a recording-dial preferably employed therewith. Fig. 3 is an elevation, partly in section, of said recording apparatus, taken at right angle to Fig. 2. Fig. 4 is an enlarged view in elevation of one of the drums and axles sustaining the test-rod and counterweight. Fig. 5 is a side elevation of said drums and axle with counterweight in section in two positions and showing an auxiliary device for making the connection between the main bell-rod and the counterweight. Fig. 6 is a sectional view of the device of Fig 5 in a different position. Fig. 7 is a front elevation at right angles to the plane of Fig. 1, showing the upper portion of the furnace, illustrating the manner of mounting the test-rod drums when a plurality of test-rods are used and the mode of making connection with the multiple indicator shown in Fig. 2.

Referring to said drawings, 8 is the brick-work of the upper portion of the furnace.

9 is the hopper-ring.

10 is the main hopper, secured to the top of the furnace.

11 is the upper or auxiliary hopper.

12 is the tubular throat of said upper hopper.

13 is the hood or cover of the furnace-top.

14 is the tubular support of the auxiliary or small bell, connected by trunnions 15 and yokes 16 to the extremity of the walking-lever 17, by which the smaller bell is operated.

18 is the counterweight by which the smaller bell is held in closed position. 19 is the pneumatic cylinder by which said bell is operated.

a is the main bell for charging the furnace.

b is the smaller bell for distributing the stock to the main bell and for preventing the escape of gas while the latter is open.

21 is the main-bell rod, which, by means of parallel motion-links 20, is connected to a walking-lever 26, counterweighted at 29, through which the main bell is operated by means of rocking pneumatic cylinder 22.

27 is the radius-rod of the parallel motion which governs the vertical rise and fall of the bell-rod 21.

38 is the sheave of one of the skips for hoisting stock to the furnace by means of rope 39 on an inclined track. (Not shown.) So far the mechanism is familiar in modern blast-furnaces and needs no further description.

25 represents the line of the upper surface of the stock as periodically delivered to the furnace by the movements of main bell *a*. For ascertaining and recording the position of this stock-line I provide one or more test-rods *i*, vertically suspended in suitable apertures in the furnace-top by a rope or ropes 28, preferably of wire, (shown in Fig. 1,) so as to touch the stock at the line. For the sake of clearness only one test-rod, with its connection, is shown in Fig. 1; but in order order to fully indicate and record the circumferential position of the stock-surface line four is a convenient number to employ, as shown in Fig. 7, in which case the apparatus affixed thereto is correspondingly duplicated. The test-rods may be used to gage the depth of the stock-line by hand at all times, if desired. The suspensory rope 28 in Fig. 1 passes upward over guiding-sheave *c* and is deflected to drum *d d*, to one portion of which it is attached. Said drum is double for a reason hereinafter explained. The drums are mounted on an axle *e*, from which by ropes 34, winding around it oppositely to the direction of ropes 28 35 on drum *d d*, is suspended a counterweight *f*. This weight has a connection *g* to the main bell *a* or its bell-rod 21 or some part moving therewith of such a nature that the weight is free to move to the limit of its upward and downward travel when the main bell is closed, as shown in Fig. 1, but comes down with the bell to its lowest position when the bell assumes the lowest position, as occurs when the bell makes a discharge. The range of the counterweight is limited by the bench or stop *h* at the bottom and coincides with the range of the main bell. The simplest means for accomplishing such a connection as above described is a flexible connection, as a rope or chain, permitting of the requisite slack; but other means may be employed, as hereinafter described.

The proportion of the respective diameters of the double drum *d d* and axle *e* is such that each test-rod may descend to the lowest position that it is advisable or necessary for it ever to reach when its counterweight *f* is at the top of its travel and that the test-rod may be at its highest position when its counterweight is at its lowest position—*i. e.*, the ratio of the diameters of the drums and axle is the same as that of the maximum travel of the test-rod and its counterweight, respectively. To the companion drum *d* is affixed a rope 35, winding around it in the same direction as rope 28, passing also over the sheave *c* to the sheave *j* of a recording apparatus, Figs. 2 and 3, and weighted at the lower end by supplementary weight *w*. The test-rod *i* and weight *w* thus have the same range of motion, and the recorded movements of one stand for the other. The weight of weight *w* is so proportioned that the counterweight *f* is able to somewhat more than raise it; but the weight of *w* and that of the test-rod together are able to raise the counterweight. The drums *d d* might be one and the same; but for convenience they are divided, so that each supporting-wire 28 35 has its own path.

For recording the movement of wires 28 34, and therefore of the test-rods, numerous devices may be resorted to. The one shown in in Figs. 2 and 3 is simple and convenient for the purpose and will be briefly described.

j j j j are sheaves, (one for each test-rod,) each of which is fixed to its own revoluble shaft, that of the outer sheave alone being solid, *l*, the others being concentric sleeves or tubes *k k k*, all held in a common tubular bearing *m*. Over these sheaves *j* pass the supporting-wires 35, one for each test-rod, wrapped one or more times each around its sheave to insure the movement thereof in correspondence with the movements of the test-rod and weight *w*. Each of these shafts *k l* is screw-threaded at its inner extremity with a thread of the same pitch, giving the same range of travel for the same number of revolutions, and each freely carries a nut *n*, guided and prevented from turning by a guideway *o*, which permits it to traverse as the threaded shafts are turned. A recording-dial *q*, rotated by a time-clock movement in case *p*, stands behind the row of movable nuts, each of which latter carries a marking-point *r*, bearing on the paper face of the dial, which is removable as a record. Said dial-plates are divided by radial lines into equal time divisions, which may represent hours and fractions thereof, and are further separated by concentric circles into bands of equal

width corresponding in number to the number of marking-points or nuts, each of which keeps the record of a test-rod. The pitch of the screw-threads on the shafts *k l* and the diameters of the sheaves *j* are so proportioned that the maximum travel of a test-rod and of its weight *w* will occasion a corresponding traverse of its nut *n* or the marker thereof just the width of one band or subdivision on dial *q*. The bands are so subdivided that the subdivisions correspond to feet of travel of the test-rod and make a record accordingly, or said linear unit may be the centimeter. Each marker *r* therefore describes on its own band a line which indicates and records the height of the stock-line at any specified time, the exact times of charging the furnace with fresh stock by the movement of the bell, the times and extent of each slip, and the comparative rates of settlement of various points around the circumference of the furnace. The nature of this line drawn on the band shows at a glance the regularity of the movements or the reverse, and the degree of correspondence between the movements for the different test-rods, which it is desirable should be uniform, will be indicated by the approximation to parallelism in the lines. All this is accomplished by the device described.

Of course where but one test-rod is used a simpler indicator is sufficient, containing but one shaft *l*. In Fig. 7 I have illustrated the several flexible connections *g* all joined to a part moving vertically in unison with bell-rod 21, which, as in Fig. 1, is the pin 40. I also show the mode of making the connections from the several test-rod drums to the common indicator. In this figure the laterally-placed drums *d d* have their suspensory test-rod connections 28 depending vertically from their respective drums, while the recorder connections 35 pass from sheaves *c'* diagonally forward and downward to sheaves c^3 in the plane of the recorder at the front of the furnace and are thence deflected downward to the recorder, passing over sheaves c^2 to restore parallelism, the several connections shown being continuous with the broken-off cords 35 of Fig. 2.

Operation: Starting at the opening of the main bell *a*, the counterweight *f* is drawn down by the bell connection therewith to its lowest position when the bell reaches the bottom of its travel, as it is designed to do on the deposit of each bell charge. By this movement the test-rod *i* and weight *w* are raised to their highest positions, the same being true for all. On the reverse movement of the bell in the act of closing, the test-rod and the weight *w* will descend, being able to overbalance counterweight *f* and raise the same until the test-rod strikes the surface of the stock, relieving counterweight *f* of its weight, when weight *w*, being unable by itself to raise counterweight *f*, comes to rest with the counterweight. The bell continues to close, and the flexible connection *g* between the bell-rod and the counterweight becomes slack. The position of the stock-line is indicated by the position of the counterweight at the point where it came to rest with the test-rod and weight *w*, and if the stock-line should settle while the bell is closed, as it does, the test-rod settles with it, adding its weight to that of weight *w*, and thereby raising the counterweight to a corresponding new position, (indicated on the dial-plate,) there being always slack enough in the connection *g* to permit of such readjustment. The lowering of the bell *a* to its lowest position for the deposit of a charge automatically raises the test-rod *i* out of the way of the entering charge of stock, and on the ascent of the bell to closed position after the deposit of the stock the test-rod descends again to the surface of the fresh stock, thereby indicating and recording the amount of the new deposit, as determined by the new position of the stock-line. When, however, the stock-line is near its highest level and a new deposit is made, the counterweight *f* being then near its lowest position, it will be seen that the bell would open a considerable distance before the slack of the connection *g* was taken up or the test-rod and weight *w* started from their positions, the stock being meanwhile deposited. This might occasion injury to the test-rods before they could be got out of the way, and to provide against such a contingency I have devised a form of connection (illustrated in Figs. 5 and 6) which may be varied, but is a practical form of a nullifier of lost motion in connection *g*. Instead of a flexible rope or chain I provide an intermittent connection, (represented by the rigid rod *s*,) attached the same as *g* to the bell-rod 21 by a forked connection 36, but passing up through an aperture in the counterweight *f*. In said counterweight there is also a recess 23, in which is a pivoted cam *t*, held normally up by spring *v*, adjustably secured to the counterweight at 37 and limited on the downward course by stop 24. To the rod *s* is attached a parallel rod *u* by pivoted links 30 31, of equal length from center to center of pivots, which maintain the two rods parallel in all positions. A spring *y* tends to force the two rods apart, while a shoulder 32 on the lower link 31, coming in contact with rod *u*, furnishes a limit to the degree of separation. Link 31 is also prolonged into a projection or detent 33, the object of which is to come in contact with bench or stop *h* on the extreme rise of the rod by the closure of the bell and force the rods *s u* together by compression of spring *y*, Fig. 6. The compound rod *s u* thus extends more or less within the aperture of counterweight *f* when the bell *a* is at its highest or closed position to an extent representing the amount of slack or lost motion in the connection. Now when the bell is lowered a very short distance the link 31 is removed from constraint, and the rods *s u* immediately open

out under the action of spring *y*, bringing rod *u* in contact with cam *t*, Fig. 5, drawing the cam downward against the tension of spring *v* and gripping the rods with sufficient force to start the counterweight *f* on its downward travel, thus raising the test-rod *i* before the bell reaches the full extent of its motion and before it can be overwhelmed by the charge of stock. When the counterweight has reached its lowest position and the test-rod and weight *w* are at their highest, the projecting end of cam *t* strikes the bench *h*, which forces the cam upward relatively and enables the rods *s u* to slip through the aperture of the counterweight with only enough friction to hold them in position. When the bell commences to close, the rods *s u* rise with it, and the counterweight also rises under stress of test-rod *i* and weight *w* until the test-rod strikes its stock-surface, when the tendency to raise the counterweight being gone said counterweight becomes stationary and the rods *s u* slip up through it freely to an extent measured by the slack or lost motion. The closing of the bell closes the rods by the contact of end 33 with bench *h*, leaving the counterweight free to assume any position determined by that of the test-rod, as before. The movements of test-rod and counterweight are recorded at each instant on the recording apparatus by means of wire 35 moving in unison with wire 28, supporting the test-rod. The means for conveying and recording these movements of the test-rod may be varied, but those above described serve the purpose.

I claim and desire to secure by Letters Patent—

1. In a blast-furnace, in combination, a movable bell adapted to open and close the mouth of the furnace, a test-rod adapted to rest on the stock, a lost-motion device between the bell and the test-rod, whereby the latter is compelled to rise when the bell is lowered, but is free to fall only on descent of the stock-line on which it rests, a mechanism for recording the movements of the test-rod both in period and degree, and suitable connections between the latter and said recording mechanism, substantially as specified.

2. In combination with the charging mechanism of a blast-furnace, a test-rod, penetrating the cover of such furnace from the top, to rest upon the stock, a suspensory cord or wire for said test-rod, a supporting drum and axle, to which drum the cord is attached, a counterweight suspended from the axle, a time and space recording mechanism connected with said drum and axle to record the movements thereof, and a connection from the counterweight to the charging mechanism of the furnace, whereby the charging movement depresses said counterweight and raises the test-rod, and the restoring movement of the charging mechanism permits the test-rod to find a seat on the stock in the furnace, substantially as specified.

3. The combination of a test-rod, a suspensory means therefor, a counterweight, connecting mechanism between the counterweight and the test-rod whereby one rises as the other falls, a furnace-bell, a connection from the bell to the counterweight, a time and space recording mechanism, and a cord connecting said recording mechanism with the suspensory means of the test-rod, whereby the movements of the latter are recorded in period and degree, substantially as specified.

4. The combination of a vertically-suspended test-rod, a drum and axle supporting the same from the drum, a counterweight suspended from the axle, overbalancing the test-rod, a supplementary weight suspended from the drum by a cord moving in unison with the test-rod, and with the latter counterbalancing the counterweight, a time and space recording mechanism connected with said cord to record the movements of the test-rod, a furnace-bell, and a yielding connection between said bell and said counterweight, whereby the latter descends with the opening of the bell, raising the test-rod, but ascends independently of the bell, by the overbalancing action of the test-rod and supplementary weight, substantially as specified.

5. In combination, a suspended test-rod, a suspended counterweight, connecting mechanism between the two, whereby as one rises the other falls, a rising and falling charging-bell, and mechanism connected to said charging-bell, forming connection with said counterweight on each downward movement of the bell to bring the counterweight down simultaneously, but independent of action upon said counterweight on any upward movement of said bell, substantially as specified.

6. In combination, a counterweight *f*, drum *d*, axle *e* from which the counterweight is suspended, parallel rods *s*, *u*, passing through said counterweight, said rods linked together by links 30, 31, a spring for separating said rods, a detent 33, spring-cam *t*, a rising and falling charging-bell connected to rod *s*, a rising and falling test-rod connected to drum *d*, a recording mechanism, and a connection between the recording mechanism and the drum whereby the movements of the test-rod are recorded, substantially as specified.

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

JOSEPH ESREY JOHNSON, JR.

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