May 6, 1941. W. J. HATHAWAY ET AL 2,241,129

LOCOMOTIVE STOKER

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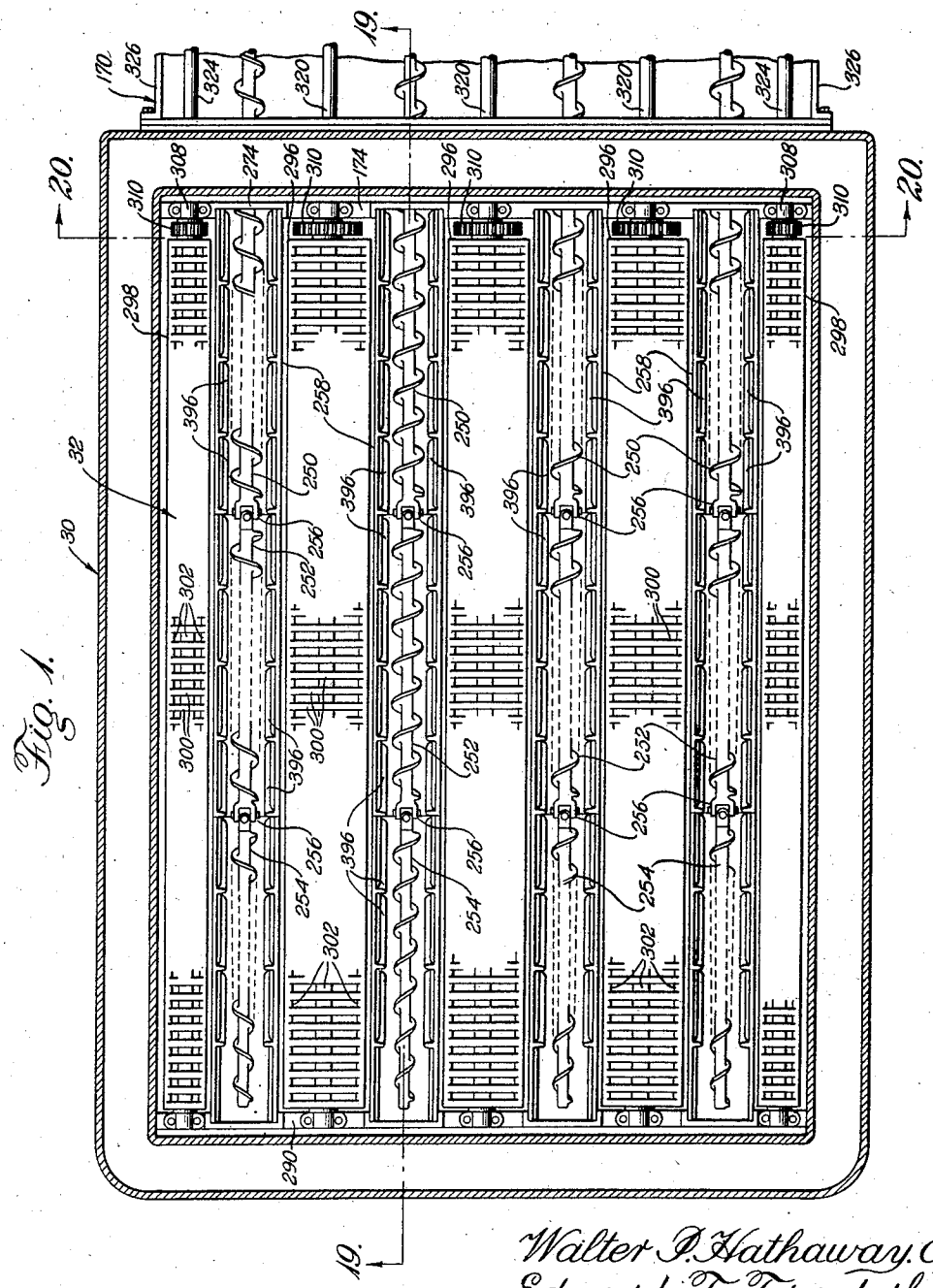


Fig. 1.

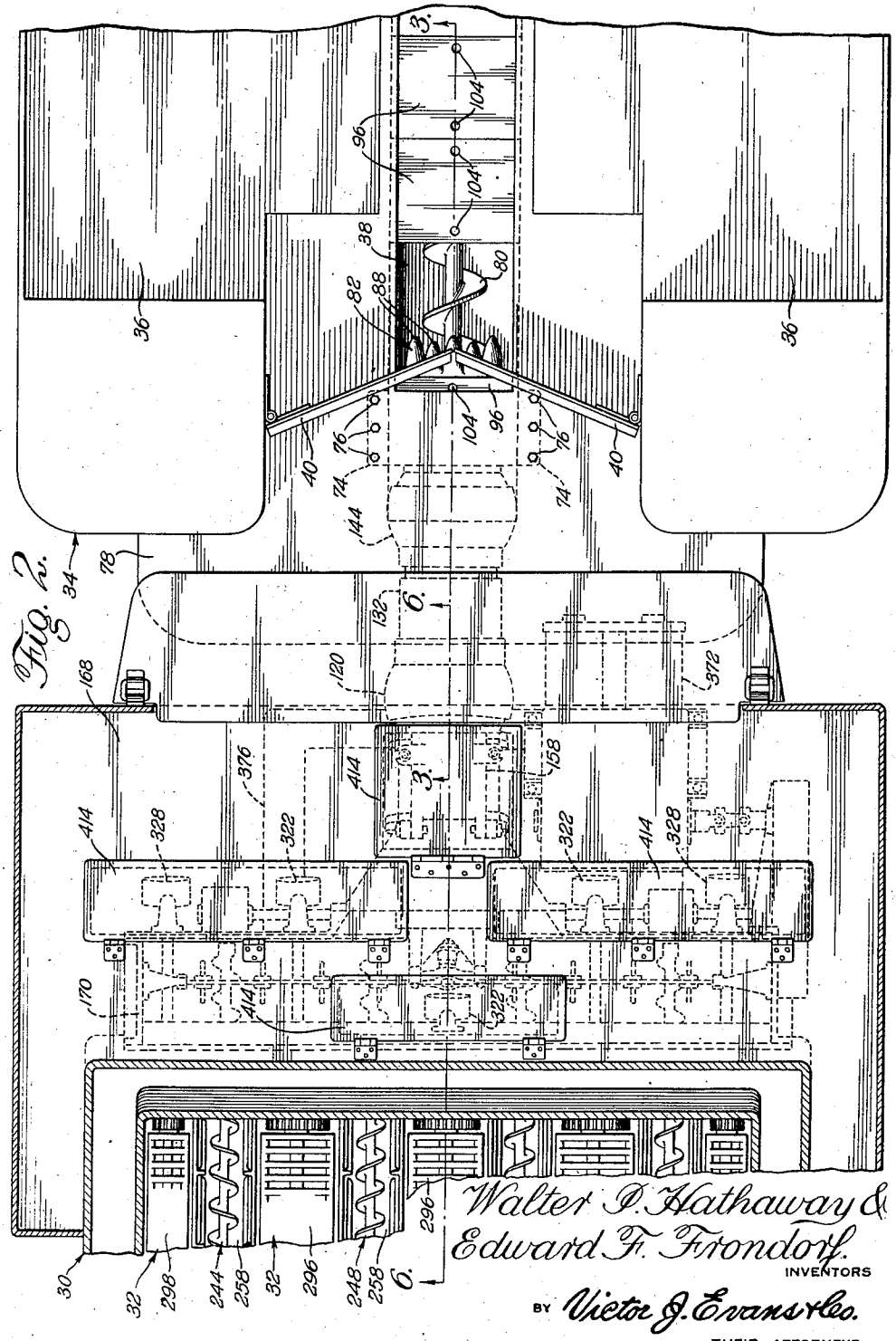
Walter J. Hathaway &
Edward F. Frondorf.
INVENTORS

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LOCOMOTIVE STOKER

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LOCOMOTIVE STOKER

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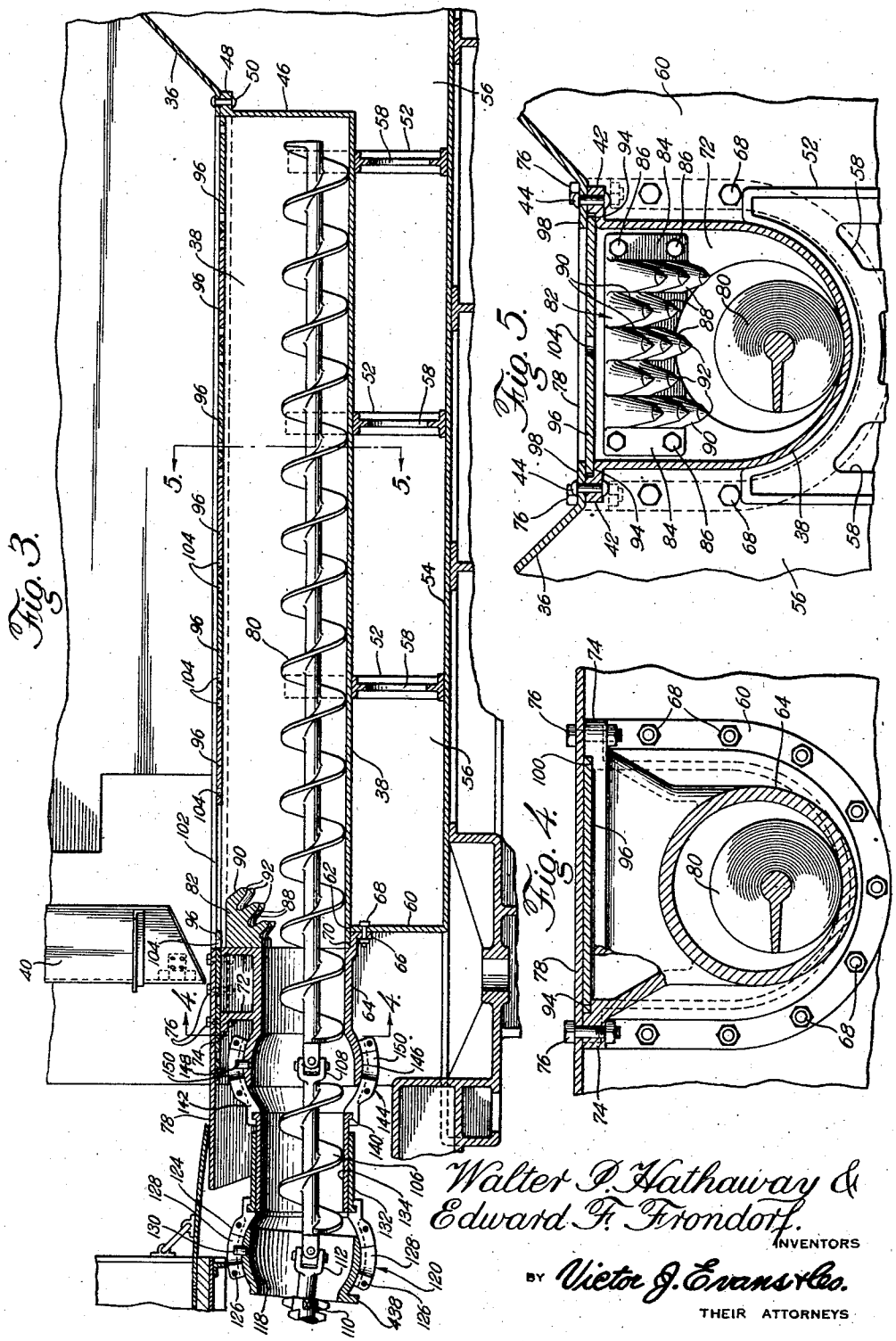


Fig. 3.

Fig. 5.

Fig. 4.

Walter P. Hathaway &
Edward F. Frondorf.
INVENTORS

BY Victor J. Evans & Co.
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LOCOMOTIVE STOKER

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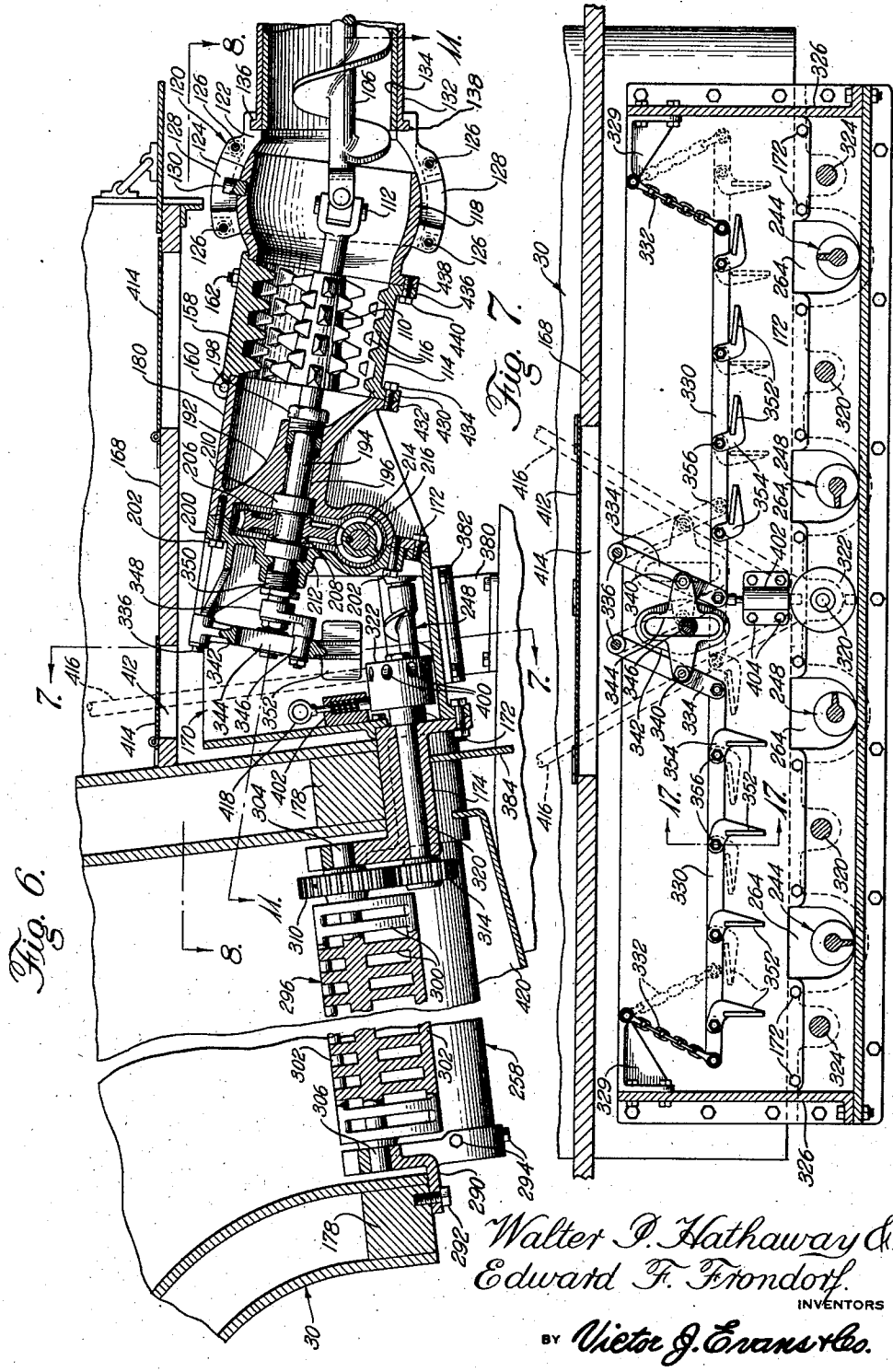


Fig. 6.

Fig. 7.

Walter J. Hathaway &
Edward F. Frondorf.
INVENTORS

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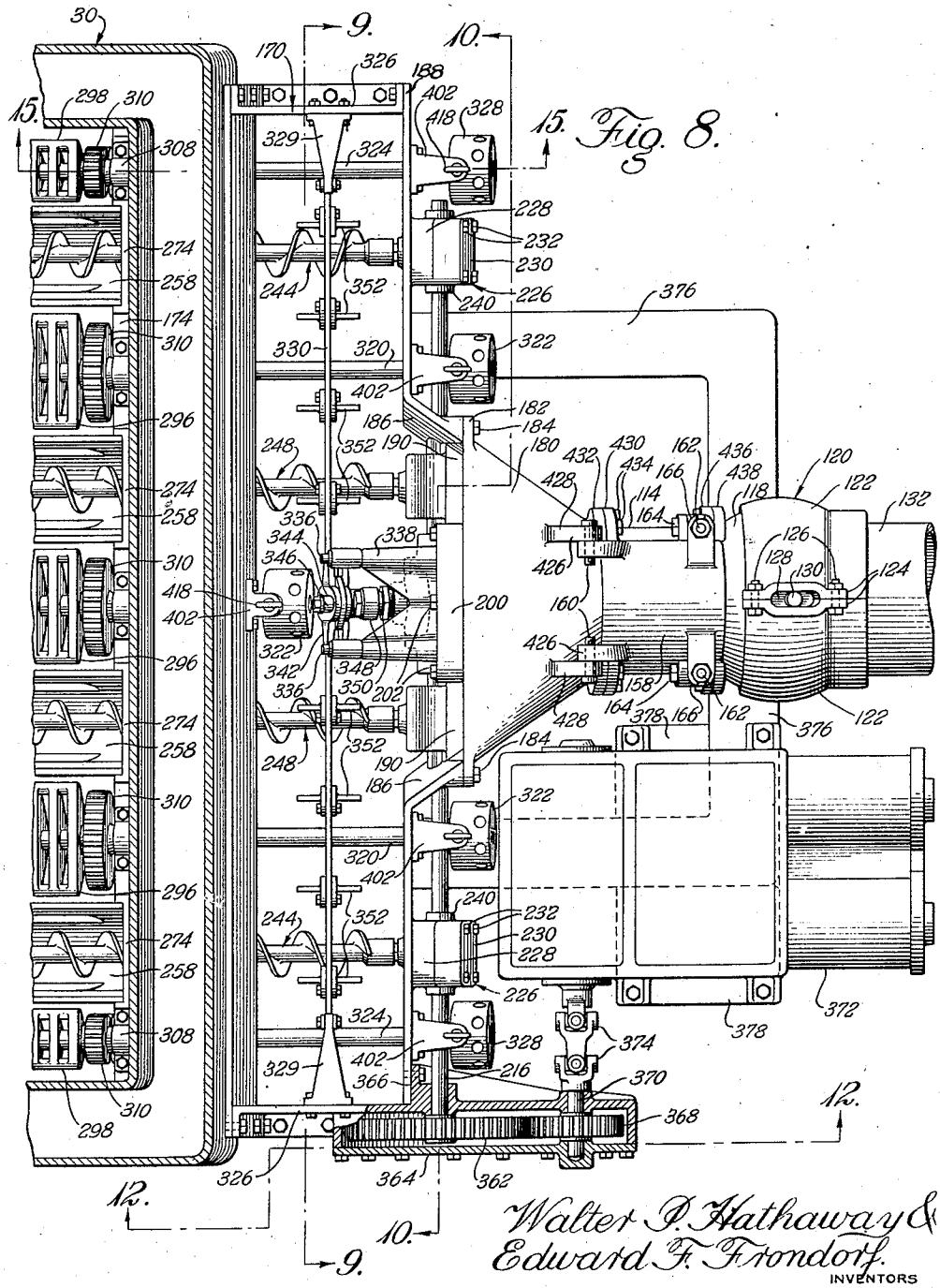


Fig. 8.

Walter J. Hathaway &
Edward F. Frondorf.
INVENTORS

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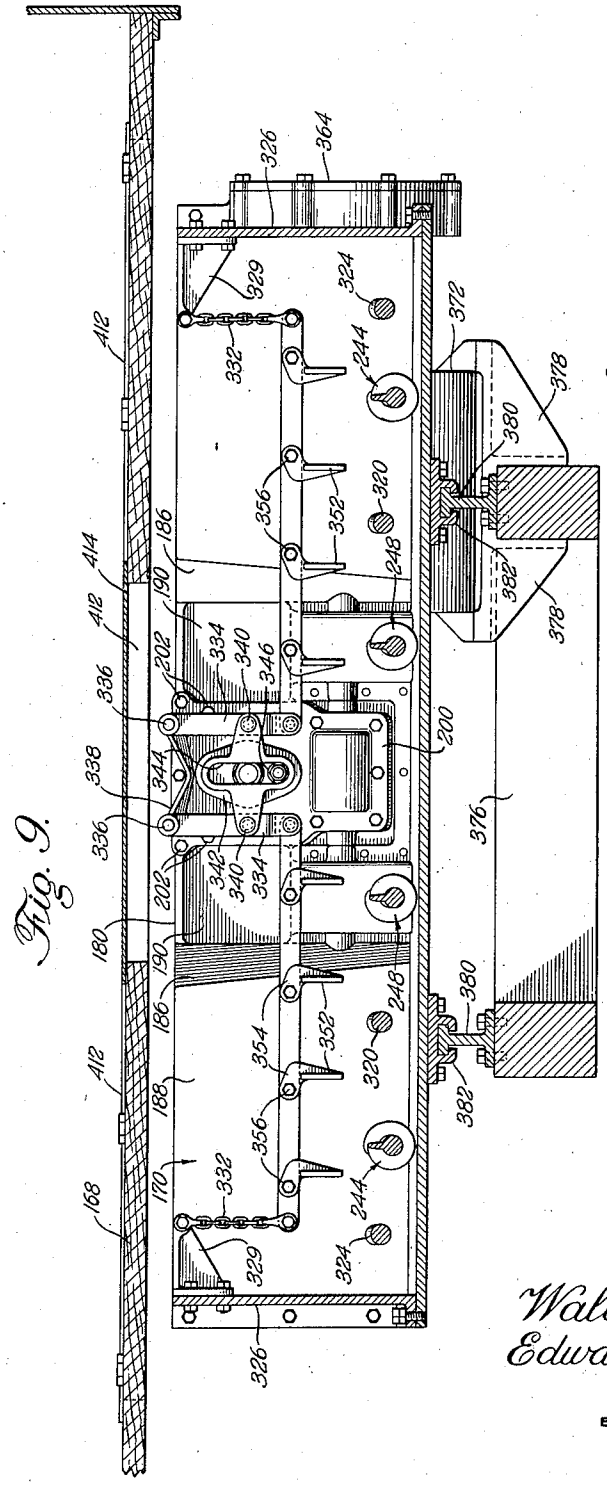


Fig. 9.

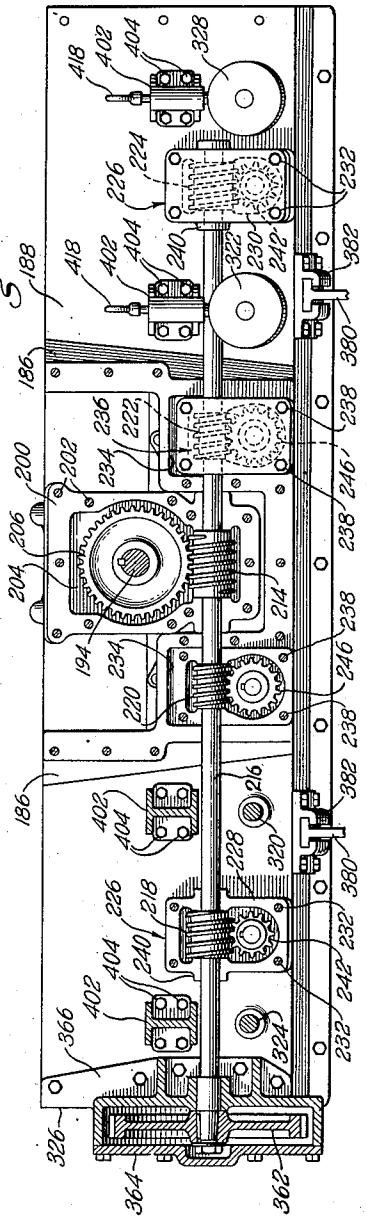


Fig. 10.

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Edward F. Frondorf.
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Fig. 11.

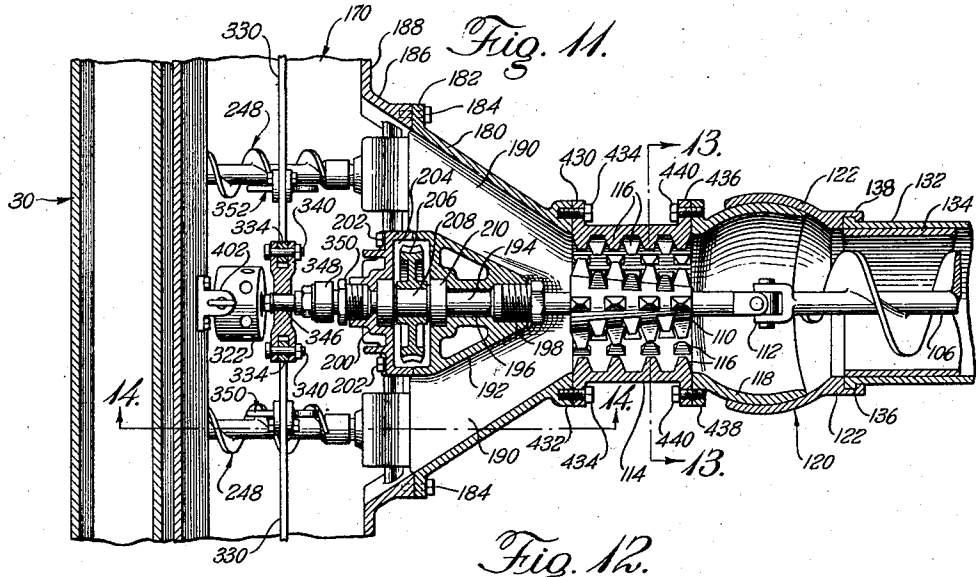


Fig. 12.

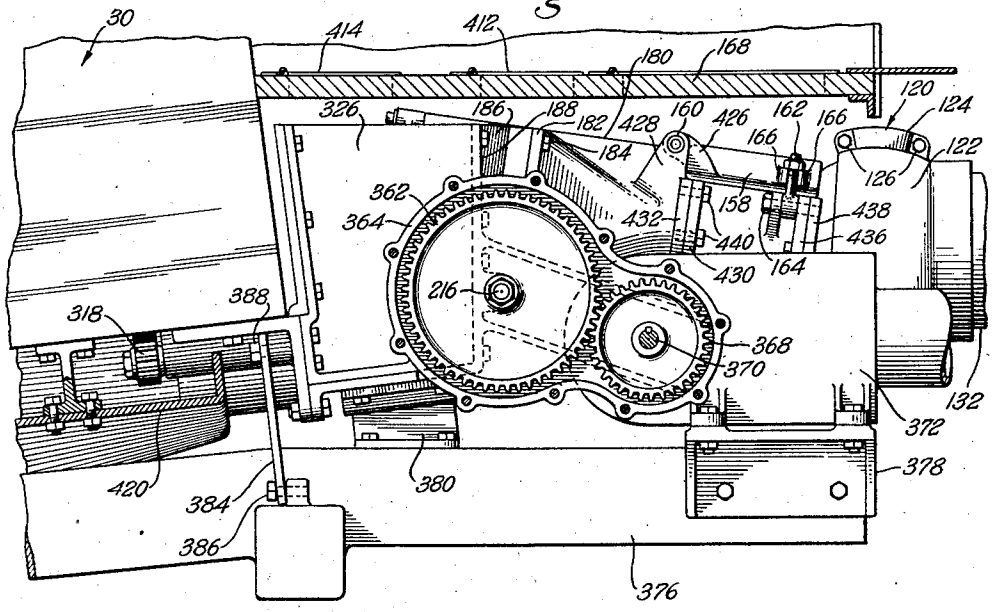
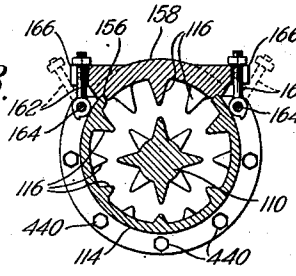


Fig. 13.



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Edward F. Frondorf.
INVENTORS

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Fig. 14.

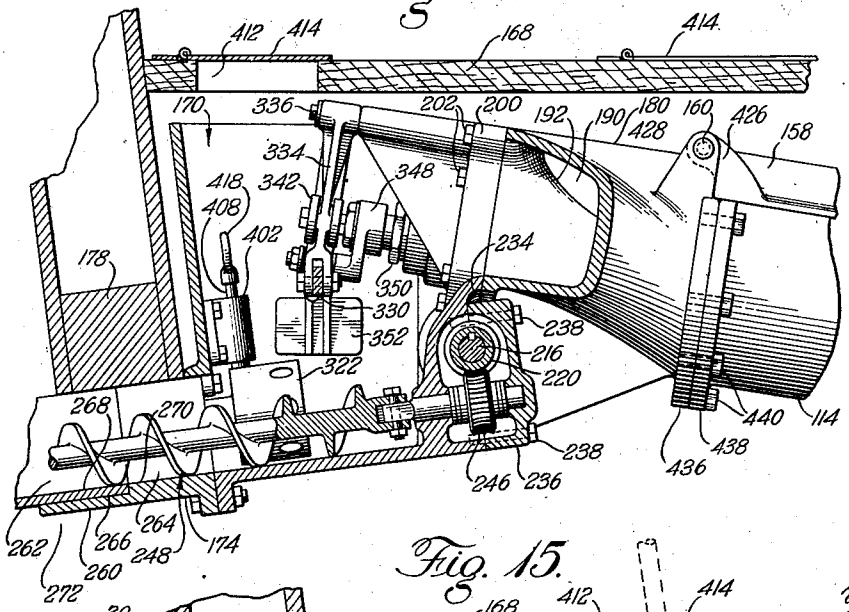


Fig. 15.

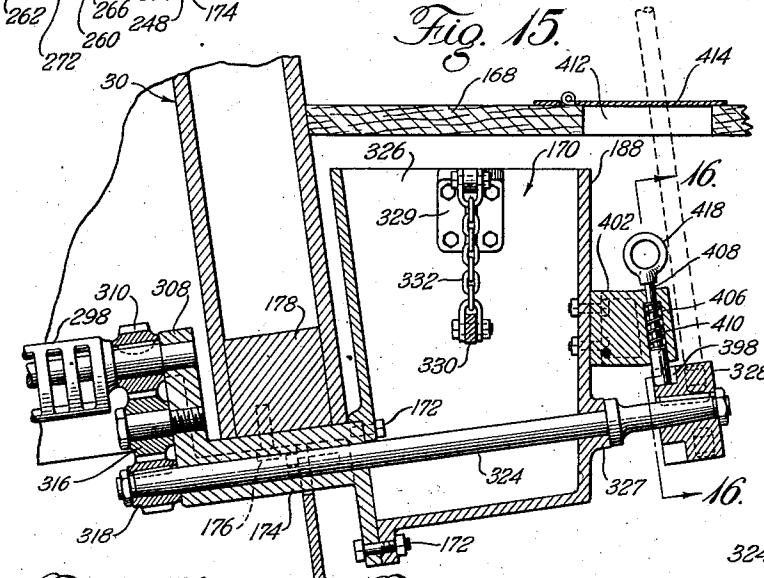


Fig. 16.

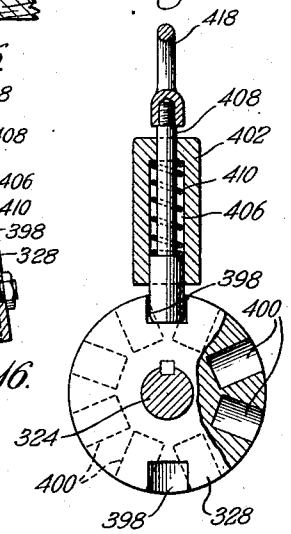


Fig. 17.

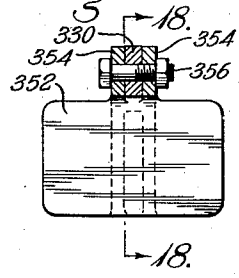
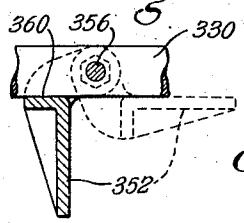


Fig. 18.



Walter P. Hathaway &
Edward F. Frondorf
INVENTORS

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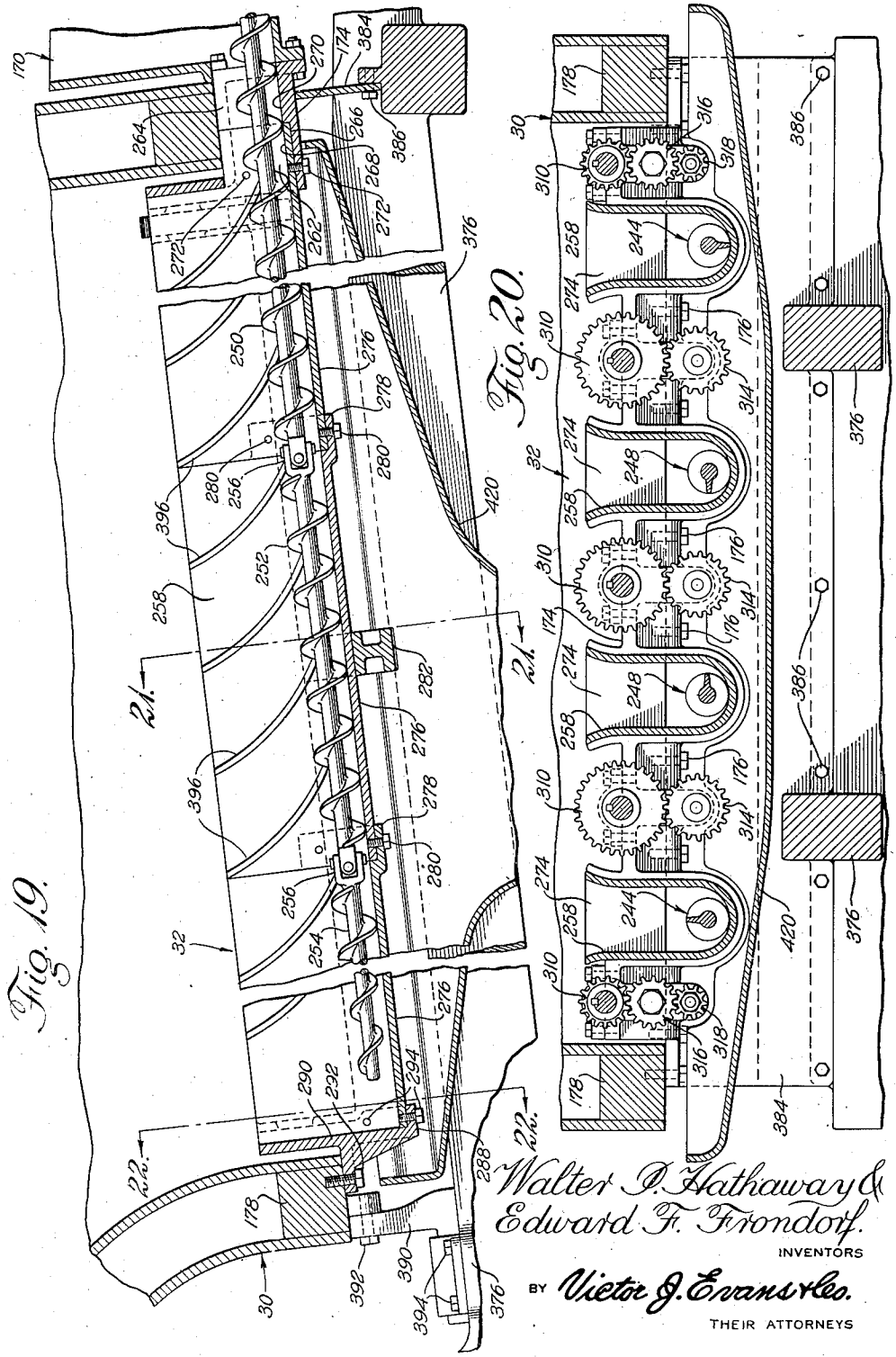


Fig. 19.

Fig. 20.

Walter J. Hathaway &
Edward F. Frondorf.
INVENTORS

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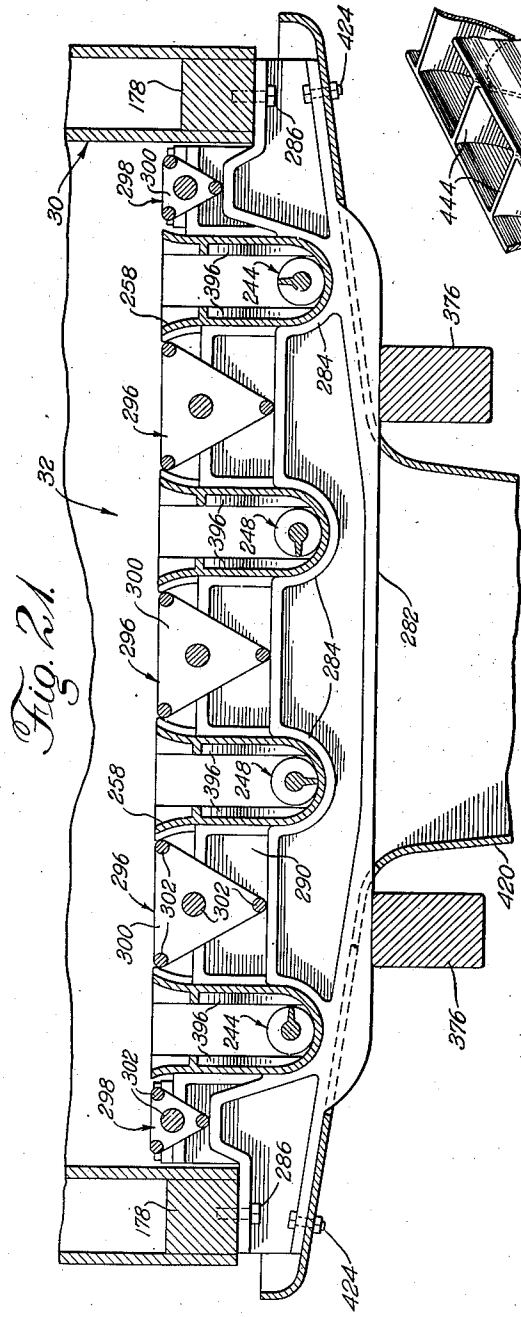


Fig. 21.

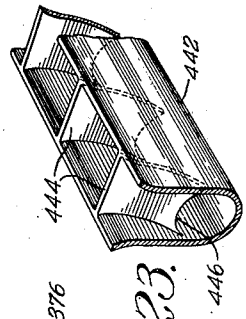


Fig. 23.

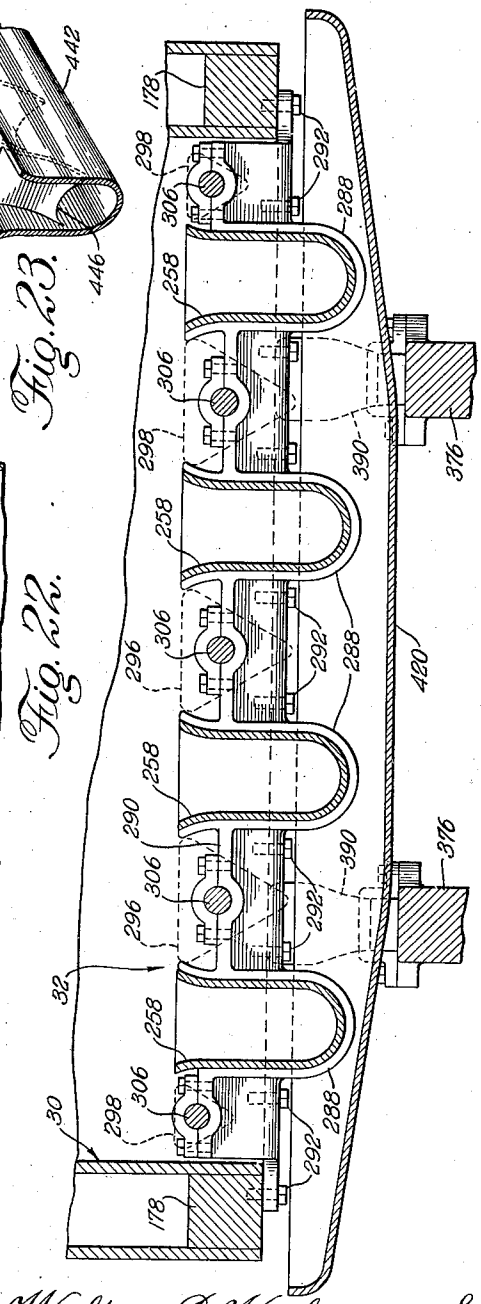


Fig. 22.

Walter J. Hathaway &
Edward F. Frondorf.
INVENTORS

BY Victor J. Evans & Co.
THEIR ATTORNEYS

Patented May 6, 1941 2,241,129

UNITED STATES PATENT OFFICE

2,241,129

LOCOMOTIVE STOKER

Walter J. Hathaway, Kankakee, Ill., and Edward F. Frondorf, Harrison, Ohio

Application January 3, 1938, Serial No. 183,190

5 Claims. (Cl. 110—44)

Our invention relates to locomotives and includes among its objects and advantages the provision of an improved underfed stoker.

In the present types of overfed locomotive stokers, large quantities of unburned fuel and gases are thrown out of the stack. In the stokers employing steam jets for distributing the coal in the fire box, variation in size of the coal as well as its specific gravity have a direct bearing on the proper distribution of the coal in the fire box. The coal varies in size and weight. At times it is dry and at other times wet. It may be hard or soft, any of which conditions makes it difficult to secure proper distribution by steam jets. In connection with the steam jet method of distribution, high and low steam pressures necessitate adjustment of the steam jets. Travelling on up or down grades will also modify the distribution. In many cases the jet openings become worn and will, thereby, decrease the efficiency of coal distribution. Because of the variable nature of the physical condition of the fuel as well as steam pressure, much of the fireman's time is directed to the proper control of the steam jets.

An object of our invention is to provide a locomotive stoker so designed as to feed fuel to the fire box from underneath the fire bed in an efficient manner.

Another object is to provide a locomotive stoker of the underfed type in which the fuel is delivered to the combustion zone in such a manner as to effectively burn all the gases as well as the finer particles of the coal.

A further object is to provide a stoker in which the fuel from the fuel bin is divided into a plurality of streams and delivered to the combustion zone of the fire box from beneath the fire bed in a uniform and efficient manner.

Another object is to provide a locomotive stoker designed to deliver coal to the combustion zone in a positive manner regardless of the physical nature of the coal, steam pressure, or inclination of the road bed.

Another object is to provide a locomotive stoker capable of operating in an efficient manner with little attention on the part of the fireman, thereby enabling the operator to give more attention to other engine duties.

Another object is to provide a locomotive stoker in which a conveyor in the nature of a screw is located underneath the coal bin of the tender within the water compartment thereof and in which the screw and the crushers associated therewith are arranged in a compact manner together with a simple driving mechanism for the screw.

A further object is to provide a locomotive stoker employing a conveyor screw located underneath the coal bin of the tender within the water compartment thereof and in which the driving mechanism for the screw is located forwardly of the tender in contradistinction to drives connected with the rear end of the screw, thereby conserving space in the tender and water compartment so as not to reduce the capacity thereof.

Another object is to provide a locomotive stoker capable of feeding fuel to the combustion zone from beneath the same in such a manner as to attain efficient combustion and smokeless operation.

Another object is to provide a locomotive stoker designed to maintain a uniform fuel bed in the fire box but in which a larger volume of fuel may be maintained therein so as to secure a hot fire with less draft, thus eliminating the necessity of constricting the engine exhaust nozzle as is done in conventional practice, thus reducing the back pressure effective on the engine cylinders so as to render the locomotive more efficient at high speeds.

A further object is to provide a locomotive stoker including an efficient conveyor system for delivering fuel to the fire box in a noiseless manner, thereby eliminating the hissing noise peculiar to stokers embodying steam distributing jets, thus facilitating the communication of signals and the oral reading of train orders between the fireman and engineer.

Another object is to provide a stoker in which the conveyor system conveys fuel underneath the floor of the cab and is delivered to the fire box from beneath the fire bed, thus eliminating the accumulation of dust in the cab.

A further object is to provide a locomotive stoker embodying primary and secondary crushers and in which the secondary or final crusher is so designed and located as to be readily accessible for removal of foreign matter in the nature of obstructions and in which the final crusher is readily accessible regardless of the amount of fuel carried in the tender.

In the accompanying drawings:

Fig. 1 is a sectional view of a locomotive boiler illustrating the fire box provided with our underfeed stoker;

Fig. 2 is a fragmentary top plan view of the

tender and a portion of the fire box illustrated in section;

Fig. 3 is a sectional view along the line 3—3 of Fig. 2;

Fig. 4 is a sectional view along the line 4—4 of Fig. 3;

Fig. 5 is a sectional view along the line 5—5 of Fig. 3;

Fig. 6 is a sectional view along the line 6—6 of Fig. 2;

Fig. 7 is a sectional view along the line 7—7 of Fig. 6;

Fig. 8 is a sectional view along the line 8—8 of Fig. 6;

Fig. 9 is a sectional view along the line 9—9 of Fig. 8;

Fig. 10 is a sectional view along the line 10—10 of Fig. 8;

Fig. 11 is a sectional view along the line 11—11 of Fig. 6;

Fig. 12 is a sectional view along the line 12—12 of Fig. 8;

Fig. 13 is a sectional view along the line 13—13 of Fig. 11;

Fig. 14 is a sectional view along the line 14—14 of Fig. 11;

Fig. 15 is a sectional view along the line 15—15 of Fig. 8;

Fig. 16 is a sectional view along the line 16—16 of Fig. 15;

Fig. 17 is a sectional view along the line 17—17 of Fig. 7;

Fig. 18 is a sectional view along the line 18—18 of Fig. 17;

Fig. 19 is a sectional view along the line 19—19 of Fig. 1;

Fig. 20 is a sectional view along the line 20—20 of Fig. 1;

Fig. 21 is a sectional view along the line 21—21 of Fig. 19;

Fig. 22 is a sectional view along the line 22—22 of Fig. 19; and

Fig. 23 is a perspective view of a portion of a modified form of retort.

In the embodiment selected to illustrate our invention, we make use of a conventional boiler 30 including the usual fire box 32 (see Fig. 1). The boiler 30 of the locomotive is associated with a tender 34 partially illustrated in Fig. 2. The tender includes the usual slope sheets 36 which direct coal to our trough 38. The tender is also provided with hinged doors 40 which may be opened inwardly but are so arranged as to abut at their free ends to take the closing position of Fig. 2. As illustrated in Figs. 3 and 5, the trough 38 includes side flanges 42 which are riveted to the slope sheets 36 at 44. The rear end of the trough 38 is closed, as at 46, and includes a flange 48 riveted at 50 to one of the slope sheets 36.

A plurality of brackets 52 is secured on the bottom 54 of the tender as by welding. The trough 38 is illustrated as having a curved bottom with the brackets 52 shaped to conform to the curvature thereof for effectively supporting the trough. Our trough 38 lies within the water compartment 56 of the tender, but its flanges 42 and 48 are arranged in water-tight relation to the slope sheets 36 so as to prevent the entrance of water into the coal bin defined by the slope sheets and the wall structure of the tender, not illustrated. The brackets 52 are opened, as at 58, to permit circulation of water. The tender structure in general is old and well known in the art and need not be described in further detail.

Referring to Figs. 3 and 4, the bottom 54 includes an upstanding wall 60 at the forward end of the tender, which wall includes an opening 62 for the reception of the forward end of the trough 38. To the outer face of the wall 60 we mount a tubular neck 64 which includes a flange 66 secured to the wall by bolts 68. Flange 66 is arranged in water-tight relation with the wall 60 while the forward end of the trough 38 has a water-tight fit with the neck 64, as at 70. Neck 64 includes webs 72 cast integrally with the flange 74 bolted at 76 to the deck 78 of the tender 34. Flange 74 is in water-tight relation with the deck.

Within the trough 38 we mount a screw conveyor 80 which normally lies on the curved bottom of the trough. The screw extends substantially the full length of the trough with its forward end extending through the neck 64. To the inner web 72 we mount a crusher head 82. In Fig. 5, the crusher head 82 includes flanges 84 provided with openings for the reception of bolts 86 threaded into the rear web 72 of the neck 64. The crusher head 82 includes a plurality of teeth 88 which have their ends terminating substantially in a common plane and at an angle of about 45° to the axis of the screw 80. The teeth are of generally tapered configuration, as at 90, with their outer ends terminating in sharp points 92.

Coal delivered to the trough 38 is advanced in the direction of the crusher head 82, which head breaks up the large lumps as they are advanced by the screw. In arranging the ends of the teeth 88 in the angular plane previously described, accommodation is provided for relatively large lumps. The lower row of teeth 88 is spaced closely to the screw, but the angularity of all the teeth is such as to permit the large lumps to pass underneath the crusher head. If the lumps wedge between the crusher head and the screw, the screw advances the lumps while the teeth break up the lumps in such proportions as to feed easily through the neck 62.

In Figs. 3, 4 and 5, the side walls of the trough 38 are recessed at 94 to receive the marginal edges of plates 96. These plates are slidably housed within the recesses 94 by the flanges 98 of the side slope sheets 36. The flange 74 of the webs 72 is also recessed at 100 in the same manner as the flanges 42.

Fig. 3 illustrates one of the plates 96 as being positioned underneath the deck 78, at which time an opening 102 is provided through which coal from the tender may enter the trough 38. As the coal supply at the forward end of the tender is used, the next plate 96 may be pulled forwardly for shifting the opening 102 under the coal. Thus, the plates 96 cover the major portion of the trough 38, but the plates may be shifted as the coal is used to establish communication between the trough and the coal bin. To facilitate adjustment of the plates 96, each plate is provided with a plurality of openings 104 for the reception of a hook.

To the forward end of the screw 80 we connect a short screw 106 by a universal joint 108 (see Fig. 3). The forward end of the screw 106 is connected with a crushing spool 110 through the medium of a universal joint 112 (see Figs. 6 and 11). Figs. 11 and 13 illustrate the crushing spool 110 as being positioned inside a tubular neck 114 having crushing teeth 116. Neck 114 is con-

nected with a curved head 118 upon which we mount a coupling member 120 (see Figs. 6, 8, 11 and 12). Coupling member 120 comprises sections 122 provided with abutting flanges 124 connected by bolts 126. The flanges are positioned on diametrically opposite sides of the coupling member with the flanges shaped to provide openings 128.

The head 118 carries a pin 130 which extends into the opening 128 in the upper flanges 124. Coupling member 120 is so related to the head 118 as to provide a universal joint. In other words, the upper opening 128 is of sufficient length to permit relative movement of the pin 130 in one direction while movement of the head in a plane at right angles thereto is about the pin 130 as an axis.

Coupling member 120 is connected with an outer slip sleeve 132 which embraces an inner slip sleeve 134 (see Figs. 6 and 11). At one end of the outer slip sleeve 132, we provide a flange 136 which is retained within a groove 138 in both sections 122 of the coupling member 120. Because of the split character of the coupling member, the flange 136 may extend completely about the circumference of the slip sleeve 132 so as to provide a good connection. Fig. 3 illustrates the inner slip sleeve 134 as being provided with a flange 140 connected with the sections 142 of a coupling member 144 identical in construction with the coupling member 120. Only one of the sections 142 is illustrated in Fig. 3.

Neck 64 includes a head 146 of the same construction as the head 118, and the coupling member 144 is connected with the head 146 in the same manner as the head 118 is connected with the coupling member 120. Head 146 is also provided with a pin 148 lying within an opening 150 corresponding to the opening 128. The universal joint 108 is located in axial alignment with the pin 148 while the universal joint 112 is located in axial alignment with the pin 130. Coupling member 144 is connected with the head 146 for universal movement in the same manner as the head 118 is connected with the coupling member 120.

Slip sleeves 132 and 134 are slidably related so as to accommodate slack between the locomotive and the tender. The sleeves constitute a conduit establishing communication between the necks 64 and 114, and the outer slip sleeve 132 may rotate about the inner slip sleeve 134 to accommodate relative swaying between the locomotive and the tender. The sections 122 of the coupling member 120 fixedly clamp the outer slip sleeve 132 against relative rotation while the sections 142 of the coupling member 144 fixedly clamp the inner slip sleeve 134.

The lower openings 128 and 150 in the coupling members 120 and 144, respectively, provide drains for any water which might be in the coal. The two coupling members fit sufficiently loose with respect to their respective heads 118 and 146 to permit free relative movement and the passage of water. Crusher head 82 constitutes a primary crusher while the crushing spool 110 and the toothed neck 114 constitute a secondary or finishing crusher. Coal processed by the secondary crusher is ready for delivery to the fire box of the locomotive.

Teeth 116 (see Figs. 11 and 13) extend about the inner face of the neck 114, but shorten progressively in the direction of the bottom area as indicated at 152. The teeth 116 define an opening of sufficient diameter to permit the screw 80 to be pushed through the neck 114, as when assembling or disassembling. In Figs. 8, 12 and 13, we illustrate the neck as being provided with an opening 156 closed by a cover 158 which carries some of the teeth 116. The cover is hingedly connected at 160 and is latched to the neck 114 by bolts 162 hingedly connected at 164 with the neck. Two spaced lugs 166 are provided on each side of the cover 158 to facilitate connection with the bolts 162.

Underneath the cab deck 168 we mount a hopper 170 (see Figs. 6, 7, 8, 9, 11 and 12). Hopper 170 extends transversely of the locomotive and is bolted at 172 to a bracket 174 bolted at 176 to the mud ring 178 of the locomotive. Referring to Figs. 6, 8, 11 and 14, the neck 114 is connected with a head 180 flanged at 182 and bolted at 184 to the flange 186 carried by the rear wall 188 of the hopper 170. Head 180 includes diverging conduits 190 communicating with the neck 114 and the hopper 170. The head 180 also includes a coal dividing rib 192 which co-operates with the head 180 to define the conduits 190.

The spool 110 includes a shaft 194 which extends through the bore 196 in the dividing head 192. The head 192 is provided with a packing gland 198 which prevents coal dust and the like from entering the bore. To the dividing head 192 we mount a bracket 200 by bolts 202. The head 192 and the bracket 200 are so shaped as to provide a gear box 204 within which we mount a worm wheel 206 fixedly mounted on the enlarged reach 208 of the shaft 194.

Thrust bearings 210 and 212 are associated with the dividing head 192 and the bracket 200 for restraining the shaft 194 from relative longitudinal movement. While the crushing spool 110 and the screws 106 and 80 are connected in end to end relation, the screws 80 and 106 may slide relatively to the trough 38 and the inner slide sleeve 134 to accommodate telescopic shifting between the slide sleeves 132 and 134.

Worm wheel 206 is arranged in mesh with a worm 214 keyed to a shaft 216 extending longitudinally of the hopper 170 exteriorly of its rear wall 188. A plurality of worm gears 218, 220, 222, and 224 is keyed to the shaft 216 (see Fig. 10). The worm gears 218, 220, 222 and 224 are housed within gear boxes 226. The gear boxes 226 associated with the worm wheels 218 and 224 each comprises a body 228 cast integrally with the rear wall 188 of the hopper 170 and a cover 230 detachably coinnected with its respective body by bolts 232 (see Figs. 8 and 10).

The head 180 includes pockets 234 (see Figs. 8 and 10), which pockets house the worm gears 220 and 222. These pockets are enclosed by covers 236 made secure by bolts 238. Gear boxes 226 include bearings 240 for supporting the shaft 216. The worm gears 218 and 224 are arranged in mesh with worm wheels 242 keyed to screws 244 (see Figs. 8 and 10). Worm gears 220 and 222 are arranged in mesh with worm wheels 246 keyed to screws 248. Screws 244 and 248 extend transversely through the hopper 170 in close relation with its bottom, as illustrated in Figs. 7 and 9. Referring to Figs. 1 and 20, the screws 244 and 248 extend into the fire box 32.

All the screws 244 and 248 are made up of sections 250, 252 and 254 arranged in end to end relation and connected by universal joints 256. In Figs. 1 and 19, it will be noted that the screws 244 and 248 taper gradually inwardly of the fire box throughout their entire length. Each of the screws lies within a retort 258 (see Figs. 1, 8, 14,

19 and 20). In Figs. 19, 21 and 22, we illustrate the retorts 258 as being substantially U-shaped in cross section and opening up with the upper margins of the side walls flared outwardly.

The bracket 174 extends the full width of the boiler 30 and includes U-shaped formations 260 which embrace the rear ends of the retorts 258 for supporting purposes (see Figs. 1 and 20). In Fig. 19, we illustrate one of the retorts as having an extension 262 extending into the opening 264 in the bracket 174. The bracket is recessed at 266 to bring its bottom 268 flush with the bottom 270 of the opening 264, which opening establishes communication between the retort and the hopper 170.

Screws 272 connect the extension 262 with the bracket 174. The bracket 174 includes plates 274 which close the rear ends of the retorts 256 above the extensions 262 (see Figs. 19 and 20). Each retort 258 is made up of sections 276 having overlapping relation, as at 278, and connected by screws 280 (see Fig. 19). All the retorts are connected in the same manner.

In Figs. 19 and 21, a cross beam 282 affords support for the retorts 258 intermediate their ends. The beam 282 includes curvatures 284 which embrace the curved bottoms of the retorts, and the ends of the beam are secured to the mud ring 178 by bolts 286. The forward ends of the retorts 258 are supported within the U-shaped formations 288 of a bracket 290 bolted to the mud ring 178, as at 292 (see Fig. 22). Bolts 294 securely fasten the forward ends of the retorts to the bracket 290 (see Fig. 19).

Between the retorts 258 we mount grates 296. In Figs. 1, 8 and 21, we illustrate the retorts 258 and the grates 296 as being arranged in alternate relation with a small grate 298 positioned between each side wall of the boiler and the retort adjacent thereto. All the grates are of triangular configuration in cross section, each comprising spaced triangular plates 300 integrally connected through the medium of spacers 302 (see Figs. 8 and 21). The central spacers 302 extend beyond each end of the grates to provide shafts 304 and 306 for rotatably mounting the grates (see Fig. 6). The shafts 304 are journaled in bearings 308 on the bracket 174 (see Figs. 6, 15 and 20), while the shafts 306 are journaled in the same manner on the bracket 290. In Fig. 21, we illustrate the normal positions of the grates 296, at which time their top surfaces lie in a plane common to the upper edges of the retorts 258. In the positions of the grates illustrated in Fig. 21, their lower points rest on the beam 282 for support.

To the shafts 304 we fixedly connect gears 310. In Figs. 1 and 20, we illustrate the gears 310 associated with the grates 296 as being of uniform diameter, but larger than the gears associated with the side grates 298. Fig. 20 illustrates the bearings 308 associated with the shafts 304 of the side grates 298 as being elevated above the other bearings to bring the top surfaces of the smaller grates 298 in a common plane with the grates 296. Fig. 22 illustrates the bracket 290 as being provided with bearings 312 for supporting the shafts 306 at the opposite ends of the grates.

In Fig. 20, we illustrate the gears 310 of the grates 296 as being arranged in mesh with gears 314, while the gears 310 associated with the side grates 298 are in mesh with idle gears 316, which in turn are in mesh with gears 318. Gears 314 are each connected with a shaft 320 rotatably journaled in the bracket 174 as illustrated in Fig. 6. Each shaft 320 is provided with an actuating head 322 with the central head located inside the hopper 170 and the two other heads located outside the hopper adjacent the rear wall 188. Gears 318 are keyed to shafts 324 journaled in the bracket 174 (see Fig. 15). Shafts 324 extend through the hopper 170 and are supported as at 327 in addition to being provided with actuating heads 328 corresponding to the heads 322. The shafts 320 associated with the two grates adjacent the central grate extend through the hopper in the same manner as shafts 324.

Coal from the tender 34 is delivered to the hopper 170 through the medium of the conduits 190. The conduits 190 deposit the coal into the hopper 170 at a midpoint but means are provided for distributing the coal throughout the entire length of the hopper into operative relation with all the screws in the fire box. To this end attention is directed to Figs. 7, 8 and 9. To the end walls 326 of the hopper we connect brackets 329 for supporting the outer ends of the bars 330 through the medium of chains 332. The inner ends of the bars 330 are pivotally connected with the lower ends of links 334. The upper ends of the links 334 are pivotally connected at 336 with a bracket 338 carried by the bracket 200. Bars 330 parallel the bottom of the hopper 170 and are located substantially midway between its top and bottom. Links 334 are arranged in parallel relation and also parallel the chains 332. These links are pivotally connected at 340 with an eccentric 342 slotted at 344 for the reception of the bushing 346 carried by the crank 348, which in turn is fixedly connected with the shaft 194, best illustrated in Fig. 6. The bracket 200 includes a packing gland 350 which embraces the shaft 194 adjacent the crank 348.

Each bar 330 carries a plurality of paddles 352 (see Figs. 7, 9, 17 and 18). The paddles 352 are provided with spaced flanges 354 pivotally connected with the bars 330 by bolts 356 (see Figs. 17 and 18). The bolts 356 are located forwardly of the faces 358 so that the paddles may move from the full to dotted line positions of Figs. 7 and 18. In the full line position of Fig. 18, the flange 360 has abutting relation with the lower edge of the bar 330 and in the dotted line position the face 358 lies adjacent the lower edge of the bar.

Rotation of the crank 348 imparts lateral motion to the eccentric 342, which in turn imparts reciprocatory motion to the bars 330. The paddles 352 associated with one of the bars 330 are mounted for reverse action with respect to the paddles on the other bar. Coal delivered to the hopper 170 is distributed toward each end of the hopper by the paddles 352. The two bars move as a unit but as one bar moves in the direction of its respective end of the hopper the paddles 352 take the vertical positions of Fig. 7 for moving the coal. At the same time, the paddles on the other bar are pivoted upwardly against their respective bar so as to ride freely over and through the coal. During the return travel of the bars, the paddles reverse their action for moving coal toward the other end of the hopper, thus uniformly distributing the coal throughout the full length of the hopper.

Figs. 8 and 12 illustrate the shaft 216 as being provided with a gear 362 located within a gear housing 364 bolted to the hopper 170 at 366. Gear 362 is in mesh with a gear 368 connected with a shaft 370, which in turn is driven by a two-

cylinder stoker engine 372 through the medium of universal joints 374. The stoker engine 372 is of the reversible type and is well known in the art and need not be described in further detail. The engine is mounted upon the framework 376 of the locomotive through the medium of a bracket 378 (see Figs. 8 and 12). The hopper 170 is supported on the frame 376. In Figs. 9 and 12, we illustrate the frame as being provided with short I-beams 380 which are bolted to the frame with the upper flanges slidably retained within guides 382 bolted to the bottom of the hopper.

The rear end of the boiler is supported by a plate 384 which has its lower edge bolted at 386 to the frame and its upper edge bolted at 388 to the bracket 170 (see Figs. 12 and 20). The forward end of the boiler is supported by a transverse bracket 390 bolted at 392 to the mud ring 178 and at 394 to the frame 376 (see Fig. 19). All such supports are well known in the art.

From the foregoing description of the various parts of the device the operation thereof will be readily understood. The screw 80 is rotated through the medium of the shaft 216, the worm 214, the worm wheel 206, shaft 194, spool 110 and screw 106. Through rotation of the screw 80, the coal is advanced and crushed into proper size as it passes the crusher head 82 and through the neck 114. The spool 110 is tapered rearwardly so as to facilitate entrance of the larger lumps between the spool and the teeth 116. As the coal passes the spool 110 it enters the conduits 190 and is delivered to the hopper 170.

Rotation of the shaft 194 rotates the crank 348, which in turn reciprocates the bars 330 for spreading the coal toward the two ends of the hopper 170 to be picked up by the screws 244 and 248. Both screws 244 and 248 are of the same size, but the screws 244 are rotated at a faster speed than the screws 248 so as to deliver a larger amount of coal to the side areas of the fire box. Fig. 10 illustrates the gears 242 as being smaller than the gears 246 with the worm gears 218 larger than the worm gears 220 so as to increase the speed of the screws 244.

As the coal is picked up by the screws 244 and 248 it is advanced in the troughs 258. The side walls of all the troughs are provided with curved vanes 396, which facilitate upward movement of the coal in the troughs. Since the retorts 258 lie beneath the upper face of the grates 296 and 298, the coal is fed to the fire box from underneath the burning coal bed so as to secure proper combustion of the fuel. A fire bed of uniform thickness is maintained in the fire box since the coal being advanced by any one auger will tend to rise more rapidly in the zones of least resistance. The combustion is faster along the side sheets of the fire box, but the screws 244 are rotated approximately twenty-five per cent faster than the screws 248 so as to compensate the additional fuel consumption along the side sheets.

The grates 296 and 298 may be dumped through the medium of the actuating heads 322 and 328. In Figs. 15 and 16, we illustrate the manner in which the heads 322 and 328 may be actuated. All the heads are of the same construction and operated in the same manner. The head 328 of Figs. 15 and 16 is provided with two diametrically opposed recesses 398 and a plurality of openings 400.

To the rear wall 188 of the hopper 170 we mount brackets 402 which are bolted to the wall 404. Figs. 6 and 14 illustrate one of the brackets as being mounted on the inner face of the opposite side wall of the hopper. In Figs. 15 and 16, the bracket is bored at 406 to slidably support a latch pin 408 urged in the direction of the head 328 by a spring 410. In the normal position of the pin 408, the head 328 is latched against rotation.

While the heads 322 and 328 are located underneath the cab deck 168, the deck is provided with three openings 412 to lend access to the heads. These openings are normally covered by hinged covers 414 (see Figs. 2, 14 and 15). In dumping grates, we make use of a bar 416 which may be passed through the openings 412 for connection with the heads. Fig. 15 illustrates the lower end of the bar 416 as being located within one of the openings 400. The head 328 is unlatched by lifting the pin 408 through the aid of a suitable hook which may be connected with the eye 418. Oscillation of the bar 416 in either direction rotates the grate. While the distance the bar 416 may be oscillated is somewhat limited, the bar may be shifted to the adjacent opening 400 to permit the grate to be rotated the necessary amount.

Our grates are triangular in cross section so that each grate has three fire bed supporting surfaces. The gears 314 (see Fig. 20) are so related to the gears 310 as to rotate the grates associated therewith 120 degrees, the pins 408 automatically drop into the other recess 398 for positively latching that in its proper position in the fire box. Grates 318 are ratioed with respect to the gears 308 in the same manner so that all the grates will be turned 120 degrees through 180 degree rotation of their respective heads. The heads in combination with the latch pins 408 provide positive means for latching the grates against accidental rotation, and the grates will be properly adjusted whenever the pins have latching relation with one of the recesses. Because of the elevated positions of the side grates 298, it is necessary to interpose the idle gears 316 between the gears 308 and 318.

The screws 244 embody positive coal delivering action throughout their entire length of the fire box. The vanes 396 aid in elevating the coal into the combustion zone, but the delivery of coal is relatively uniform in that it tends to elevate in the areas of least resistance, thus maintaining a fire bed of uniform thickness. In providing a stoker of the underfed type, the gases must of necessity pass through the combustion zone. The gases do not escape unburned, as is true of stokers of the overfed type. Similarly, the fine particles of coal in the nature of dust cannot pass off in an unburned condition. In overfed stokers, fine coal, particularly when dry, is far from consumed in that large quantities are thrown out of the stack because of the strong draft. In our stoker such fine coal cokes and will burn as a lump. There is no waste in coal or gases, thus effecting a large saving in expense of operation. Because of thorough and efficient combustion, we attain smokeless operation.

The system is compactly arranged and is applicable to locomotives and tenders of conventional design. Our stoker will operate with little attention on the part of the fireman so that more time may be devoted to other duties such as observing signals, crossings, and the like.

In filling the tender 34 with coal the trough 38 is closed. The trough may be completely closed by arranging the plates 96 according to Figs. 2 and 3 and pushing the plate 96 underneath the deck 78 into abutting relation with the adjacent plate. Similarly, the opening be-

tween the fuel bin and the trough 38 may be completely closed before arriving at a terminal and operating the conveyor system for a short time so as to empty the same of coal. In this way the conveyor system may be emptied to prevent wet coal from freezing, which might interfere with the starting of the stoker.

Figs. 19 and 21 illustrate an ash pan 420 underneath the fire box. This ash pan is cut out at 422 (see Fig. 21) to accommodate a portion of the beam 282. The ash pan may be bolted at 424 to the beam. The lower part of the ash pan is not illustrated in view of its conventional nature.

The pivotal connection 160 for the cover 158 comprises pins passing through flanges 426 on the cover 158 and flanges 428 on the head 180. Neck 114 includes a flange 430 abutting a flange 432 on the head 180. These flanges are fixedly connected by bolts 434. Neck 114 is also provided with a second flange 436 which abuts a flange 438 formed on the head 118. These flanges are fixedly connected by bolts 440.

Cover 158 permits access to the spool 110 for checking purposes. Should the teeth 116 become damaged, a new neck may be substituted by merely removing the bolts 434 and 440. By removing the cover 158, the neck may be lowered for removal purposes, since the opening 156 is of sufficient proportion to accommodate the spool 110.

Fig. 23 illustrates a modified retort 442 which corresponds to the retorts 258. The difference lies in the nature of the vanes 444. In the modification, the vanes are integrally connected with the walls of the retort and extend downwardly thereof at an angle to the axis of the retort, but the lower edges of the vanes are curved at 446 and are spaced sufficiently far from the bottom of the retort to accommodate the screw.

Without further elaboration, the foregoing will so fully describe our invention that others may, by applying current knowledge, readily adapt the same for use under various conditions of service.

We claim:

1. In a locomotive fire box, spaced grates, a hoper extending transversely of the fire box exteriorly of the same, a conveyor for moving fuel from a source of supply into the hopper, rotary conveyors disposed between the spaced grates extending into said hopper for feeding fuel into the fire box from positions underneath the grates, reciprocatory fuel distributing means inside the hopper for distributing fuel into receiving relation with the rotary conveyors, a power operated shaft extending longitudinally of the hopper exteriorly of the latter, an operating connection between the power operated shaft and said conveyor, an operating connection between said power operated shaft and the fuel distributing means, and gear connections between the power operated shaft and said rotary conveyors.

2. In a locomotive fire box, spaced grates, a hopper extending transversely of the fire box exteriorly of the same, a conveyor for moving fuel from a source of supply into the hopper, rotary conveyors disposed between the spaced grates extending into said hopper for feeding fuel into the fire box from positions underneath the grates, fuel distributing means inside the hopper for distributing fuel into receiving relation with the rotary conveyors, a power operated shaft, an operating connection between the power operated shaft and said conveyor, an operating connection between said power operated shaft and the fuel distributing means, and operating connections between the power operated shaft and said rotary conveyors.

3. In a locomotive fire box, spaced grates, a hopper extending transversely of the fire box exteriorly of the same for receiving fuel from a source of supply, rotary conveyors disposed between the spaced grates extending into said hopper for feeding fuel into the fire box from positions underneath the grates, reciprocatory fuel distributing means inside the hopper for distributing fuel into receiving relation with the rotary conveyors, a power operated shaft extending longitudinally of the hopper exteriorly of the latter, an operating connection between said power operated shaft and the reciprocatory fuel distributing means, and gear connections between the power operated shaft and said rotary conveyors.

4. In a locomotive fire box, spaced grates, a hopper extending transversely of the fire box exteriorly of the same for receiving fuel from a source of supply, rotary conveyors disposed between the spaced grates extending into said hopper for feeding fuel into the fire box from positions underneath the grates, fuel distributing means inside the hopper for distributing fuel into receiving relation with the rotary conveyors, a power operated shaft, an operating connection between said power operated shaft and the fuel distributing means, and operating connections between the power operated shaft and said rotary conveyors.

5. In a locomotive fire box, spaced grates, retorts positioned between the grates, rotary conveyors disposed in said retorts for feeding fuel into the fire box from positions underneath said grates, a fuel hopper extending transversely of the fire box exteriorly of the same and communicating with said retorts with each rotary conveyor extending into the hopper, a deck associated with said fire box, said hopper being located underneath said deck, a rotary screw for moving fuel from a source of supply into said hopper, a power shaft, an operating connection between the power shaft and said screw, operating connections between said power shaft and said rotary conveyors, reciprocatory fuel distributing means inside the hopper for distributing fuel into receiving relation with the rotary conveyors, and an operating connection between said power shaft and the reciprocatory fuel distributing means, with the latter horizontally positioned underneath said deck.

WALTER J. HATHAWAY.
EDWARD F. FRONDORF.