J. A. CALDWELL.

MECHANICAL STOKER.

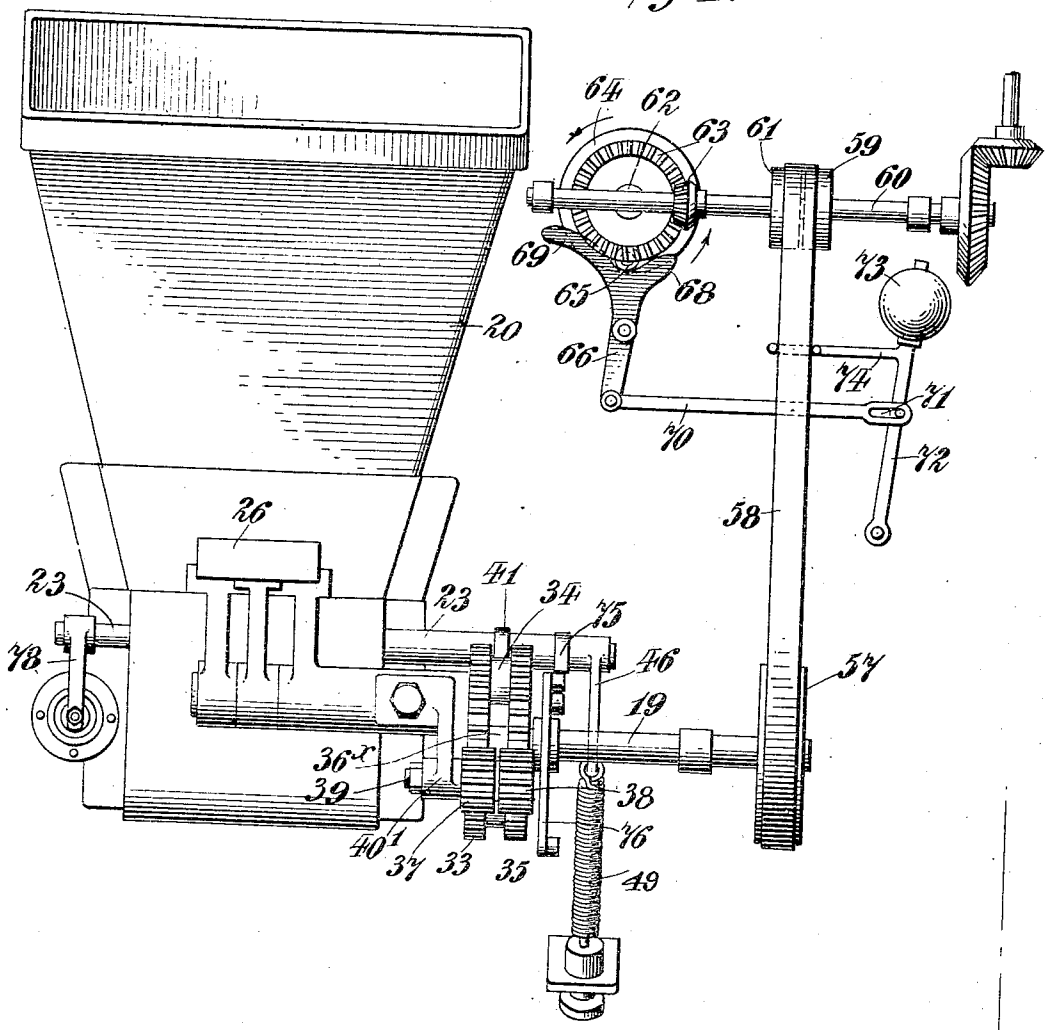
APPLICATION FILED AUG. 17, 1908.

954,717.

Patented Apr. 12, 1910.

4 SHEETS—SHEET 1.

Fig. 1.




WITNESSES

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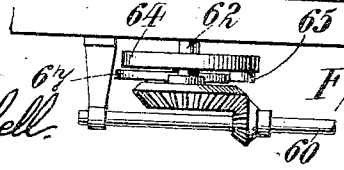


Fig. 2.

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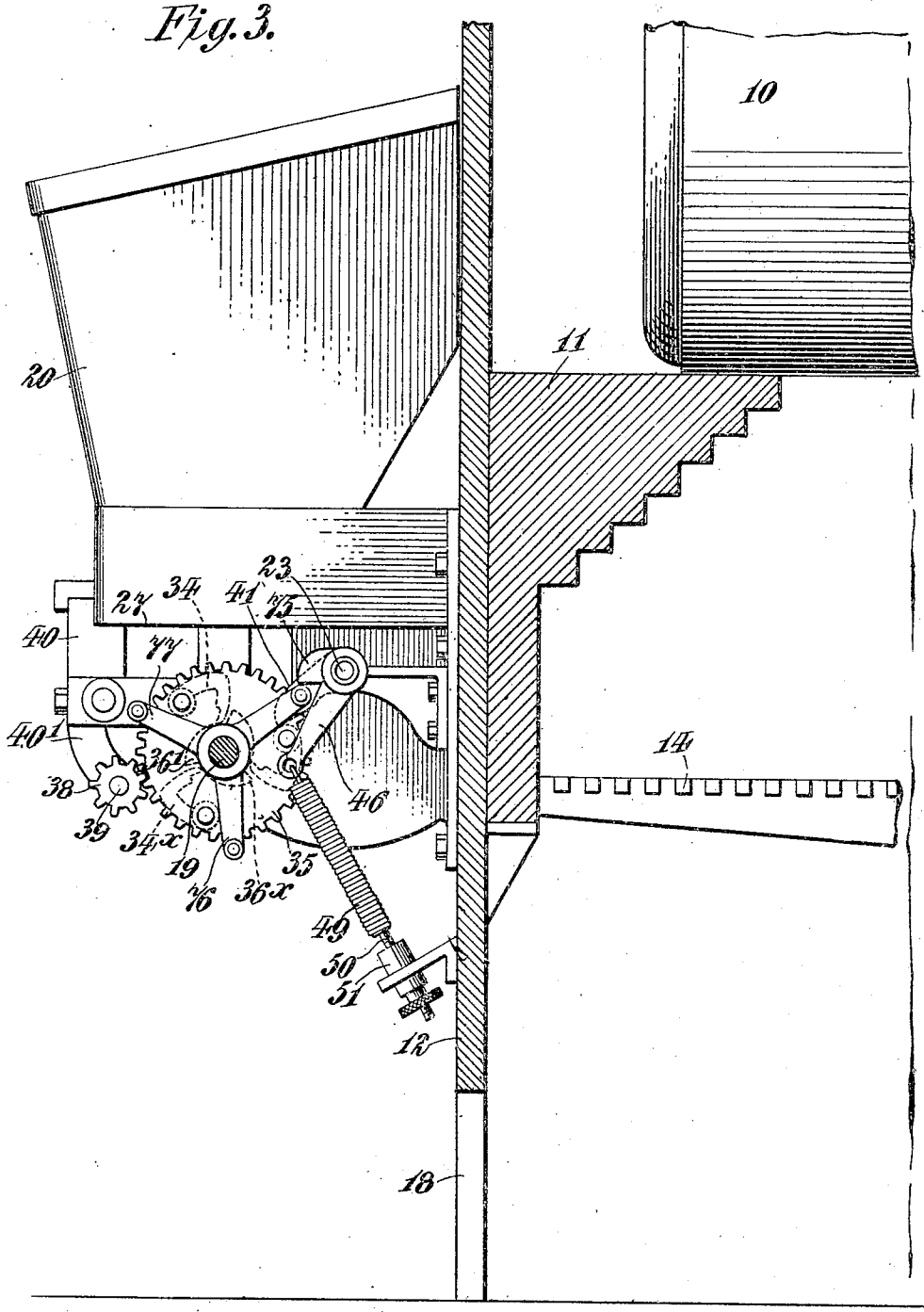
4 SHEETS--SHEET 2.

Fig. 3.

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4 SHEETS—SHEET 3.

Fig. 4.

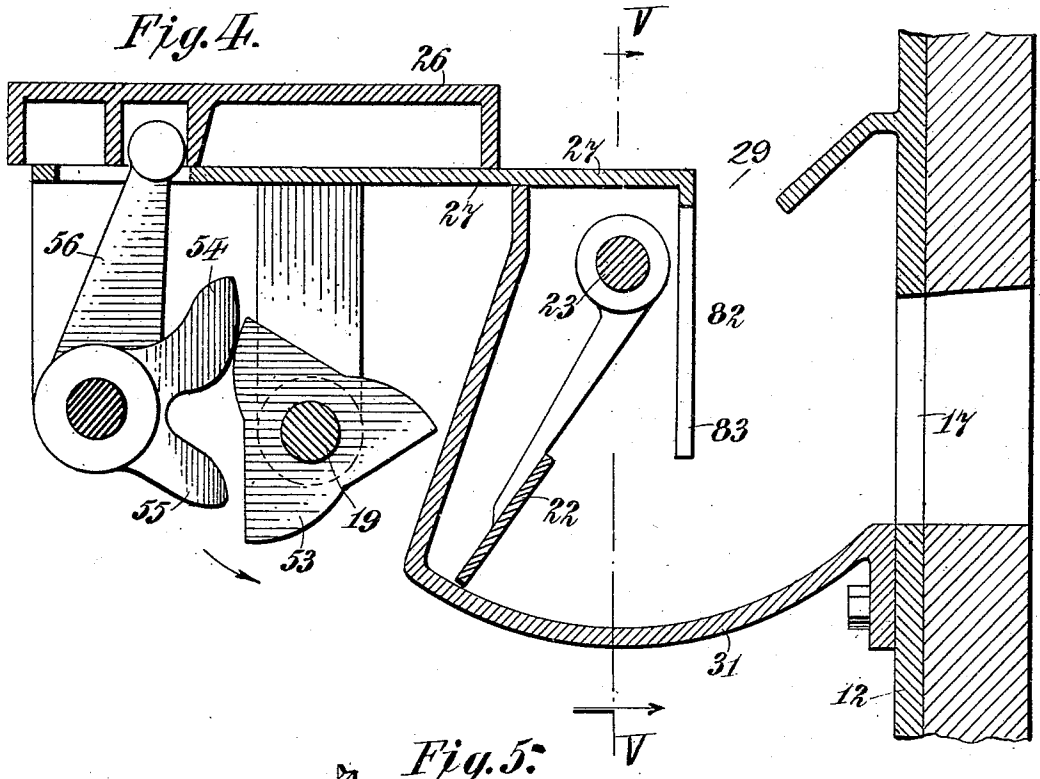
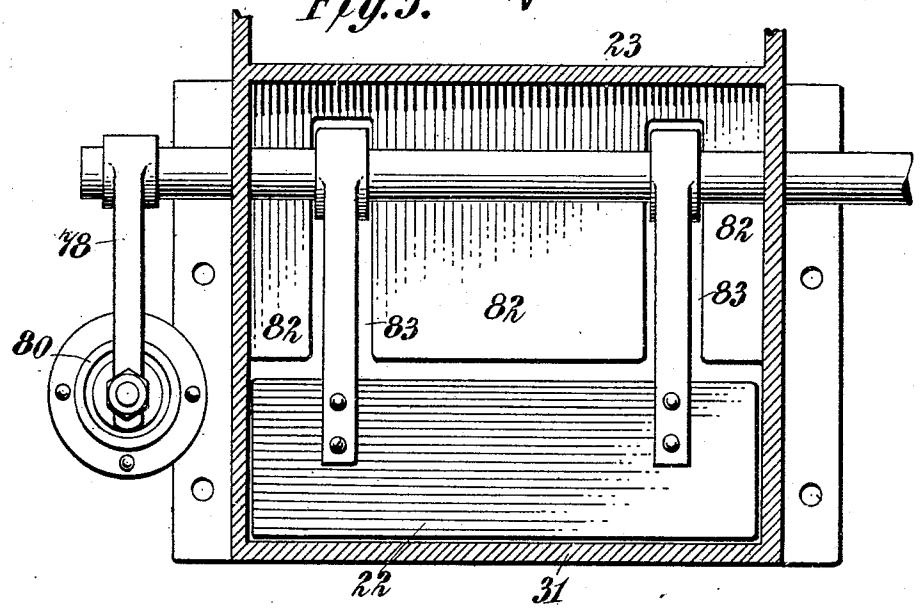



Fig. 5.

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4 SHEETS—SHEET 4.

Fig. 6.

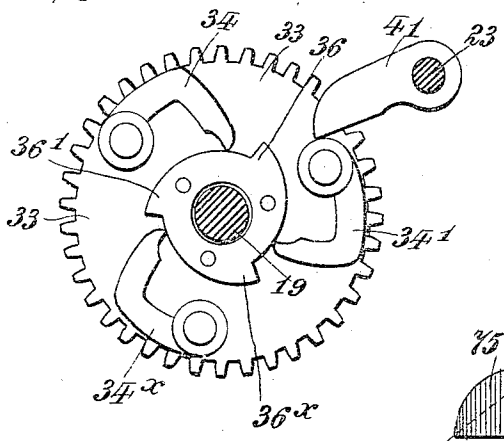
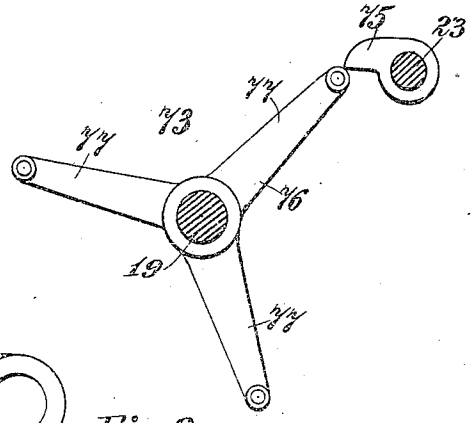



Fig. 7.



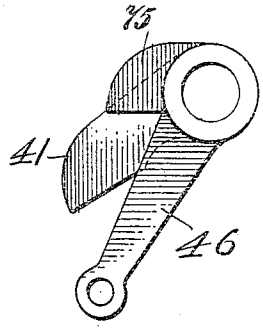




Fig. 8.

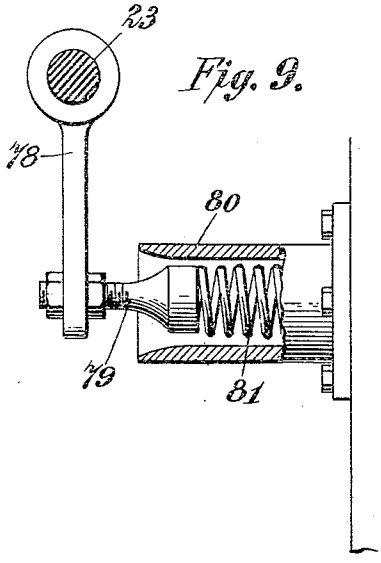



Fig. 9.

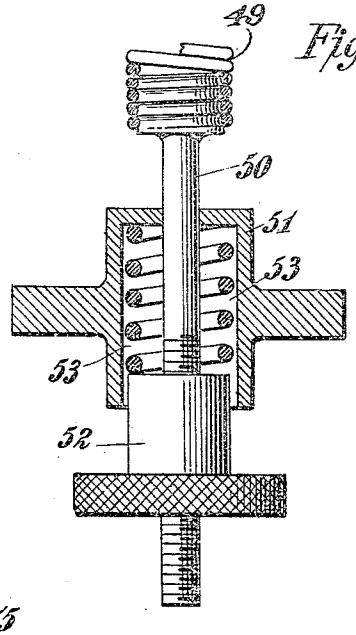
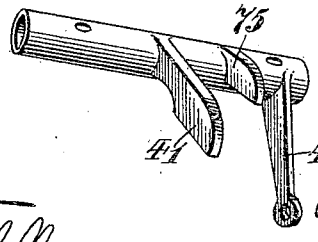



Fig. 10.

Fig. 11.

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# UNITED STATES PATENT OFFICE.

JOHN A. CALDWELL, OF MONTCLAIR, NEW JERSEY.

## MECHANICAL STOKER.

954,717. Specification of Letters Patent. Patented Apr. 12, 1910.

Application filed August 17, 1908. Serial No. 448,813.

*To all whom it may concern:*

Be it known that I, JOHN A. CALDWELL, a citizen of the United States, residing at Montclair, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Mechanical Stokers, of which the following is a specification, reference being had therein to the accompanying drawings, in which—

Figure 1 is a front elevation of an automatic stoker provided with my invention; Fig. 2 a detail plan view of a portion of the automatic stopping and starting mechanism; Fig. 3 a vertical longitudinal sectional view of a portion of the boiler front showing my automatic stoker mechanism in side elevation; Fig. 4 a vertical longitudinal sectional view of the shovel and ram compartment; Fig. 5 a transverse vertical sectional view on the line V—V of Fig. 4; Fig. 6 a detail view showing cam tappets and shovel tappet; Fig. 7 a detail view showing the advanced tappet and the striker arms; Fig. 8 a detail side elevation of a portion of the shovel-operating mechanism; Fig. 9 a detail view showing the shovel-arresting means; Fig. 10 a detail sectional view showing the means for preventing vibration of the shovel-moving spring; and Fig. 11 a detail perspective view showing the shovel tappet and the advanced tappet.

This invention relates to that type of automatic mechanical stokers covered by my Reissue Letters Patent No. 12,598, dated January 22, 1907, and wherein the fuel is automatically thrown over the fire by a shovel, each successive throw of the shovel being stronger than the preceding throw, until the maximum throw is reached when it returns to the minimum. The operation of the shovel mechanism as will be seen in said reissue patent, is continuous. There is some objection to this method of firing a steam boiler furnace. It is well known that in hand firing, that is to say, by stokers, there is always a period when the fire is at rest, when no fuel is being thrown thereon. During this period of rest the steaming efficiency of the fire gradually rises to the maximum and then decreases until it becomes necessary to again feed fuel to the fire. It is desirable that the fire shall have this period of rest.

It is one of the main objects of this invention to provide a stoking means which will, after covering the fire with fuel, automatically come to rest for a predetermined time, and then automatically continue the feeding of fuel. The stoking mechanism operates to feed a fresh covering of fuel over the fire and then stops until that bed is consumed, or approximately consumed, the timing of the apparatus being determined by the nature of the fuel used and the draft. At the end of the predetermined time the stoking mechanism is again automatically operated to feed another covering of fuel over the fire, so that by my improved apparatus I obtain the nearest possible approach to the conditions of hand firing, while at the same time preserving the machine-accuracy and steadiness, and the many other advantages of the automatic mechanical stoker.

Other objects of the invention are to simplify and improve the construction of the parts of the apparatus; to provide improved means for preventing vibration of the shovel at the end of its fuel throwing movement; to provide means for protecting the shovel from the intense heat of the fire, and to provide means whereby the operating strain will be small and will be brought on the shovel shaft outside of the shovel compartment and at a point not subject to the heat in the shovel compartment.

There are other important objects and advantages of the invention which will appear hereinafter.

Referring to the various parts by numerals, 10 designates the front portion of the boiler, supported upon brick work 11.

12 designates the metallic boiler front and 14 the furnace grate. Fuel is thrown into the furnace through the fuel opening 17 of the stoker mechanism and 18 designates the ashpit opening.

The main shovel-operating shaft 19 is mounted in suitable bearings depending from the bottom 27 of the ram compartment. Above the ram compartment is arranged the fuel hopper 20 from which the fuel passes to the ram compartment, the bottom of the ram compartment also forming the bottom of the hopper. Mounted to slide on the bottom of the ram compartment is a plunger or ram 26, said ram being so arranged that when it is in its withdrawn position fuel will drop from the hopper in front of said ram on the bottom 27. The forward movement of the ram will push the coal forward

until it drops into the shovel compartment through the opening 29 in the bottom of the hopper. Below the hopper and arranged to receive the fuel dropping through the opening 29 is a shovel compartment having a concave platform or bottom wall 31 which receives the fuel. Extending through the shovel compartment is a shovel shaft 23 which carries a depending shovel 22. The shovel shaft is adapted to be rocked in its bearings and the shovel 22 oscillates in the shovel compartment. The bottom of the shovel compartment is an arc of a circle struck from the center of the shovel shaft and is secured to the boiler front just below the fuel opening 17.

For the purpose of properly actuating the stoker it is necessary to let the movements of the plunger or ram alternate with those of the shovel, providing for one uniform movement of the plunger toward the furnace prior to each swinging movement of the shovel in the same direction, and as it is not practicable to cover the entire depth of the furnace by one throw of the shovel means must be provided for successively covering different spaces until coal has been distributed over the entire depth of the furnace. Different kinds of coal must be deposited on a fire in layers of different thicknesses to obtain best results. To provide for all these conditions I employ the following means: 33 is a gear-wheel fixedly mounted upon shaft 19. 34 34′ 34× are tappets hinged to said wheel. The same are actuating devices and are hereinafter termed "cam-tappets". 35 is another gear-wheel revolubly mounted upon said shaft, and 36 36′, and 36× are cams attached to said gear-wheel 35, and said cam-tappets are adapted to successively engage with different portions of said cams, as gear 35 is being revolved with reference to gear 33. I provide such relative movements by means of pinions 37 and 38, both mounted on a shaft 39, which has its bearings upon a lower arm 40′, bolted to an extension of a bracket 40, attached to the bottom of the hopper. Pinion 37, meshing with gear 33, is revolubly mounted upon shaft 39, while pinion 38, meshing with gear 35, is fixedly but detachably secured to pinion 37. As the two gear-wheels revolve at different speeds, the cam-tappets will successively come in contact with different portions of said cams and will thereby have imparted to them movements of different extents, as more fully referred to hereinafter.

As fully described in my herein mentioned reissue patent the gear wheel 33 is to have one tooth more than gear wheel 35. Pinions 37 and 38 are to have an equal number of teeth. Upon each complete revolution of gear wheel 33 gear wheel 35 will fall behind to the extent of one tooth, thereby securing a differential movement between the cams 36, &c., and cam tappets 34, &c. By this means I secure the variation in the throw of the shovel necessary for the proper distribution of the fuel over the fire.

By reason of the automatic adjustment of the shovel-moving means the throw of the shovel is so regulated that the fuel will be evenly distributed over the grate-surface by the gradually-increasing strength of the throw of the shovel. If the fuel-bed is not advanced by minute steps, it is practically impossible to secure an even distribution of the fuel over the grate, and I have found it practically impossible to secure these minute steps or increases in the fuel-bed without providing the automatically-adjustable shovel-moving means.

41 is a tappet rigidly secured to the shaft 23 and is adapted to successively contact with the outer surfaces of the cam tappets as the gear wheel 33 is revolved. The ram 26 is operated by cams 53 carried by shaft 19, said cams revolving in the direction of the arrow in Fig. 4, and alternately actuating fingers 54 and 55. These fingers are secured to a short rock shaft which carries arm 56, whose upper end engages the ram, as fully described in my aforesaid reissue patent.

The shovel tappet is secured to the shovel shaft 23 at the side of the shovel compartment and near the right hand end of the shaft, as viewed in Fig. 1. Secured to the shovel shaft near the right hand end thereof and a suitable distance from the tappet 41 is a depending arm 46. Connected to the free end of this arm is an actuating spiral spring 49, the lower end of which is rigidly connected with a depending screw rod 50. The lower end of this rod extends through the tubular bracket 51 secured to the boiler front and adjustably mounted on its lower end is a nut 52. The upper end of this nut is cylindrical and is adapted to fit loosely within the lower end of the tubular bracket. Surrounding the rod 50 and confined within the tubular bracket by the cylindrical nut is a coil compression spring 53, said spring being somewhat weaker than the shovel-actuating spring 49, and forming an auxiliary shovel-actuating spring.

In operation the auxiliary shovel actuating spring 53 will be first compressed when the arm 46 is swung upward by the shovel tappets. When this spring has reached the limit of its compression the main shovel-actuating spring will be extended throughout the remainder of the length of the movement of the shovel tappet. When the shovel tappet is released from the shovel-actuating cams the shovel-actuating spring will be the first to collapse and after it has returned to its normal position the auxiliary spring will expand and immediately bring the main

spring to a tense position. The object of this is to prevent any vibration of the main-actuating spring upon the completion of the fuel-throwing movement of the shovel. In the apparatus shown in my Reissue Letters Patent mentioned herein there is at times a vibration of the shovel-actuating spring at the completion of the fuel throwing movement of the shovel and I have found that by the use of this auxiliary spring this vibration is prevented.

To automatically stop and start the operation of the shovel I provide the following mechanism: On the main actuating shaft 19 is secured a belt pulley 57 over which passes a belt 58 which is driven by a pulley 59 on the power shaft 60. This shaft is driven continuously by any suitable power. As the shaft 19 is to be driven intermittently, I provide automatic means for shifting the belt 58 from the fast pulley 59 to an adjoining loose pulley 61. This means consists of a constantly and slowly rotating shaft 62 which receives its motion through suitable gears 63 driven from the power shaft 60. On the shaft 62 is secured a disk 64 which carries an eccentric pin 65. Pivoted below the disk is an upright lever 66. The upper portion of this lever is provided with upwardly extending divergent arms 67 and 68. The arm 67 is longer than the arm 68 and is curved on its upper edge to form a cam face 69 which is adapted to be engaged by the roller 65 as the disk 64 revolves. Connected to the lower end of the lever 66 is a link 70, said link being connected to a belt shifting device by a pin-and-slot connection 71. The belt shifter consists of an upright lever 72 carrying a weight 73 and a belt shifter arm 74 which engages the belt. When the roller 65 engages the cam face 69 the lower end of the lever 66 is moved to shift the belt to the fast pulley. The stoker as shown, operates and continues to operate until the roller 65 engages the arm 68 and swings the lever 66 in the opposite direction, thereby operating the belt-shifting device to throw the belt 58 over to the loose pulley 61, thereby stopping the stoker mechanism. The weight 73 assists in throwing the belt-shifter lever. When said lever is swung toward either side of its vertical position the weight materially assists in quickly shifting the belt by giving said lever a quick swinging movement toward one side or the other according to the direction in which it has been moved by the belt-shifting lever 66. In order to permit the lever to have this free movement the pin and slot connection is employed between the link 70 and the lever 72.

It will be observed that the period of dwell for the stoker mechanism is the period required for the movement of the roller 65 after it leaves arm 68 until it again reaches cam face 69 of the arm 67. It will be readily observed that the period during which the stoker mechanism is to operate and the period during which it is to remain at rest may be readily varied by varying the shape of the lever 66. It will also be readily understood that there are many ways for automatically operating the belt-shifter to start and stop the stoker mechanism; and also that there are many mechanisms that may be interposed between the power shaft and the shovel-actuating shaft to secure the intermittent rotation of the latter shaft; and I do not wish to be limited to the particular means shown, except, of course, as the same may be made the subject matter of specific claims.

From the foregoing it will be seen that the stoker mechanism is operated to deposit a thin layer of fuel over the fire, and then stopped for sufficient time to permit that layer to be consumed, and it is then automatically set in motion to deposit another layer of fuel over the fire. By this means I approximate the hand method of firing without the disadvantages of opening the fire door and cooling the fire box during each fuel feeding operation. I thus provide the ideal stoking operation and obtain perfect fire conditions in the furnace.

On the shovel shaft adjacent to the shovel tappet 41 is secured what I term an advanced tappet 75. On the shovel-actuating shaft 19 I secure a striker 76 formed with three striker arms 77. This advanced tappet and striker are for the purpose of positioning the shovel tappet so that said shovel tappet will be properly engaged by the cam tappets, as fully described in my Letters Patent No. 891,904; dated June 30, 1908. In Figs. 6 and 7 is illustrated the relative positions of the shovel tappet and the striker arm 77 and the advanced tappet 75. In Fig. 7 the striker arm has engaged the advanced tappet and has brought the shovel tappet to the position shown in Fig. 6 where it will be properly engaged by the actuating cams.

I prefer to form the shovel tappet, the advanced tappet and the arm 46 in one casting, as shown in Figs. 8 and 11, in order to relieve the shovel shaft of any torsional strain, and also to relieve the fastening devices, which secure the cams and the arm 46 to the shaft, of all strain. It is manifest that the strain of extending the spring 49 will be taken up entirely by the casting and that the only strain on the shaft is the strain of moving the shovel to deposit the fuel in the fire box. This feature of my invention has many advantages. I have found that where the arm 46 and the shovel tappet 41 have been individually connected to the shovel shaft the strain on the fastening pins is sometimes sufficient to shear the pins. I

have also found that where the arm 41 is secured to the shovel shaft at one side of the shovel compartment and the shovel-actuating tappet secured to the shaft at the other side of the said compartment, the twisting strain on the shovel shaft is sometimes sufficient to distort the shaft and shift the shovel sufficiently to interfere with the proper operation of the stoker. It will be understood that the shovel shaft, within the shovel compartment, becomes highly heated and that, therefore, it is necessary to relieve that portion of said shovel shaft of all torsional or twisting strains. A great advantage of forming these arms in one piece is that their relative positions to one another are thereby fixed, and independent adjustment of the parts on the shovel shaft to secure their proper relative positions is not necessary. I have found it quite difficult to properly adjust these arms with respect to each other to secure the proper operation of the apparatus. It is manifest that by forming them all in one piece, as by casting, their relative positions are fixed and separate readjustment is not necessary. It is of the greatest importance that the arm 26 and the shovel tappet be secured to the shovel shaft near the same end thereof, so that the heated portion of the shaft will not be between them.

I have found it desirable to suddenly arrest the movement of the shovel during its fuel throwing movement, in order to accurately control the placing of the fuel on the fire. Where the shovel is permitted to complete its swinging movement in depositing the fuel in the fire box, the fuel is apt to be scattered or spread over too great an area. By suddenly arresting the movement of the shovel instead of permitting it to complete its swinging or sweeping movement, the fuel is deposited at the point desired and undue spreading avoided. Secured to the shovel shaft on the opposite side of the shovel compartment from the shovel-actuating means is a depending shovel-arresting arm 78, and connected to this arm is a plunger rod 79. The inner end of this plunger rod slides into a cylinder 80 which contains a compression spring 81 adapted to be engaged by the plunger. When the shovel is released to make its fuel-throwing movement the plunger is brought with full force against the arresting spring 81 so that the shovel is brought to an abrupt stop. The spring acts as a cushion to prevent any undue strain on the shovel. The plunger is adjustably connected to the arresting arm 78 in order that the point at which the shovel is arrested may be varied if desired. By this means the fuel will be deposited within a comparatively small area at each operation of the shovel. This is desirable as it insures an even distribution of the fuel over the fire.

To protect the shovel shaft from the heat of the furnace a depending shield 82 is formed at the inner end of the bottom 27 of the ram compartment. Said shield extends down in front of the shovel shaft a considerable distance and is slotted at 83 for the passage of the shovel-carrying arms. Said shovel carrying arms are provided with large hubs which protect the shaft at points adjacent to the slots 83. By this means the shaft is protected from the severe heat from the fire box.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A mechanical stoker comprising a vibratory shovel, means for imparting fuel throwing movements to said shovel, means to gradually and progressively vary the force of the shovel movements during a predetermined number of movements, and means for automatically arresting the shovel actuating mechanism at the end of each of said predetermined number of movements and for starting said mechanism again at the end of a predetermined period of rest or dwell, whereby the shovel movements will be divided into groups and the fuel will be delivered over the grate by a series of progressively varying throws and the shovel will be arrested for a predetermined period on the completion of each group of throws or movements.

2. A mechanical stoker comprising a vibratory shovel, means for imparting fuel throwing movements to said shovel, means for gradually and progressively increasing the force of the shovel movements during a predetermined number of movements, and means for automatically arresting the shovel actuating mechanism at the end of each of said predetermined number of movements and for starting said mechanism again at the end of a predetermined period of rest or dwell.

3. A mechanical stoker comprising a vibratory shovel, means for imparting fuel throwing movements to said shovel, means to gradually and progressively increase the length of throw of said shovel during a predetermined number of movements thereof, and means for automatically arresting the shovel-actuating mechanism at the end of each of said predetermined number of movements and for starting said mechanism again at the end of a predetermined period of rest or dwell.

4. A mechanical stoker comprising a fuel delivering device, means for imparting fuel throwing movements to said device, means to gradually and progressively vary the force of the movements of said device during

a predetermined number of said movements, and means for automatically arresting the mechanism for actuating the fuel delivering device at the end of each of said predetermined number of movements thereof and for starting said mechanism again at the end of a predetermined period of rest or dwell.

5. An automatic stoker comprising a shovel, a tension means for moving said shovel through its fuel throwing movement, means for moving said shovel in opposition to the tension means and then suddenly releasing it, means for automatically varying the length of throw of the shovel in succeeding throws and for a predetermined number of throws, and means for automatically stopping the shovel actuating means at the end of a predetermined number of throws and for automatically starting the shovel after a predetermined period of rest or dwell.

6. An automatic stoker comprising a shovel, a tension means for moving said shovel through its fuel throwing movement, means for moving said shovel in opposition to the tension means and then suddenly releasing it, means for automatically varying the length of movement of the shovel in succeeding throws whereby the fuel will be delivered at different points by successive throws, and means for automatically stopping the shovel actuating means at the end of a predetermined number of throws and for automatically starting the shovel after a predetermined period of rest or dwell.

7. An automatic stoker comprising a shovel, a tension means for moving said shovel through its fuel throwing movements, means for moving said shovel in opposition to the tension means and suddenly releasing it, means for automatically increasing the length of travel of the shovel in opposition to the tension means from its shortest travel to its longest travel during a predetermined number of shovel movements and then returning it to its shortest travel again, means for automatically stopping the shovel actuating means at the end of the predetermined number of movements and when said shovel has reached its maximum travel, and then automatically starting the shovel actuating mechanism, whereby the shovel will begin each series of movements at its shortest travel.

8. A mechanical stoker comprising a shovel compartment, a shovel shaft therein, a shovel carried by said shaft within the said compartment, a tension spring connected at one of its ends to said shaft and adapted to move the shovel through its fuel throwing movement, a support for the other end of said spring, means connected to said spring and having a sliding engagement with the support and a resilient means interposed between the said support and the spring connection, said resilient means being compressible under a strain insufficient to extend the shovel actuating spring.

9. A mechanical stoker comprising a shovel compartment, a shovel shaft therein, a shovel carried by said shaft within the said compartment, a tension spring connected at one of its ends to said shaft and adapted to move the shovel through its fuel throwing movement, a support for the other end of the spring, means connected to said spring and having a sliding engagement with the support, and a compression spring interposed between the said support and the spring connection, said compression spring being compressible under a strain insufficient to extend the shovel actuating spring.

10. A mechanical stoker comprising a shovel compartment, a shovel shaft therein, a shovel carried by said shaft within the said compartment, a tension spring connected at one of its ends to said shaft and adapted to move the shovel through its fuel throwing movement, a support for the other end of the spring, means connected to said spring and having a sliding engagement with the support, and a compression spring interposed between the said support and the spring connection, said compression spring being compressible under a strain insufficient to extend the shovel actuating spring, and means for adjusting the connection between the shovel actuating spring and the compression spring whereby the strain required to further compress the compression spring may be varied.

11. A mechanical stoker comprising a shovel compartment, a shovel shaft therein, a shovel carried by said shaft within the said compartment, a tension spring connected at one of its ends to said shaft and adapted to move the shovel through its fuel throwing movement, a support for the other end of the spring, a rod connected to said spring and having a sliding engagement with the support, an adjustable nut on said rod and a compression spring interposed between said nut and the support, said compression spring being compressible under a strain insufficient to extend the shovel actuating spring whereby the said compression spring will be compressed before the shovel actuating spring is extended and will resume its normal position after the shovel actuating spring has returned to its normal position.

12. A mechanical stoker comprising a vibratory shovel, means for imparting fuel throwing movements to said shovel, means to vary the force of the shovel movements during a number of movements, and means for automatically arresting the shovel actuating mechanism at the end of each of said number of movements and for starting said

mechanism again at the end of a period of rest or dwell, whereby the shovel movements will be divided into groups and the fuel will be delivered over the grate by a series of varying throws and the shovel will be arrested for a given period on the completion of each group of throws or movements.

13. A mechanical stoker comprising a shovel compartment, a shovel shaft, a shovel carried by said shaft, a coil contractile spring connected at one of its ends to said shaft and adapted to be extended when the shovel is moved to its fuel throwing position and to contract to move the shovel through its fuel throwing movement, a support, means connected to the other end of said spring and having a sliding engagement with the support, a stop carried by said means beyond the support, and a compressible, resilient means interposed between the said stop and the support and adapted to be compressed against the support when the coil spring is extended, said resilient means expanding when the coil spring is released to move the shovel and to return to its normal position.

14. A mechanical stoker comprising a shovel compartment, a shovel shaft, a shovel carried by said shaft, a coil contractile spring connected at one of its ends to said shaft and adapted to be extended when the shovel is moved to its fuel throwing position and to contract to move the shovel through its fuel throwing movement, a support, means connected to the other end said spring and having a sliding engagement with the support, a stop carried by said means beyond the support, and a compression spring interposed between said stop and the support, whereby said compression spring will be compressed when the coil spring is extended and will be permitted to expand when the coil spring returns to its normal position.

15. A mechanical stoker comprising a shovel compartment, a shovel shaft therein, a shovel carried by said shaft, a coil contractile spring connected at one of its ends to said shaft and adapted to be extended when the shovel is moved to its fuel-throwing position and to contract when the shovel is released, a support, a rod connected to the end of the spring and having a sliding engagement with said support, a stop on the end of said rod beyond the support, a compression spring arranged between said stop and the support and adapted to be compressed by said stop when the contractile spring is extended and to expand when the contractile spring returns to its normal position to thereby prevent undue vibrations of the contractile spring.

In testimony whereof I hereunto affix my signature in the presence of two witnesses this 29th day of July 1908.

JOHN A. CALDWELL.

Witnesses:
E. H. H. KAUFMANN,
WM. R. DAVIS.