Jan. 4, 1944. J. BECKER 2,338,618

COKE OVEN STRUCTURE

Filed Oct. 3, 1942. 4 Sheets-Sheet 1

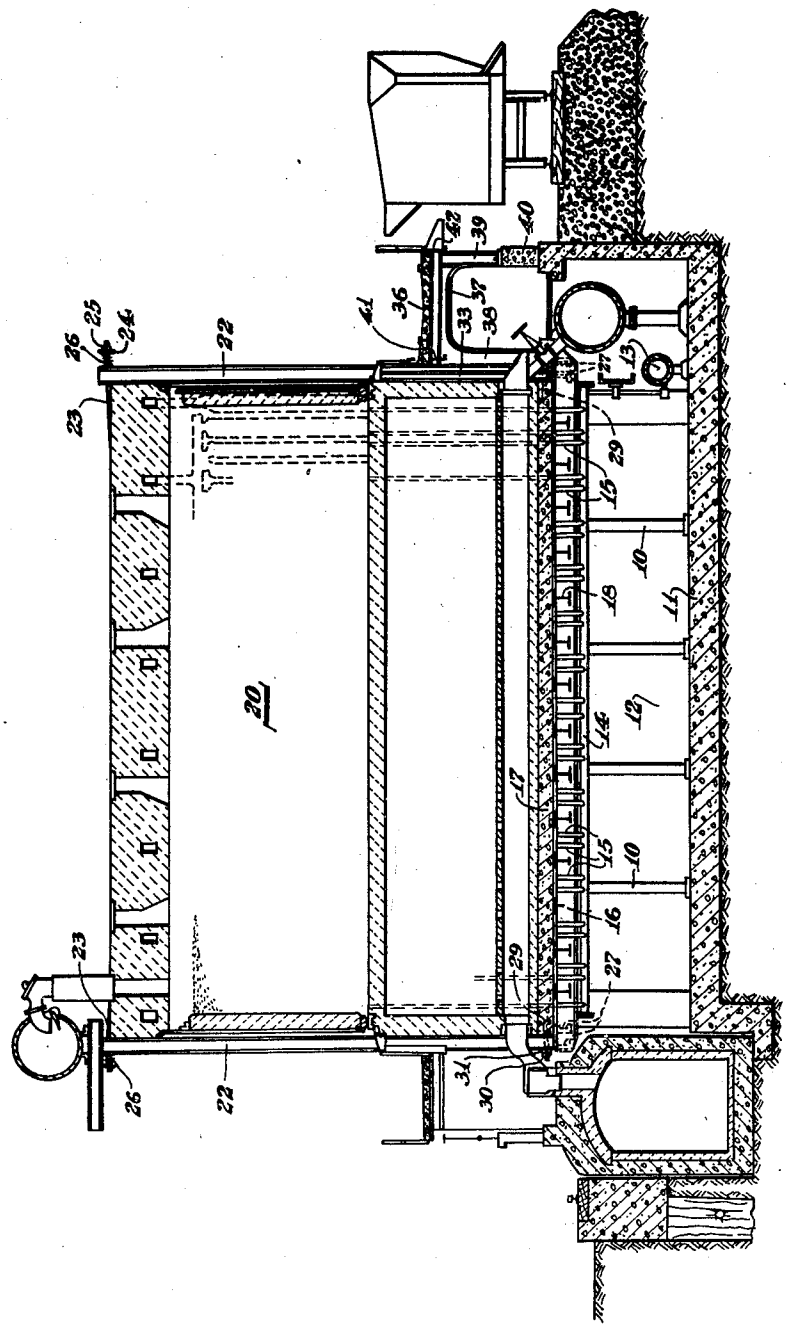


Fig. 1

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COKE OVEN STRUCTURE

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Fig. 3

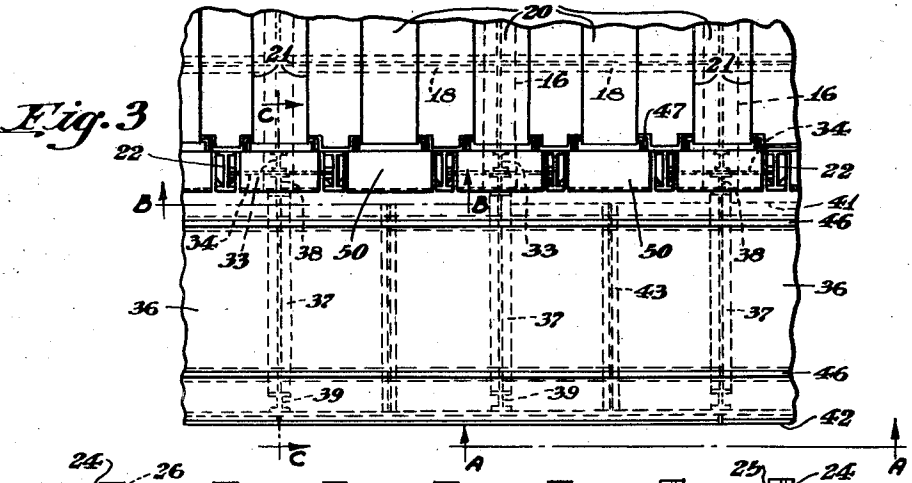
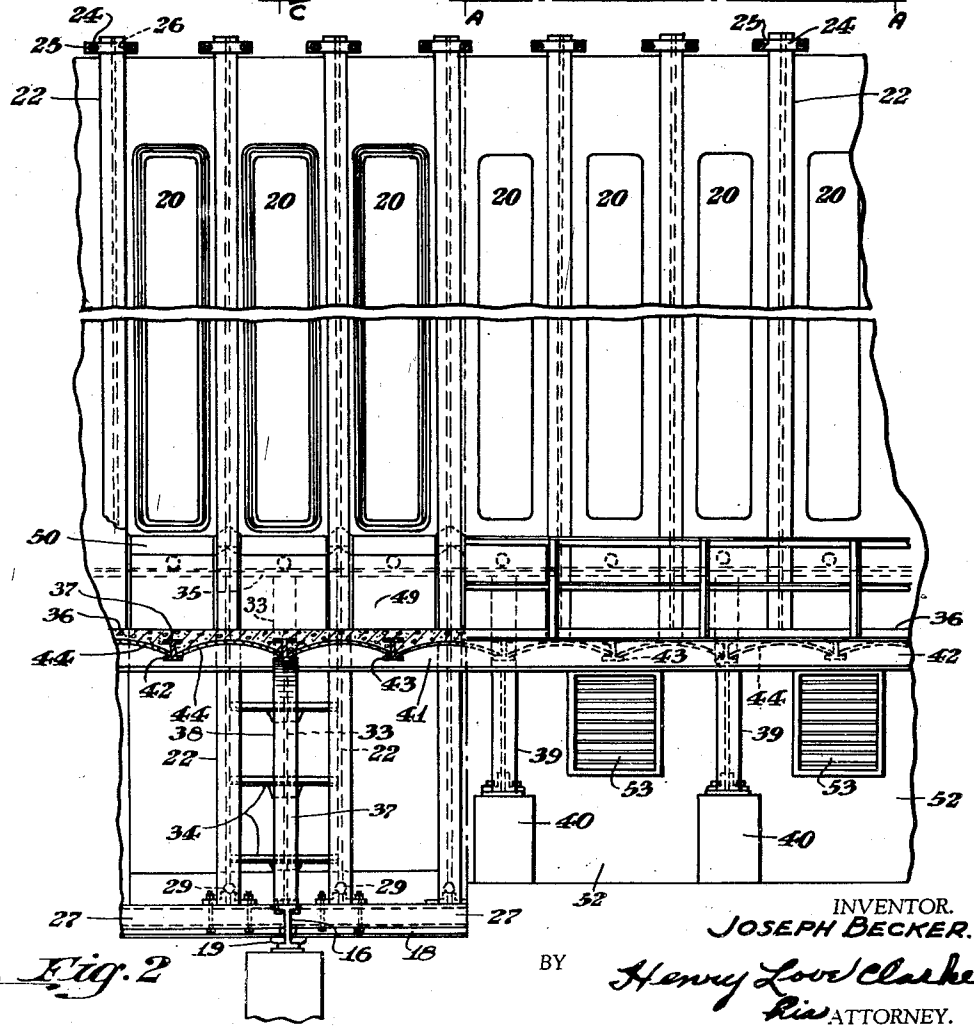


Fig. 2



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COKE OVEN STRUCTURE

Filed Oct. 3, 1942 4 Sheets-Sheet 3

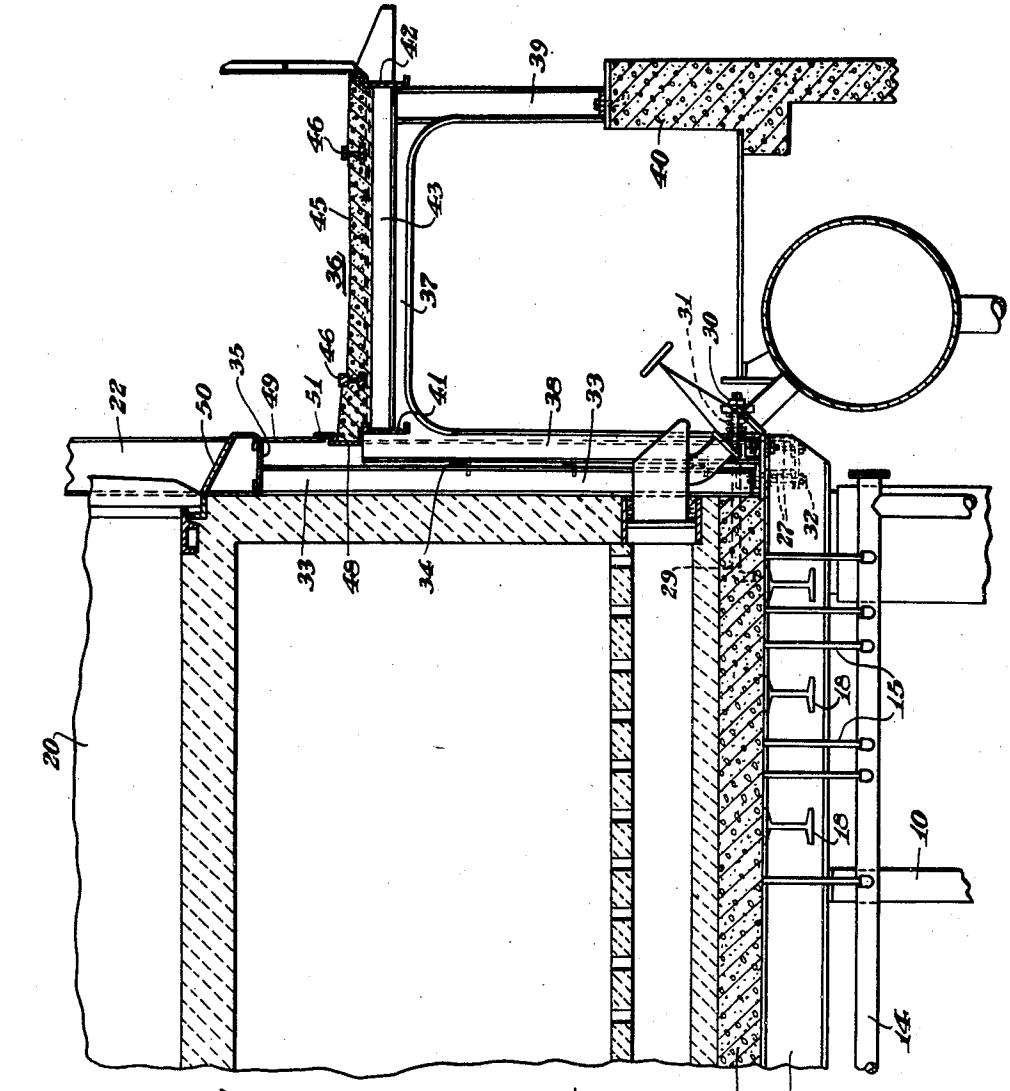


Fig. 4

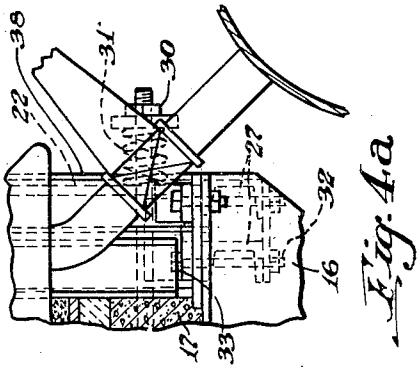


Fig. 4a

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COKE OVEN STRUCTURE

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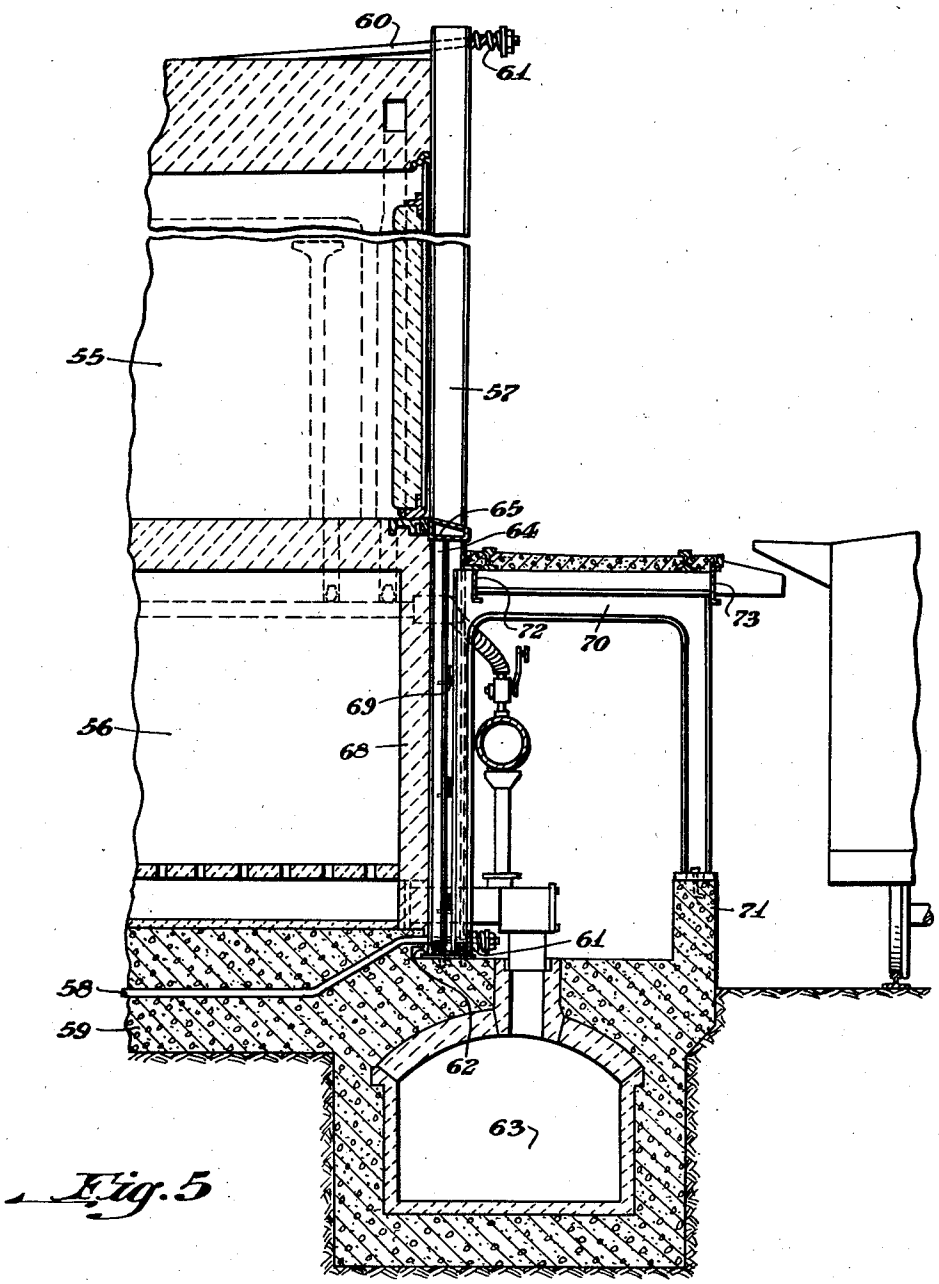


Fig. 5

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UNITED STATES PATENT OFFICE

2,338,618

COKE OVEN STRUCTURE

Joseph Becker, Pittsburgh, Pa., assignor to Koppers Company, a corporation of Delaware

Application October 3, 1942, Serial No. 460,629

10 Claims. (Cl. 202—268)

The present improvement relates to horizontal coke ovens and is more especially concerned with improvements in the construction and support of the operating benches therefor that are located at either side of a coke-oven battery just below the oven-soles and extend longitudinally along the battery-faces. Amongst the functions of said benches is to provide support for the trackage wherealong heavy oven-operating equipment, such as the coke-guides, door-machines, and the like, is normally propelled from oven to oven.

Structurally the bench of a horizontal coke-oven battery comprises an operating platform that is the top or roof of an arcade-like passageway extending its entire length. It is formed from a series of aligned portal-like members each comprising a horizontally-disposed beam that extends parallelly of the coking chambers and is supported at its opposite ends by means including spaced vertically-disposed members. Of these latter members, those remoter from the battery-face are commonly anchored in the ground or have their lower ends resting on concrete piers that are themselves so secured. Heretofore it has been common practice to employ adjacent portions of the battery buckstays themselves for the support of the inner ends of the said horizontally-disposed beams and in such construction their said inner ends have been commonly directly attached to the said buckstays, and, in some instances, they have been additionally supported by such auxiliary means as rigid inclined bracing-members that each engage the lower portion of a buckstay and a said horizontal beam at some point intermediate its ends, thereby still further decreasing the possibility of independent movement of the one in respect of the other.

The primary purpose of the buckstays of a coke-oven battery is to retain at all times and under all operating conditions stability of alignment of the masonry comprising it, so as to prevent any opening up of joints whereby gases can undesirably short-circuit through the structure. In the external structural frame-work for the battery and of which the buckstays form a part, the latter are assembled in combination with adjustable resilient means adapted to provide a restricted independence of movement between the buckstays and the masonry while maintaining a predeterminable buckstay pressure on said masonry irrespective of its temperature at any one time; there is thus a limited degree of play possible between the masonry and its restraining buckstays.

Vibrations set up in the buckstays by propelling the above-mentioned heavy operating machinery along a battery-bench that is supported by said buckstays are naturally transmitted to the masonry and are not conducive to maintenance of its integrity and the effect of such vibrations is amplified as a result of the said resilient means necessarily provided between the masonry and the buckstays for regulating the pressure therebetween. In addition to vibrations engendered by travel of oven-operating machinery along the bench, the masonry and buckstays are also subjected to the horizontal thrust occurring during the operation of pushing coke from the oven-chambers and the accumulated effects of which are exhibited to greater degree at the battery's coke-side often by extensive bowing of the buckstays especially in the region of the oven soles. The distortional effect on the buckstays of all these circumstances is aggravated by the great mass both of the benches and of the heavy operating machinery moved therealong, and, occasionally, the results are so serious that extensive repairs to the brickwork and the buckstays must be undertaken.

A primary object of the present invention is to provide cheap and practical improvements in the support and design of horizontal-coke-oven operating benches whereby the above-recited disadvantages of prior practice can be in greater part obviated.

The invention has for further objects such other improvements and such other operative advantages or results as may be found to obtain in the processes or apparatus hereinafter described or claimed.

Briefly stated, according to the present invention, the operating bench of a battery of horizontal coke ovens is formed of a series of horizontal beams that are arranged along the battery front in parallelism with the coking chambers and are supported at their ends by spaced uprights, the combination forming a series of stationary gantry-like members. Those uprights adjacent the battery-face are disposed intermediately of the battery buckstays and are preferably supported entirely independently thereof in spaced relationship to the battery-face with their lower ends supported by some foundation member of the battery; for example, by the refractory mat or by metallic members whereby the mat itself is supported. The individual beams of the said series of gantry-like members are spaced apart by stretchers that extend lengthwise of the battery.

Some of the benefits provided by the present improvement in coke-oven benches can, however, be also realized by supporting the said battery-face uprights directly on the buckstays themselves either at their lower ends or at points therealong nearer such ends than to the oven-soles. This is in consequence of the fact that the bending moment of the buckstays is greatest at or adjacent the oven-soles and it decreases

as the buckstay ends are approached. Thus, if the said battery-face uprights are attached to the buckstays for support, the present invention provides that their points of attachment be nearer the buckstay lower ends than to the oven soles; that is, at points where the buckstay bending moment is lower and a given bench-vibration can be absorbed with less deformation to those buckstay portions adjacent the oven-soles.

As will be clearly understood from the following description of the present improvement, the invention is equally adapted for use in combination with a coke-oven battery of which the supporting-mat rests on the ground or with a battery of underjet coke ovens of which the mat is supported on piers, or the like, between which there are passageways wherethrough the operators can pass to make adjustments of combustion media delivered to the individual heating flues from beneath.

In the accompanying drawings forming a part of this specification and showing for purposes of exemplification preferred apparatus in which the invention may be embodied and practiced but without limiting the claimed invention specifically to such illustrative instance or instances:

Fig. 1 shows a vertical section taken crosswise of a battery of underjet coke ovens and through a coking chamber thereof, said battery being provided with the improved operating-bench construction of the present invention at its coke-side;

Fig. 2 shows in enlargement a composite side elevational view of the battery illustrated in Fig. 1, the portion at the right hand thereof showing the coke-side bench in full and being taken along the line A—A of Fig. 3, whereas that portion at the left hand illustrates a vertical section taken along the line B—B of Fig. 3 and showing clearly the arrangement for supporting, adjacent the battery-face, the present improvement in coke-oven benches;

Fig. 3 is an enlarged fragmentary view in plan of a portion of the battery illustrated in Fig. 1 and showing constructional details of the coke-side bench;

Fig. 4 is an enlarged view of the coke-side bench of the battery illustrated in Fig. 1 and showing in greater detail the present improvement in constructing the same;

Fig. 4*a* is an enlarged fragmentary view of Fig. 4; and

Fig. 5 shows the improvement of the invention employed in combination with a coke-oven battery of which the supporting-mat is in direct contact with the yard surface.

Referring now to the drawings and more especially to Figs. 1, 2, and 3: the structure of the coke-oven battery therein illustrated is supported from beneath by a plurality of piers **10** of which the lower ends rest on the concrete foundation **11** and, between said piers, there are provided passageways **12** through which the operator can go from oven to oven to regulate quantities of heating gas delivered to the individual heating flues of the heating walls and flowed thereto, for example, in series from rich-gas main **13** into heating-wall headers **14** and thence in individually regulable quantities through a branch-line **15** upwardly into a vertical heating flue through a conduit located in the masonry of a regenerator wall.

Resting on top of aligned piers **10** and extending cross-wise of the battery beneath alternate coking chambers are the rugged I-beams **16** which assist in the support of the battery-structure above the said accessible passageways **12**, the upper surface of said I-beams resting against the lower surface of the battery-supporting mat **17**. The I-beams **16** are, as is clearly shown in Fig. 1, of greater length than is the width of the battery-masonry and consequently they protrude beyond the masonry at both battery-faces. Extending longitudinally of the battery between adjacent I-beams **16**, to which they are affixed at both ends, there is a multiplicity of less massive I-beams **18** which together with the former form a massive grid-like metallic structure which supports the entire battery-mat **17** at its lower surface. It might be added that said lower surface of the mat is in only direct contact with the upper surfaces of the large and small I-beams, the contact between said mat and said beams being such that they are free to expand and contract independently of each other. Bearing members **19** included at the junction between the I-beams **16**, **18**, serve as additional support for the latter.

At each side of a coking chamber **20** there is a heating wall **21** formed of masonry comprising bricks arranged to form vertical heating flues. At each end of each heating wall, the masonry is supported in alignment during its expansion and contraction by means of a buckstay **22** formed of a single heavy I-beam that is maintained at a regulable pressure in contact with those metallic flash-plates **47** that provide a protective covering for the jamb-bricks which form the heating-wall ends. The tops of the buckstays at opposite ends of the same heating wall are tied together by means comprising a pair of tie-rods **23** that pass through a pair of bores in tie-plates **24**. By means of nuts **25** arranged to travel on the threaded ends of the tie-rods, the effective length of the latter is variable to adjust to a preferred pressure the bearing contact between a pair of buckstays and their flash plates and thus indirectly on the masonry of the flued heating wall therebetween. Spring members **26** located between the buckstays and tie-plates **24** serve to permit minor expansions and contractions of the heating wall without greatly altering the compressive force that an existing buckstay setting impresses on the heating-wall masonry.

The lower ends of the buckstays are each independently affixed to the concrete of the battery-mat **17** by means of anchor-bolts **29** embedded in the latter. Between the outer flange of each buckstay and the adjusting nut **30** of said anchor-bolt there is placed a spring **31**, or any other preferred resilient member, that serves the same previously described purpose as that used in combination with tie-rods **23** at the top of the battery. The buckstays, the masonry of the battery, and the battery-mat thus comprise a single unit that is freely able to expand and contract above the supporting grid-work formed by I-beams **16**, **18**.

Adjacent their outer ends and extending lengthwise of the battery there is supported between each of the contiguous transversely-extending I-beams **16** and to which they are affixed, a pair of spaced channel-bars **27** which is thus structurally disposed to form in effect a pair of spaced channel-bars coursing from one end of the battery to the other. As is clearly evident in Fig. 2, the lower ends of the buckstays **22** are adapted to rest in slideable contact with said spaced channel-bars **27** to which they can be adjustably affixed by means of bolts **32** inserted through slotted holes that permit limited shift-

ings of the buckstays' lower ends transversely of said channel-bars and the battery. By means of said bolts 32, certain expansive forces impressed on the battery during the heating-up period and which might tend to cause the buckstays to migrate upward can be simply counteracted.

Along the battery-face in alternate buckstay-interspaces, the shorter and less massive intermediate buckstays 33 are rigidly supported against the brickwork of the ends of regenerator walls, by angle bars 34 that are attached to the intermediate buckstays, and are supported in part by the primary buckstays 22. At their upper ends the said intermediate buckstays each depend by bolts from a plate 35 which itself extends across the interspace between primary buckstays and has its opposite ends affixed to the latter. As shown in Fig. 2 of the drawings, only the alternate primary-buckstay interspaces are provided with the said shorter intermediate buckstays. This results from the fact that in the illustrated battery, the cross regenerators are arranged in laterally adjacent groups of which each comprises a large intermediate regenerator flanked on either side by a co-extensive smaller regenerator, such grouping being clearly set forth in Becker U. S. Patent No. 2,015,657, issued October 1, 1935. The principal utility of the intermediate buckstays is support for those regenerator-walls that are not directly beneath heating walls and consequently are not directly supported by the primary buckstays. In the construction of the battery illustrated in Figs. 1 to 4, alternate coking chambers have a regenerator-wall directly therebeneath which is provided at both battery-faces with an above-described intermediate buckstay. It is of course obvious that in those structures wherein there is a regenerator-wall beneath each coking chamber, a said intermediate buckstay 33 will be furnished in each of the primary-buckstay interspaces.

The lower edges of the intermediate buckstays are all disposed in the battery adjacently above the upper flange of an I-beam 16 and preferably out of pressure contact therewith.

The coke-oven bench 36 of the present invention is shown at the coke-side only of the batteries illustrated in the drawings, at which location the benefits to be derived from its novel features are to greater extent realizable because, as is appreciated by those skilled in the art, the benches at the battery's pusher-machine side are required to be of only relatively light construction since the operating machinery, such as the pusher and the door machine, are both usually supported on trackage at the yard surface and the bench at that battery-face is provided principally for the convenience of the attendants.

According to the present novel design for coke-oven benches, they are formed of a series of spaced gantry-shaped members or portals 37, preferably of jointless construction. They are arranged at right angles to the battery-face and are located intermediate a pair of primary buckstays with the longer of their side-supports 38 themselves supported immediately in front of but out of contact with the said intermediate buckstays 33 and with their lower ends each resting on that above-mentioned projection of transverse I-beam 16 which extends beyond the masonry at the face of the battery and to which said supports are affixed by bolts inserted through slotted holes in their lower parts whereby a certain amount of relative movement is made possible between said side-supports 38 and said I-beams. The outer shorter legs 39 of the said portals adjustably rest on individual concrete piers 40 that are firmly anchored in the ground. These outer supports 39 of the portals 37 are preferably made shorter than those adjacent the battery front, thereby the better to resist operating practices creating horizontal thrusts tending to force the bench away from the battery face; for example, the pressure of the door-machine against the oven door when latching it in closed position.

The individual portal members are all rigidly tied together and spaced from each other to form for the bench a stable and resistant framework that is entirely out of contact with any of the buckstays of the battery. At their inner upper parts the various portals are interconnected by means of channel-bars 41 that extend between individual portals and at their outer upper parts they are attached and supported in vertical positions by a facial channel-bar 42 that extends from end to end of the battery-bench.

Also supported by said channel-bars 41, 42, are other small channel-bars 43 that are disposed in alternation with the said portal members, said channel-bars 43 serving not only to provide greater stability to the bench structure but also for the support of the material comprising the platform thereof and the trackage for the door machine, and the like.

The platform of the improved coke-oven bench itself comprises a series of arcuate metallic strips 44 that each extend between channel-bars 41, 42, and are supported at their opposite sides on the lower flanges of the horizontal section of a portal member 37 and of a channel-bar 43. These arcuate strips form a base for the support of the concrete or bituminized aggregate 45 wherein are embedded rails 46 of the door-machine trackage.

The material 45 wherein trackage 46 is embedded is supported at the battery-face by means of angle-bar 48 which has a relatively longer vertically-disposed leg and extends between buckstays along the upper flange of a channel-bar 41.

In order to prevent the falling of coke breeze and the like between the buckstays into the alleys and the battery basement where it would have a deleterious effect on the operation of the gas-flow reversing mechanism and the valves of the gas-distribution system of the battery, there is attached, by means of an angle-bar, to the outer edge of each of those plates 35 from which the intermediate buckstays depend and which are themselves supported by the primary buckstays, a vertically-disposed plate 49 that extends vertically downwardly as a sort of extension of that spillage-plate 50 at the bottom of the oven mouth; it does not however make contact with the upper edge of the angle-bar 48, the joint space therebetween being covered by metal strip 51 which depends from the former but is out of contact with the latter.

The contact between the shorter leg or support 39 of each portal member 37 and the pier 40 is of a sliding type that is also susceptible of being made a fixed contact, so that any stresses thereon engendered by expansion or contraction of the I-beams 16, for example, can be compensated for without distortion of the bench. For this purpose, it is practical to rest the lower end of the support 39 on a metallic plate and to provide in the former slotted holes through

which protrude threaded bolts anchored in the concrete of the supporting-pier 40.

For the protection against the weather of the spaces of the alley-ways located beneath the platform of the present improved battery-bench, the openings between the outer bench-supports 39 are, as shown in Fig. 2, closed by metallic sheets 52 having louver-openings 53 therein whereby ventilation through said spaces is controllable.

In the accompanying Fig. 5, the present improved design of operating bench for horizontal coke ovens is shown adapted for use in such of said ovens as have their supporting mat in direct contact with the yard surface. In this figure, showing diagrammatically the coke-side end of a conventional cross-regenerative horizontal coke oven, the masonry 55 of a flued heating wall adjacent a coking chamber located above a regenerative space 56, is supported at its each jamb-end by a massive buckstay 57, the lower end of said buckstay being supported by anchor-rods 58 that are embedded in the concrete of the battery-supporting mat 59, the upper end being tied to a similar buckstay at the pusher-side of the battery by tie-rod 60 in the usual manner. Springs 61 permit minor expansions and contractions in the masonry of the heating wall without greatly increasing the tension on said anchor-rod and tie-rod. The lower end of massive primary buckstay 57 is also slidably supported on metallic block 62 thereby to increase facility of movement in response to the pressure of said heating wall and springs, said block resting on the upper surface of waste-heat canal 63. To counteract any tendency of buckstay 57 to move in a vertical direction, its lower end is adjustably held by means of bolts which are anchored in the concrete therebeneath and co-act with horizontal slotted-openings in said buckstay's lower end, said bolts and openings being arranged to permit horizontal but not vertical movement of the buckstay.

Smaller intermediate buckstay 64 depends from that plate 65 which is itself affixed to adjacent massive buckstays 57, the said intermediate buckstay being held in pressure contact with the regenerator-wall end 68 by means of heavy straps 69 that press against those massive buckstays that are at each end of said straps. By means of this arrangement the intermediate and massive buckstays are free to move in unison under the influence of springs 61.

In this latter application of the invention, as hereinabove described in combination with a coke-oven battery of the underjet type, the present improvement in coke-oven benches comprises a plurality of portal members 70 that are disposed between the primary buckstays 57 of the battery and immediately in front of but out of contact with the smaller intermediate buckstays 64, the said portal members being supported at the lower ends of their supporting legs by means of bolts that are correspondingly embedded in the concrete of the roof of the waste-heat canal and the piers 71. The upper ends of all the portal members are rigidly tied together by means of channels 72, 73, as hereinbefore described, to form a rigid, self-supporting arcade-like passageway adapted to carry the material of the bench-platform and trackage for the door-machine, coke-guide, and the like.

The principal distinction between the battery-bench of Figs. 1 to 4, inclusive, and that of Fig. 5 resides in the fact that in the former figures a practical arrangement is shown for supporting said battery-bench independently of the battery-mat whereas in the latter the improved bench is supported by an extension of the material of the mat itself.

By means of the above-described novel design therefor, it now becomes possible completely to free the buckstays of horizontal coke-ovens of the stresses and strains caused by the older practice of supporting the great weight thereof at least in part by said buckstays. The improved design is advantageously adapted to protect the buckstays from substantially all vibrations and strains incident to the travel of oven-operating machinery along the bench and also of the coke-cake through the coke guide, most of such shock being absorbed either by the mat or by the bench-supports at their points of minimum movement. Instead of operating to augment such forces, for example, as the horizontal thrusts incident to pushing coke and tightening of the doors, both of which tend in the older construction to distort the buckstays to force them outward, especially at the coke-side, the independent bench of the improved design offers resistance to limit such detrimental displacement. A further advantage resides in the fact that the pressure of the buckstay springs and buckstays against the battery-masonry may be limited to that required only to maintain a preferred pressure against the masonry.

The invention as hereinabove set forth is embodied in particular form and manner but may be variously embodied within the scope of the claims hereinafter made.

I claim:

1. In a horizontal regenerative coke-oven battery of the underjet type the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert pressure against said heating wall-ends, thereby to retain alignment of the heating-wall masonry; a supporting mat for said battery; means for supporting said mat above accessible passageways and providing lateral projections that extend beyond the masonry of said battery; and a bench that extends adjacently along the face of said battery out of contact with said buckstay members and is supported entirely from beneath the platform portion of said bench by means comprising a plurality of stationary spaced gantry-like members that are adapted to support said bench independently of said buckstay members and have their battery-face legs themselves supported by said projections of said mat-supporting means.

2. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert pressure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry and having their lower ends at least as low as the bottoms of the regenerators; resilient means disposed at least partially to determine the pressure of the buckstay members against the heating-wall masonry; and a bench that extends adjacently along the face of said battery, said bench comprising an operating platform that is tension-free and pressure-free of said buckstay members and is supported entirely from beneath, independently of at least the portions of the buckstay members that are nearer to the soles of said coking cham-

bers than to the lower ends of the buckstay members by means including a plurality of stationary spaced gantry-like members that are adapted to support said bench and have their battery-face legs themselves supported in the battery-structure nearer to the lower ends of said buckstays than to the soles of said coking chambers.

3. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert prssure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry; a lower support for said battery having projections that extend beyond the masonry of said battery; and a bench that extends adjacently along the face of said battery out of contact with said buckstay members and is supported entirely from beneath the platform portion of said bench by means comprising a plurality of stationary spaced gantry-like members that are adapted to support said bench independently of said buckstay members and have their battery-face legs themselves supported by said projections of the said lower support of the battery.

4. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath all supported on a battery supporting mat located below the regenerators; buckstay members adapted to exert pressure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry; and a bench that extends adjacently along the face of said battery out of contact with said buckstay members and is supported entirely from beneath the platform portion of said bench by means comprising a plurality of stationary spaced gantry-like members that are adapted to support said bench independently of said buckstay members and have their battery-face legs themselves supported by the battery-supporting mat independently of said buckstay members.

5. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert pressure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry; and a bench that extends adjacently along the face of said battery out of contact with said buckstay members and is supported entirely from beneath the platform portion of said bench by means comprising a plurality of stationary spaced gantry-like members that are adapted to support said bench independently of said buckstay members and have their battery-face legs themselves supported at a level of the battery adjacent the lower ends of said buckstays.

6. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert pressure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry and having their lower ends at least as low as the bottoms of the regenerators; and a bench that extends adjacently along the face of said battery out of contact with said buckstay members and is supported entirely from beneath the platform portion of said bench, independently of at least the portions of the buckstay members that are nearer to the soles of said coking chambers than to the lower ends of the buck-stay members by means comprising a plurality of stationary spaced gantry-like members that are adapted to suport said bench and have their battery-face legs themselves supported nearer the lower ends of said buckstays than to the soles of said coking chambers.

7. In a horizontal regenerative coke-oven battery, the combination of: a plurality of coking chambers alternating with flued heating walls and having regenerators therebeneath; buckstay members adapted to exert pressure against said heating-wall ends, thereby to retain alignment of the heating-wall masonry and having their lower ends at least as low as the bottoms of the regenerators; and a bench that extends adjacently along the face of said battery, said bench comprising an operating platform that is tension-free and pressure-free of said buckstay members and is supported entirely from beneath by means including a plurality of stationary spaced gantry-like members that are adapted to support said bench, independently of at least the portions of the buckstay members that are nearer to the soles of said coking chambers than to the lower ends of the buck-stay members and have their battery-face legs themselves supported in the battery-structure nearer to the lower ends of said buckstays than to the soles of said coking chambers.

8. In combination with a horizontal regenerative coke-oven battery having masonry-retaining buckstays, a stationary operating bench that extends along the face of said battery and comprises a platform portion that is out of contact with the masonry-retaining buckstays of said battery and is supported entirely from beneath by means including inverted U-shaped members for which the supports are spaced from the mass of said platform.

9. In combination with a horizontal regenerative coke-oven battery having masonry-retaining buckstays, a stationary operating bench that extends along the face of said battery and comprises a platform that is out of contact with the masonry-retaining buckstays of said battery and is supported entirely from beneath by means including inverted U-shaped members for which the supports are spaced from the mass of said platform nearer the lower ends of said buckstays than to the oven soles of said battery.

10. The combination of: a regenerative horizontal coke-over battery with regenerators at a level below the level of the soles of the coking chambers; a vertically-disposed buckstay at its face for retaining battery-masonry in alignment having a portion of the buckstays extending from the level of a coking chamber sole to at least as low as the bottoms of the regenerators; and along the face of the battery, an operating bench having a battery-side support that is independent of at least the portion of the buckstay above about the median point between a coking-chamber sole and the lower end of the buckstay, the platform portion of said operating bench being tension-free and pressure-free of said buckstay.

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