May 9, 1939. J. S. POTTER 2,157,566

COKE OVEN DOOR MACHINERY

Filed June 25, 1935 3 Sheets-Sheet 1

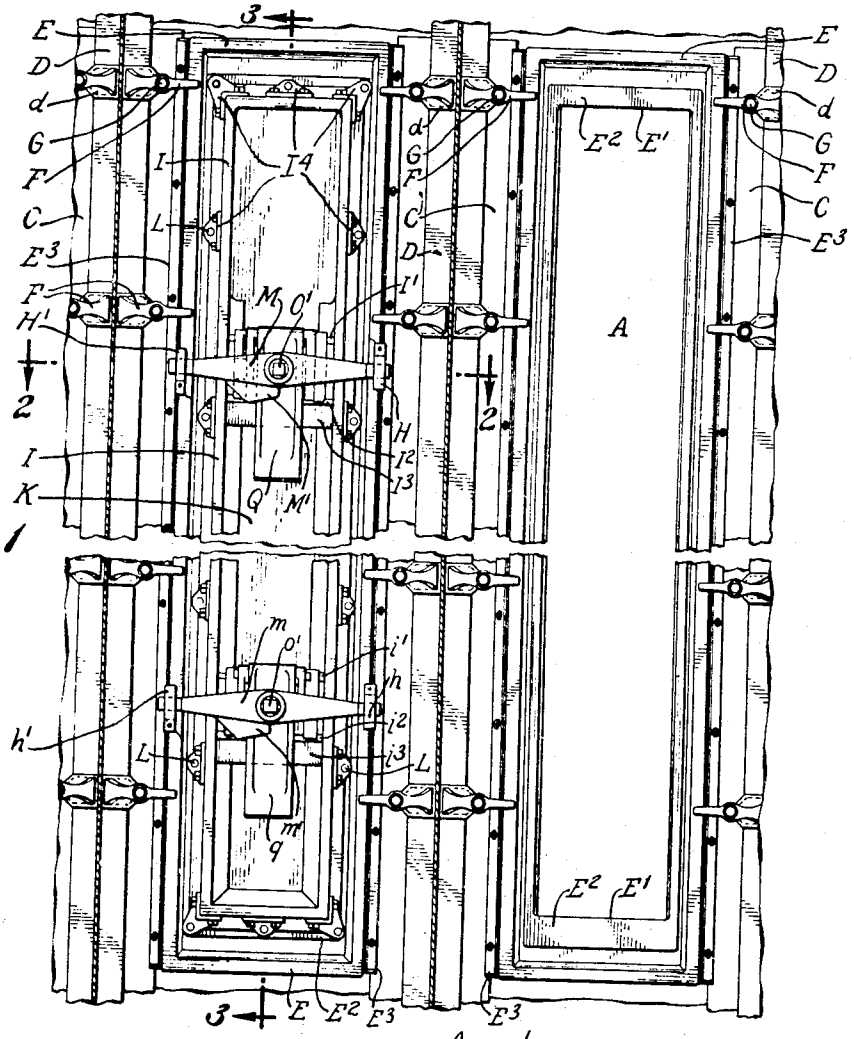


Fig. 1

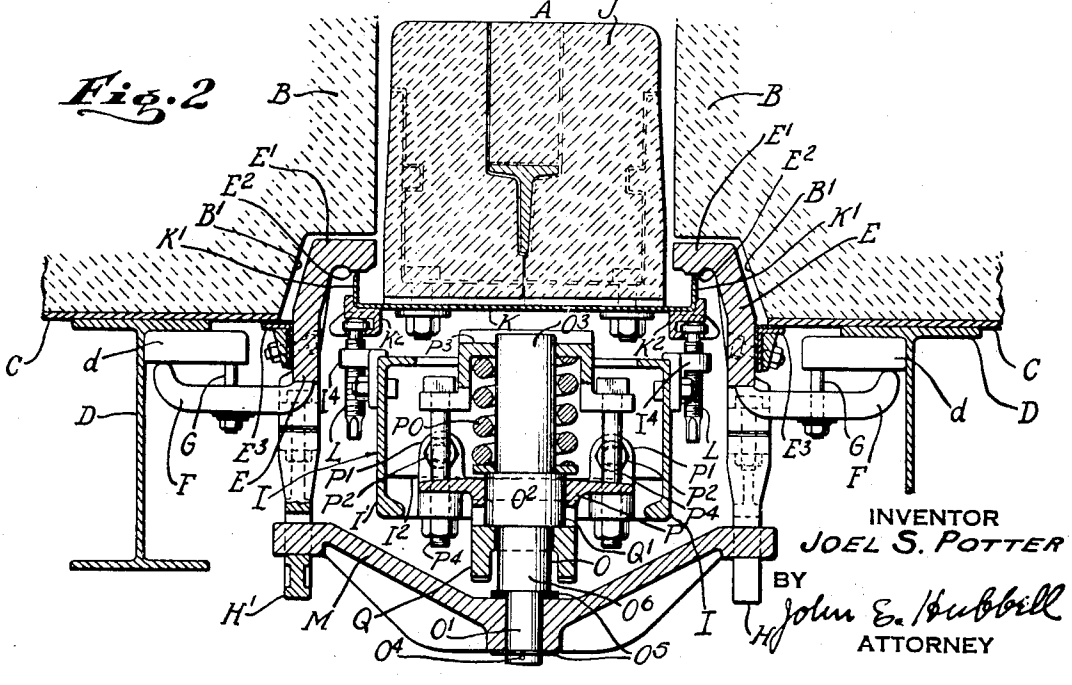


Fig. 2

INVENTOR
JOEL S. POTTER
BY
John E. Hubbell
ATTORNEY

May 9, 1939. J. S. POTTER 2,157,566

COKE OVEN DOOR MACHINERY

Filed June 25, 1935 3 Sheets-Sheet 2

Fig. 6

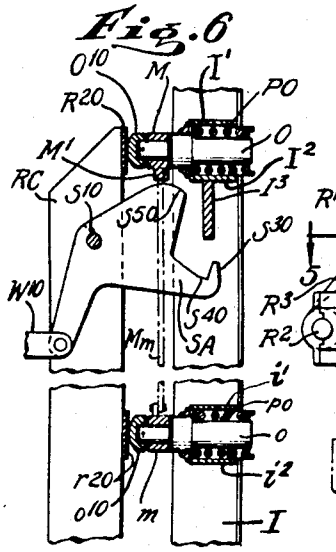


Fig. 3

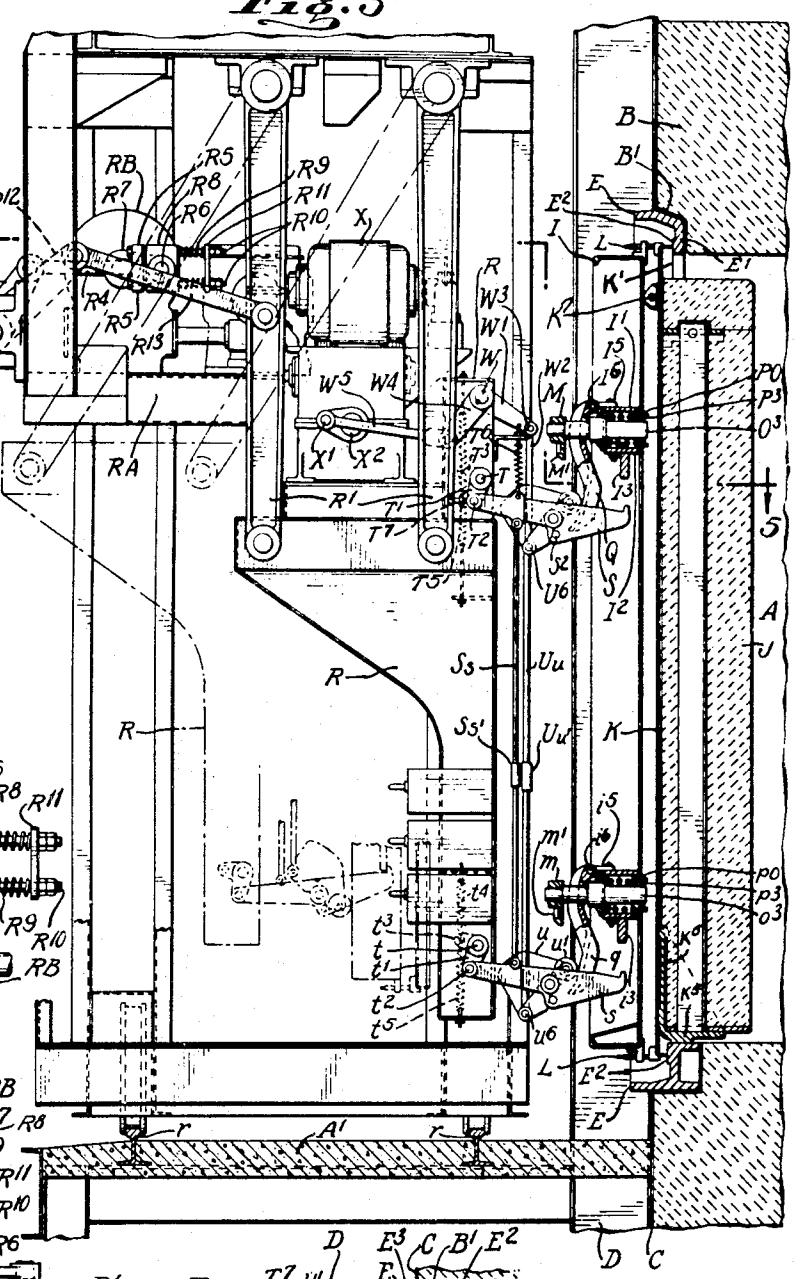
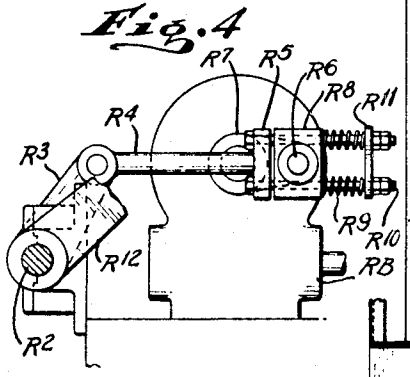


Fig. 4



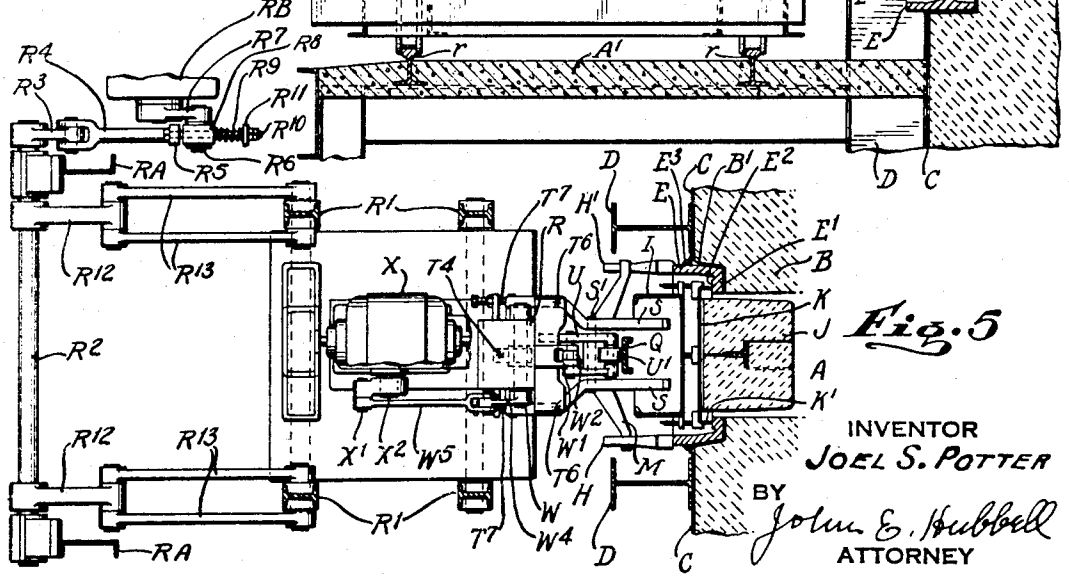


Fig. 5

INVENTOR
JOEL S. POTTER
BY
John E. Hubbell
ATTORNEY

May 9, 1939. J. S. POTTER 2,157,566

COKE OVEN DOOR MACHINERY

Filed June 25, 1935 3 Sheets-Sheet 3

Fig. 7

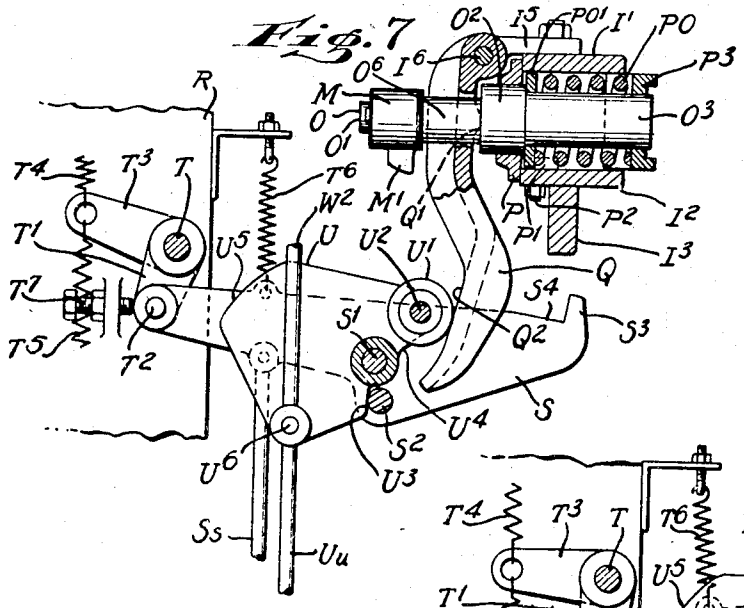


Fig. 8.

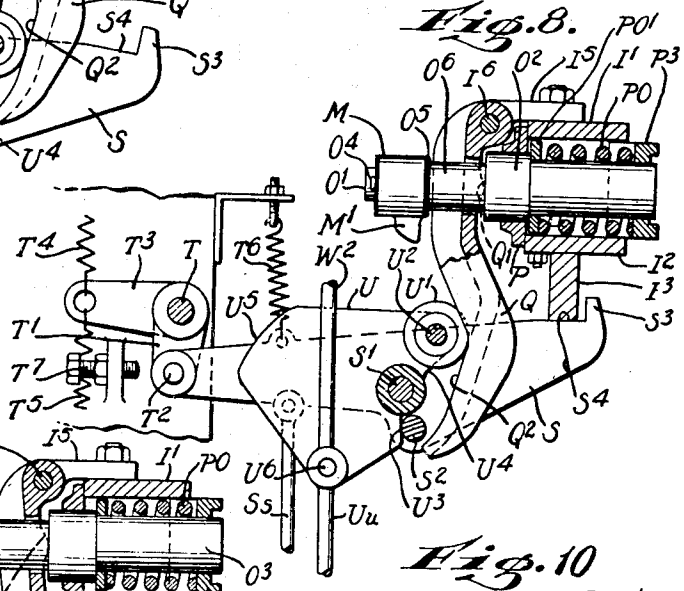


Fig. 9

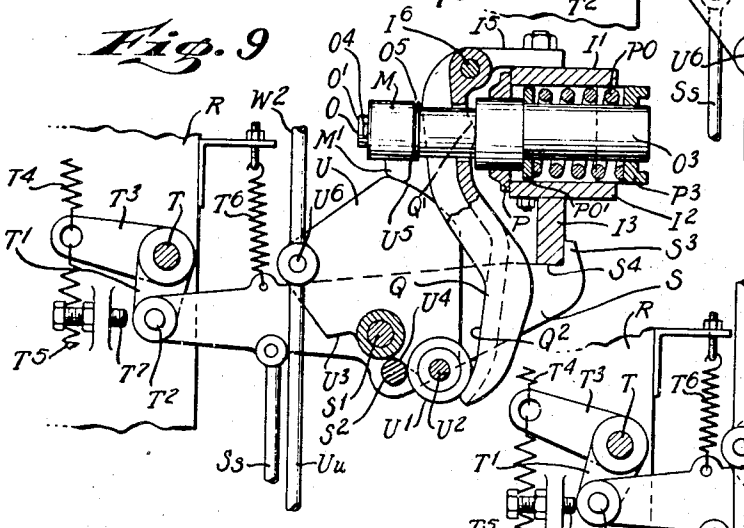


Fig. 10

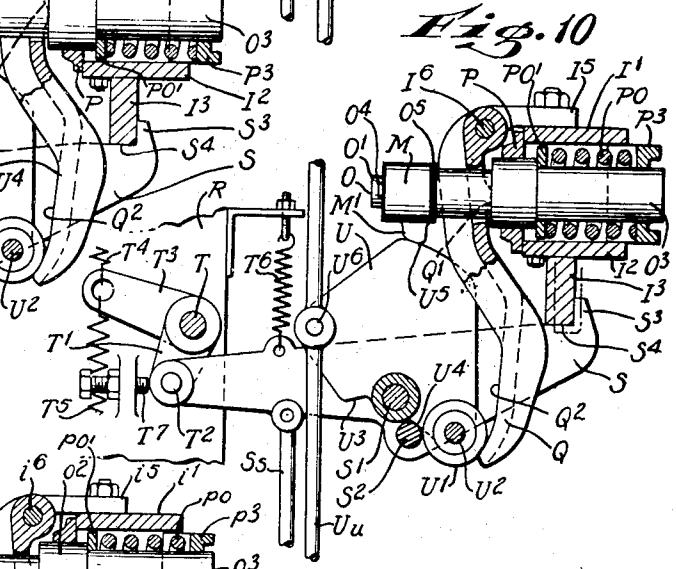
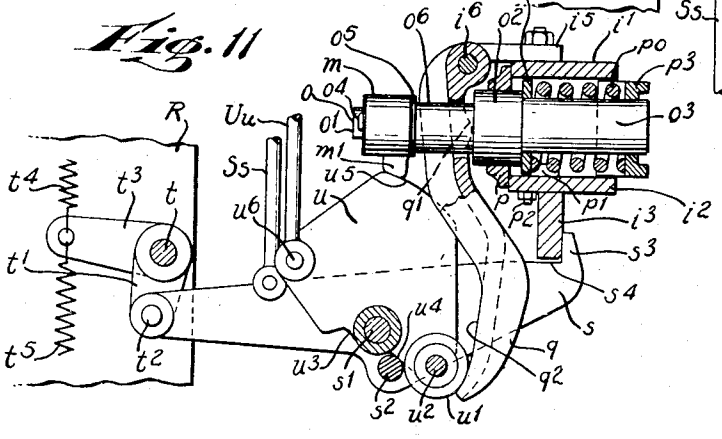


Fig. 11



INVENTOR
JOEL S. POTTER
BY
John E. Hubbell
ATTORNEY

Patented May 9, 1939

2,157,566

UNITED STATES PATENT OFFICE

2,157,566

COKE OVEN DOOR MACHINERY

Joel Sanford Potter, Valley Cottage, N. Y., assignor to Louis Wilputte, New Rochelle, N. Y.

Application June 25, 1935, Serial No. 28,264

4 Claims. (Cl. 212—4)

The present invention relates to door handling machinery adapted for use in handling furnace doors, and particularly doors of the type employed to form the removable end closures for the horizontally elongated coking chambers of coke ovens of the type most commonly used in the manufacture of metallurgical coke. The invention is directly concerned with and comprises improvements in door handling machinery specially devised and adapted for use in moving doors having my improved door securing means devised by me, into and out of their normal closed positions.

Coke oven doors of the type referred to are heavy structures and must be anchored securely in place in their normal closed positions, to prevent gas leakage through the joints between the doors and cooperating door frames. It is now standard practice to secure a coke oven door of the type in place by the use of one or more, usually two, locking bars acting between a rigid metallic outer portion of the door, and stationary hook parts located at the sides of the door and carried by a metallic door frame member or other portion of the metallic armor at the sides of the coke oven battery and in normally fixed relation with the coke oven brickwork.

My door securing means improvements involve no departure from prior practice in respect to the features just mentioned. Preferably, also, my improved door securing means follows a known prior practice, in that each door locking bar is pivotally connected to its door for rotation about a horizontal axis for turning movement from a horizontal position in which it engages a cooperating stationary hook part or parts, into an inclined position in which the locking bar is disengaged from the hook part or parts.

The improved door securing means are of especial utility in the case of so-called self sealing doors. Heretofore it has been usual to employ a rigid or positive force transmitting connection, usually a threaded connection between each locking bar and the rigid outer metallic door portion, which may be so adjusted that when the bar is in engagement with the stationary hooks, the door is held in engagement with the door frame member with the proper sealing pressure. The pressure with which a self sealing door needs to be held against its seat on the door frame member is substantial, and in practice, may well be some six or seven tons or so. In the improved doors, the positive or unyielding, though adjustable, connection between the door and its locking bar, is replaced by spring means, the spring tension of which holds the door against the door frame member with the required pressure.

One specific object attained by the use of such spring means, is a certain automatic insurance against the effect of an improper adjustment of the nut and screw, or other positive adjusting means, heretofore employed, and which, if not properly adjusted, will hold the door against the door frame member with a pressure greater or less than is desirable.

The sealing pressure between the door and its sealing seat on the door frame member, ordinarily is so heavy that it must be released before the locking bars are moved out of engagement with, and cannot be reestablished until the bars are back in position to engage said hook parts. Heretofore the release and reestablishment of that pressure with doors of the type improved upon herein, has required two independent manual operations, one respectively prior to the engagement and subsequent to the disengagement of the door by the door handling machinery which is employed to move the door out of and back into its closed position. A specific object of my present invention is to render said manual operations unnecessary and to automatically release and reestablish the sealing pressure, by the door handling machinery as the latter operatively engages and releases the door at the beginning and conclusion, respectively, of a door removal and replacement operation.

The tension with which the spring means acts on the latching bar may be reduced to permit the rotation of the latter into its unlocking or locking position, by causing the door handling machinery to press the spring means toward the door frame member, and thereby temporarily increase the sealing pressure with which the door engages the door frame member. Such an increase in the sealing pressure, if material is undesirable, and one object of my invention is to so relate the door and door handling mechanism as to avoid or minimize such increase in sealing pressure by the machinery when the latter is operated to reduce the spring action on the latching bar. To this end, in a preferred form of the present invention, the door carried spring means, and the cooperating door machine parts, are so arranged that the spring means may be held under the increased tension required to release the locking bar, without requiring any significant pressure between the door and door frame member.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a

part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with it, reference should be had to the accompanying drawings and descriptive matter, in which I have illustrated and described perferred embodiments of the invention.

Of the drawings:

Fig. 1 is a side elevation, partly broken away, of a portion of a coke oven battery with one door in place and a second door removed;

Fig. 2 is a partial horizontal section on the line 2—2 of Fig. 1;

Fig. 3 is an elevation in section on the line 3—3 of Fig. 1, and showing door machine parts not shown in Fig. 1;

Fig. 4 is an elevation of some of the parts shown in Fig. 3;

Fig. 5 is a plan view of a portion of the coke oven machine shown in Fig. 3;

Fig. 6 is a fragmentary view taken similarly to Fig. 3, illustrating a modified arrangement.

Figs. 7, 8, 9, and 10 are views with parts broken away and in section, illustrating different positions of the upper door engaging parts of the machine shown in Figs. 3 and 4, relative to one another of the portion of the door to stay engaged as said parts are brought into operative engagement with the door and the latter is given its initial opening movement; and

Fig. 11 is a view of the lower door engaging parts of the machine shown in Figs. 3, 4, and 5, and the portion of the door engaged by them, when said parts are in the position corresponding to the position of the parts shown in Fig. 9.

In the coke oven structure shown in part in Figs. 1, 2, and 3, horizontally elongated coking chambers A and heating walls B, are arranged side by side in a row, in which the coking chambers alternate with the heating walls. The coke oven masonry is reinforced and supported at the sides of the battery by a metallic armor, which as shown, comprises a flash plate C at each heating wall end, a corresponding vertical buckstay D by which the flash plate is held in place, and a door frame member E at each end of each coking chamber. Each door frame member E may be, and as shown, is a one piece casting extending around the door opening, and includes a portion E′ which extends into the coke oven brick work, and is shaped to provide an outwardly sealing surface E^2 extending transversely to the length of, and surrounding the coking chamber. The corners of the heating walls are recessed at B′ to permit the door frame member to extend into the oven structure as described. The door frame member E is also provided as shown, with adjustable side flanges E^3 abutting against the adjacent flash plates C.

In the construction shown, each door frame member E is anchored in place by adjustable clamping connections between its sides and the adjacent buckstay members D, said connections comprising parts *d* welded to the buckstays, clamping levers F, and bolts G. Each lever F has one end pressed against the door frame member, and has its other end pressed against the corresponding part *d* by a bolt G. Each door frame member E, as shown, has rigidly attached thereto an upper hook part H and a lower hook part *h* at one side of the door, and an upper hook part H′ and lower hook part *h′* at the opposite side of the door. The hook parts at the opposite sides of the door extend in opposite directions. As shown, the hooks H and *h* extend downwardly, and the hooks H′ and *h′* extend upwardly. The door illustrated, comprises a rigid outer frame section I, an inner plug section J of refractory material, and sealing means adapted to engage the above mentioned sealing surface E^2. As shown, the frame section I comprises main vertical angle bars connected by cross frame members which are welded at their ends to said channel bars, and which include the hereinafter mentioned members I′, I^2, I^3, *i′*, i^2, and i^3. The sealing means portion of the door shown comprises a flexible metal plate K forming a section of the door intermediate the rigid outer frame section I and the inner plug section J. The plate K extends across the doorway in the closed position of the door, and is formed with a transverse marginal flange K′ at its inner side. The edge of the flange K′ is pressed into sealing engagement with the door frame surface E^2 in the closed position of the door. In the door shown, the element K forms a mechanical connection between the rigid outer frame section I and the plug section J, through which the latter is supported from the frame section, when the door is being moved by door handling machinery engaging the section I as hereinafter described. To this end, in the particular door construction illustrated, the refractory plug section material is supported on a horizontal base portion K^5 of a metallic bracket member K^6 secured to the lower portion of the member K, and the latter is pivotally connected adjacent its upper end to the outer frame section I by a horizontal shaft K^7 through which the member K and the plug section J are suspended from the frame section I when the door is supported by the door handling machinery as hereinafter described. In the normal closed position of the door, the base portion K^5 engages, and is supported by the subjacent sill portion of the door frame member E, as shown in Fig. 3. Horizontal screws L extending parallel to the length of the oven, and threaded through brackets I^4 carried by the outer frame section I, engage bearing parts K^2 secured to the flexible element K adjacent its outer margin, at points distributed around the doorway, and form means by which the edge K′ may be caused to bear properly against the door frame sealing surface, notwithstanding relative distortion of the door frame and door parts developing in use. Upper and lower locking bars M and *m*, respectively, are mounted on the outer frame section I for movement into and out of their normal position shown in Fig. 1, in which the upper bar M engages the door frame hooks H and H′, and the lower bar *m* engages the hooks *h* and *h′*, and the door is thereby held in place, with its sealing edge bearing against the sealing surface E^2 of the door frame.

The particular door arrangement illustrated in Figs. 1, 2, and 3, insofar as it has been described in detail, is a typical example of one of various forms of self sealing coke oven doors with which my invention may be used with advantage. Various above mentioned special features of door construction and arrangement shown in Figs. 1, 2, and 3, form the subject matter of the Louis Wilputte Patent No. 2,025,967, and application Ser. No. 977, filed January 8, 1935, and are not necessarily employed in coke oven doors with which the present invention is used. For the purposes of the present invention, it is in general essential, however, that the door should comprise a strong outer metallic portion on which locking bars, such as the bars M and *m* are mounted; and

that the door should be of the self sealing type, and comprise sealing means like, or more or less analogous to those formed by the plate K with its sealing edge K', for engagement with a door frame sealing surface like or analogous to the hereinbefore mentioned surface E^2.

In the form of the invention shown in Figs. 1, 2, and 3, the locking bars M and *m* are similar, and similarly mounted on the door section I. The bar M is pivoted for turning movement into and out of engagement with the hooks H and H' on a horizontal pivot extending transversely of the battery and formed by the reduced outer end portion O' of a pivot member O mounted between two spaced apart cross frame members I' and I^2 of the outer door section I, and the lower bar *m* is similarly mounted on the reduced outer end portion *o'* of a second pivot member *o* mounted between two other cross frame members *i'* and i^2, of the door section I.

The cross frame members I' and I^2 shown are in the form of heavy horizontal metal plates or bars, welded or otherwise secured at their ends to the vertical angle bar members of the door section I. The pivot member O is a spring pressed plunger element comprising an intermediate enlarged or collar portion O^2 slidingly received in an aperture formed for the purpose in an uprising plunger support P. The latter has a convex inner face shown in Fig. 2, which bears against the edges of the cross frame members I' and I^2, as shown clearly in each of Figs. 2 and 7. In the particular construction shown, the support P is loosely held in place. For that purpose the member P (see Figs. 2 and 7) is formed with inwardly extending arms P' resting on the cross frame member I^2, and connected to the latter by bolts P^2 which pass loosely through bolt holes in the arms P' to permit some self adjustment of the member P relative to the members I' and I^2. The portion O^3 of the plunger O, which is at the inner side of, and smaller in cross section than the collar portion O^2, is surrounded by a helical spring PO acting between the plunger portion O^2 and an abutment yoke P^3 connected to the support P by bolts P^4. As shown, the abutment part P^3 has its ends slidingly received between the members I' and I^2 and assists in holding the plunger member O in proper relation to the parts I' and I^2. The yoke P^3 is formed with an aperture through which the inner end of the plunger portion O^3 extends and in which the latter is slidingly received. As shown, the spring PO acts on the collar O^2 through an annular bearing part PO' which surrounds the plunger portion O^3 and extends radially outward beyond the periphery of the portion O^2, so that when the plunger O does not oppose the expansion of the spring PO, the latter expands and moves the plunger outward until the bearing part PO' engages the adjacent face of the member P. As shown, the locking bar M is held on the plunger O by a pin O^4 and a washer O^5. The outward thrust of the plunger O on the bar M is transmitted from the shoulder at the inner end of the reduced portion O' of the plunger to the bar through washers O^5. By varying the number or thickness of the washers O^5 at the inner and outer sides of the locking bar, the latter may be axially adjusted on the plunger portion O'.

Beneath the cross frame member is a third cross frame I^3, in the form of a vertically disposed plate or bar having its ends welded to the vertical angle bar portions of the door section I. As hereinafter explained, the member I^3 serves as the door part through which the door may be lifted by the door handling machine. The part I^3 and a cooperating part Q (Figs. 9 and 10) also form means through which the machine takes the tension of the spring PO off the locking bar M. The part Q is a lever pivotally connected at its upper end to the member I by means shown as comprising a pivot shaft I^6 connecting the lever Q to a bracket I^5 which is bolted to member I' The lever Q is formed with an aperture loosely receiving the plunger portion O^6. The latter connects the plunger portions O' and O^2 and in cross section is smaller than the portion O^2 and larger than the portion O'. The lever Q has rounded bearing surfaces Q' engaging the outer end of the collar O^2 at opposite sides of the axis of the plunger O. As will be readily apparent, force acting between the frame member I^3 and lever Q, and tending to move the latter toward the former, will move the plunger O inward and compress the spring PO without necessarily transmitting any reactive force through the door to the door frame member E. Associated with the lower locking bar *m* are parts i^1, i^2, i^3, i^5, i^6, *o*—o^6, *p*—p^4, *po*, *po'* and *q*, corresponding to the above mentioned parts I^1, I^2, I^3, I^5, I^6, O—O^6, P—P^4, PO, PO', and Q, respectively.

To remove and replace coke over doors including the above mentioned features of my invention, I have devised an improved coke oven door machine, one form of which is shown in Figs. 3 and 4. Said door machine comprises a main frame or supporting member R which is adapted to be moved bodily in the direction of the length of the oven chambers, as required for operative engagement with a door and for the movement of the latter out of its closed position far enough to clear the armor at the corresponding side of the battery, and which is adapted to be moved longitudinally of the battery, into positions for engagement with the different doors, and to move a door engaged and held by the door machine laterally of the coking chamber to which the door pertains, so that such chamber may be discharged. In accordance with the customary practice of the prior art, illustrated, for example, in Patent No. 1,357,058, granted October 26, 1920, the door machine member R, at the pusher side of the battery, may be mounted on the coke pusher machine which supports and actuates the ram by which the coke is discharged from the coking chambers of the battery, and at the coke side of the battery the member R may be mounted on a special door machine carriage running on a trackway extending longitudinally of the battery. The door machine shown in Figs. 3 and 4, is intended for use at the coke side of the battery, and has its member R mounted on a special door machine carriage RA running on track rails *r* carried by the battery bench structure A'. In the particular form of the machine shown, the member R is suspended by parallel links R' from the upper portion of the carriage RA. There are two links R' at each side of the member R, and the links are of such length, and so vertically disposed that the required movement of the member R toward and away from the side of the battery differs little from a straight line horizontal movement, the slight up and down movement imparted to the member R as the latter moves between the limits of its movement toward and away from the door, being without significance.

The member R is moved toward and away from the door by a motor of which only the speed reducing gear portion RB is shown, which is mounted on the carriage RA and gives oscilla-

tory movements to a horizontal rock shaft R^2. The latter extends longitudinally of the battery and is journalled in the carriage RA, and has a crank arm R^3 connected by a rod R^4 to a yoke member R^5 through which the motor RB oscillates the rock shaft R^2. As shown, the motor RB acts on the yoke member R^5 through a crank pin R^6 carried by a crank arm R^7 rotated by the motor. To limit the thrust which the door machine can impress through a door on the corresponding door frame of the battery, a yielding connection is provided between the motor RB and rock shaft R^2. That connection in the form shown, is provided between the crank pin R^6 and yoke member R^5, and comprises a cross head R^8 in which the crank pin R^6 is journalled, and which is mounted in the yoke member for sliding movement relative to the latter away from a yoke bearing surface, against the action of cushion springs R^9 by which the cross head is normally held against said surface. The springs surround rod extensions R^{10} of the yoke forming guides for the cross head and having spring abutment nuts R^{11} threaded on them. The rotative movements of the rock shaft R^2 are positively related to the horizontal movements of the member R toward and away from the battery through crank arms R^{12} carried by the rock shaft, and links R^{13} connecting the arms R^{12} to the suspension links R' at opposite sides of the member R.

Mounted on the supporting member R, and projecting forwardly from the latter toward the adjacent side of the coke oven battery, are upper and lower door engaging levers S and *s*, which may be identical in form, though as hereinafter explained, the lever S may perform a door lifting function not performed by the lever *s*. The lever S is conveniently formed of two side parts or halves rigidly connected by a nonrotatable shaft S' and bar S^2 (Figs. 5, 7–10). The lever S is connected to the support R by means permitting turning movement of the lever to raise and lower the door engaging end of the lever, and preferably, and as shown, to permit of a limited horizontal bodily movement of the lever relative to the support, toward and away from the door. As shown, the connection means between R and S, comprises a rock shaft T journalled in the support R and provided at its end with crank arms T' carrying oppositely extending crank pins T^2 on which the adjacent side parts of the lever S are journalled. Intermediate its ends, the shaft T carries an arm T^3 (Figs. 5, 7–10) connected to the support R by oppositely acting tension springs T^4 and T^5, which tend to hold the shaft T in a predetermined or normal angular position in which the crank pins T^2 are directly below the shaft T. Springs T^6 adjustably connected at their upper ends to the support R and connected at their lower ends to the opposite sides of the lever S, serve a letter lifting function hereinafter described. The clockwise rotation of the rock shaft T is positively limited by engagement of each crank arm T' with a corresponding adjustable abutment or stop shown as a bolt T^7 threaded through a corresponding integral lug or ear portion of the member R. Preferably no such stops are provided to limit the movements of the crank arm *t'*.

At its door engaging end, each side part of the lever S is formed with an uprising hook portion S^3 adapted to pass back of the previously mentioned door part I^3, when the lever S is moved from the position shown in Fig. 7 into that shown in Fig. 8. In the position shown in Fig. 8, the door part I^3 is engaged by the upper edge portions S^4 of the lever S adjacent the hooks S^3.

A cam lever member U journalled on the shaft S', comprises a part adapted to engage the previously mentioned lever Q, and shown as a roller U' turning on a pivot or crank pin U^2 carried by the member U. When the member U is turned clockwise about the shaft S' from the initial lever Q engaging position of the member shown in Figs. 3 and 7, the roller U' gives a relative movement of separation to the shaft S' and lever Q. The angular movements of the member U are limited by the engagement of its edge portions U^3 and U^4 with the shaft bar S^2. An edge portion U^5 of the member U engages a cam portion M' of the locking bar M and tilts the latter into unlocking position when the parts are in the positions shown in Fig. 10. The locking bar *m* has a similar cam part *m'*. The member U is connected through a pivot pin U^6 to the end of a link W^2 (Fig. 3) connected at its other end to a crank pin W^3 carried by an arm W^1 secured to a rock shaft W parallel to the shaft T and journalled in the support R. The rock shaft W is oscillated, as shown, by means of a second arm W^4 carried by the shaft W, and connected by a connecting rod W^5 to a crank pin X' carried by a crank arm secured on the end of a crank shaft X^2. The shaft X^2 carrying crank arm X, is rotated by a motor X. The motor X may advantageously be an electric motor which has its armature shaft connected to the shaft X^2 by speed reducing gearing, and which is provided with controlling provisions, whereby the motor, whenever energized, will give a half turn to the shaft X^2.

The door mechanism parts cooperating with the lower door parts i^3 and *q*, comprise parts *s*—s^2, *t*—t^5, *u*—u^6, corresponding to the previously mentioned parts S—S^2, T—T^5, U—U^6

The springs T^6 exert a lifting action on the lever *s* as well as on the lever S, as a result of the connection of the lever *s* to the lever S by one or more links Ss. Advantageously, there are two links Ss arranged side by side, and respectively connecting the two side parts of the lever S to the corresponding side parts of the lever *s*. Each link advantageously includes a turn buckle Ss' for adjusting the link length, so that the turning movements of the lever *s* will properly follow the turning movements of the lever S. The turning movements of the two levers would be identical except for some horizontal movement of crank arms T' relative to the crank arms t^4 occurring under certain conditions. The member *u* is given movements corresponding generally to the movements of the part U by means of a link Uu pivotally connected at its upper end to the member U and at its lower end to the member *u*. Advantageously, and as shown, the link Uu includes a turn buckle Uu' by which the length of the link may be varied. The door and door machine parts are shown in Fig. 3 and in Fig. 7 in the relative positions occupied by them, when the door machine is in position to engage the door preparatory to its removal. The levers S and *s* and members U and *u* are then in their lowermost positions.

This results from the link connection between the lever *s* and S, the action on the lever S of the member U, and the fact that the rock shaft W is at the limit of its clockwise movement and, through the link W^2, holds the pivot shaft U^6 in the lowermost position of the latter. The lifting springs T^6 are under tension sufficient to move

the levers S and s upward to the upward limits of the movements permitted them, when not prevented from doing so by the action on the levers of the members U and u. In the position shown in Figs. 3 and 7, the shoulders U^3 and u^3 engage the bars S^2 and s^2, respectively, and the levers S and s are positively held in their lowermost positions.

With the lever Q directly above the lever q, it is theoretically possible to bring the rollers U' and u' into respective engagement therewith without disturbing the tension of the springs T^4 and T^5, t^4 and t^5, and without displacement of the pivots T^2 and t^2 from their normal positions directly beneath the shaft T and t, respectively. In normal operation, however, the movement of the door machine frame or support R into the door engaging position, will cause the rollers U' and u' to engage levers Q and q, respectively, with sufficient force to angularly adjust the crank arms T' and t' in the clockwise direction until the arms T' engage the corresponding abutments T^7. In practice, the engaging pressure will be sufficient, ordinarily, to produce a slight movement of the cross head R^8 against the action of the cushion springs R^9.

After the rollers U' and u' are brought into their operative engagement with the levers Q and q, respectively, the motor X is started into operation, and gives a counterclockwise adjustment to the rock shaft W, which through its connection to the pivot U^6, then moves the lever S and member U from their positions shown in Fig. 7, successively through the positions shown in Figs. 8 and 9 into the positions shown in Fig. 10, and gives generally similar movements to the lever s and member u. The cam edge Q^2 of the lever Q engaged by the roller U', is preferably so shaped that the initial upmovement of the parts S and U will permit the arm T' to move away from the abutment T^7, as the parts move from the position shown in Fig. 7 into those shown in Fig. 8. During such initial movement, the lever S is raised by the springs T^6 so that there is then no relative movement of the parts U and S. This initial upmovement of the lever S terminates when the edge portions S^4 of the lever S engage the underside of the door part I^3, as shown in Fig. 8.

As the upward movement of the pivot U^6 continues after the upmovement of the lever S is arrested by engagement with the part I^3, the member U turns about the shaft S' from the position shown in Fig. 8 into that shown in Fig. 9, in which the edge or shoulder U^4 engages the bar S^2. Thereafter, further upmovement of the pivot U^6 raises the hook end of the lever S, and lifts the door to the extent indicated by the difference between the full and dotted line positions of the part I^3 shown in Fig. 10.

As the member U turns about the shaft S' from the position shown in Fig. 8 into that shown in Fig. 9, the roller U' moves downward along the cam edge Q^2 of the lever Q. The cam edge Q^2 is so shaped relative to the path of movement of the roller U', that as the member U turns from the position shown in Fig. 8 into that shown in Fig. 9, some relative movement of the shaft S' and lever Q away from one another must occur. Owing to the strong tension of the spring PO, the above mentioned relative movement does not initially effect the position of the lever Q, but does move the shaft S' away from the battery until the hook portions S^3 of the lever S engage the door part I^3. Thereafter the continued movement of the roller U' along the edge Q^2 of the lever Q turns the latter counterclockwise about its pivot I^6, thereby compressing the spring PO and relieving the pressure which that spring had previously exerted against the latch bar M. The latter is thus freed to turn about its pivot O' before the cam edge U^5 of the member U engages the edge of the cam portion M' of the lever M. That engagement, occurring during the final portion of the movement of the member U from the position of Fig. 8 into the position of Fig. 9, tilts the locking bar M out of engagement with the door frame hooks H and H'. The door is thus unlocked and free for removal when the parts have reached their positions shown in Fig. 9.

The cam edges Q^2 and q^2 are preferably so shaped that no turning movements are given the levers Q and q by the turning movements of the levers U and u, which occur while the cam portions U^5 and u^5 are in operative engagement with the cam portions M' and m', respectively.

As the up movement of the pivot U^6 continues from the position of the latter shown in Fig. 9, into that shown in Fig. 10, the lever S lifts the door sufficiently to provide bottom clearance for the door removal. The latter is effected, after the door is raised as shown in Fig. 10, by the action of the motor RB, which is then started into operation to rotate the shaft R^2 counter-clockwise and move the door outwardly from the battery to provide the desired clearance between the inner side of the door and the outer edges of the buckstays. Thereafter, the door machine carriage RA is moved along the track rails r out of line with the oven from which the door has been removed, and coke in that oven can be discharged.

The door machine parts are so proportioned, that in the condition of the parts shown in Fig. 9, the pivots T^2 are then necessarily displaced toward the abutment T^7 from their normal positions directly beneath the rock shaft T. In consequence, the pull of the link W^2 on the pivot U^6, as the weight of the door is taken by the lever S, will move the lever S away from the battery until that movement is arrested by the abutment T^7. The initial lifting of the door is thus accompanied by a slight outward movement of the door part I^3, as is indicated by the full and dotted line showings in Fig. 10. The engagement of the abutment T^7 by crank arm T', effected on the movement of the parts into the positions shown in Fig. 10, will be maintained in normal operation until the door is put back in place and the door machine support R is thereafter moved outwardly from the battery by the action of the motor RB.

During the door engaging and removing operation, the lever s and member u are given movements corresponding generally to those of the lever S and part U, respectively, except for some differences in the bodily movement of the two levers S and s relative to the shafts T and t, respectively. Those differences result from door and oven distortion, the omission of stops corresponding to the stops T^7 for limiting the turning movement of the shaft t, and the non-lifting engagement of the lever s with the door.

Some distortion of coke oven doors and the coke oven structure proper, is an inevitable result of their continued use. That distortion does not significantly effect the vertical distance between the door parts I^3 and i^3, but it does change the relative positions horizontally of those parts and of the parts Q and q, in the closed position of the door. If the part I^3 is not directly above the part i^3 of a door in the closed position of the latter, the

initial forcible engagement of the levers Q and q of the door, by the rollers U' and u', will result in unequal horizontal displacements of the levers S and s. It will also result in inequality in such displacements when the hooks S^4 engage the part I^3, as shown in Fig. 9, and the hooks s^4 similarly engage the door part i^3. As previously explained, the parts are so proportioned that when the lower edge of the door part I^3 is engaged by the lever portions S^4, the corresponding portions of the lever s will be below the lower edge of the door part i^3, so that when the door is lifted, none of its weight is borne by the lever s. In consequence, the pull of the link Uu does not tend to move the lever s toward the support R when the door is lifted.

Advantageously, the springs t^4 and t^5 are so proportioned that when the door sealing flange K' is not in engagement with the door frame seat E^2, the lever s will be so displaced from the support R that when the door machine moves the door back into place, the bottom portion of the door flange K' will engage the seat E^2 before the top of the door flange engages that seat. This is desirable in the case of a self sealing door, since if the bottom portion of the door sealing flange is not in snug engagement with the door frame sealing surface when the weight of the door is transferred from the door machine to the sill portion of the door frame, it is difficult, if not impossible, to prevent gas leakage at the bottom of the door.

In putting the door back into place, the movement of the door machine frame R toward the door frame is ordinarily continued until the pressure of engagement is sufficient to cause the cushion springs R^9 to yield. Those springs should be so proportioned that they will yield under an engagement pressure, appreciably below that produced by the springs PO and po when the door is locked in place. The yielding pressure of the springs R^9 is preferably high enough, however, to so overcome the action of the springs T^5 and t^5 so that the levers s and S may move toward the member R as much as may be necessary to insure engagement of the sealing flange K' with the door frame seat E^2 from top to bottom of the door, before the weight of the latter is transferred from the door machine to the door frame. However, if the bottom of the door sealing flange is brought into suitably snug engagement with the door frame C before the door is locked in place, the spring PO will insure suitable engagement between the upper portion of the sealing flange K' and seat E^2, when that spring is free to act between the door and the locking bar M.

In the door replacement and relocking operation, the parts are moved from their positions shown in Fig. 10 into their positions shown in Fig. 9, and thence through their positions shown in Fig. 8 into the positions shown in Fig. 7, after which the door machine frame R is moved outward to separate the rollers U and u from the levers Q and q, respectively, and permit the springs PO and PO' each to exert its full force between the door and the corresponding locking bar. As will be apparent, the cam portions M' and m' of the locking bars M and m, respectively, give the locking bars a gravitational bias for counter-clockwise movement, as seen in Fig. 1, into their locking positions shown in that figure, and as the apparatus is adjusted from the condition illustrated in Fig. 9 to that illustrated in Fig. 8, the locking bars M and m automatically move into their locking positions under the said gravitational bias.

While my improved doors may be handled with especial advantage by a door machine having the general operating characteristics of the machine illustrated by Figs. 3–11, the improved doors may be removed and replaced by other door handling machines. In general, however, the door handling machine employed should be adapted to automatically compress the springs normally acting between the door and door locking bars, so that the latter may readily be turned between their locking and unlocking positions. Each such spring may be so compressed by the direct action of the door machine on the corresponding plunger O or o, as in the arrangement shown in Fig. 6. The door machine frame member RC of Fig. 6 may correspond in its general functions and movements, to the frame R of Figs. 3 and 11, but includes a part R^{20} adapted to abut against the door plunger O and compress the spring PO. The plunger O is provided, as shown, with a cap member O^{10} for direct engagement by the part R^{20}. A lever SA pivoted at S^{10} to the frame part RC may be turned about the pivot S^{10} by a link W^{10} motor actuated generally as is the link W^2 of the machine shown in Fig. 3, to move the lever SA, after the spring PO has been compressed by the part R^{20}, into and out of the position in which the lever hook S^{30} is back of the door part I^3 and the latter is engaged and lifted by the hook portion S^{40}. The lever SA has a cam edge portion S^{50} which is adapted to engage the cam portion M' of the locking bar M and to tilt the latter into its unlocked position as the lever turns into operative engagement with the door part I^3.

The frame member RC is provided with another bearing part r^{20} for engagement with, and the compression of the lower latch bar spring o, but need not, and as shown, does not include a hook or other part for engaging the lower portion of the door. The lower locking bar m is given such locking and release movements as are given the bar M, by means of a link Mm in connection between the bars. By locating the link Mm at the same side of the vertical plane of the axes of the plunger O and o, as the projections M' and m' are located, the weight of the link and projection M' each contribute to the gravitational action returning the locking bars to locking position when the cam portion S^{50} and the compression of the springs PO and po permit such return.

To insure practically simultaneous and similar spring compression movements of the upper and lower plungers O and o, suitable provisions should be made for compensating for the effects of door and door frame distortion on the relative positions of the upper cap member O^{10} and the corresponding lower cap member o^{10} of the door. Such provisions may take various forms. It is possible, for example, to provide a movable support for one or both of the parts R^{20} and r^{20}, so that the latter are automatically adjusted relative to one another on their engagement with the two spring plungers, but with the construction shown in Fig. 6, the desired compensation for distortion may be secured by the simple expedient of replacing the lower cap member o^{10}, by another cap member differing therefrom only in that it is of greater or less axial length than the cap member which is replaced.

With an assortment of interchangeably usable cap members of different lengths in stock, it is thus relatively simple and inexpensive to maintain the relative effective lengths of the plungers O and o of the doors of a coke oven battery required for generally similar compression of the springs PO

and *po* of the different doors by the door machine parts R^{20} and r^{20}. Certain novel door machine features and door and door machine combination features disclosed but not claimed herein are claimed in my application, Serial No. 95,806, filed August 13, 1936, and certain other novel door and door machine combinations and the novel door features and combinations, disclosed but not claimed herein, are claimed in my copending application, Ser. No. 84,596, filed June 11, 1936.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

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

1. A coke oven door machine comprising a support, a door lifting part adapted to engage an upper portion of a door at the outer side of the center of gravity of the door and lift the latter, a door engaging part adapted to engage the lower portion of a door being lifted by the first mentioned part, each of said parts being mounted on and supported by said support for horizontal movement relative thereto in a direction to diminish the distance between the portion of the door engaged by it and said support, resilient means opposing such movement of the first mentioned part, means for subjecting the latter to a door lifting force acting on said part in a direction to move the latter horizontally against the action of said resilient means, and resilient means acting between tho second mentioned part and the support and opposing the said horizontal movement of the second mentioned part with a force great enough to prevent such horizontal movement from being effected by the tendency toward angular movement of the door created when the door is lifted by the first mentioned part.

2. In a door machine, the combination with a support, of a hook lever pivotally connected at one end to and supported by said support and having a door engaging hook at its opposite end, a second lever connected to said hook lever to turn relatively thereto and including a door engaging portion adapted to be moved into engagement with a door engaged by said hook by turning movement of said second lever relative to said hook lever and to interrupt the latter on such engagement, and means for applying a force to said second lever to effect said turning movement and to lift said hook lever when said turning movement is interrupted.

3. A coke oven door machine comprising a support, an upper hook lever and a lower hook lever, each formed at its one end with a door engaging hook and each connected at its other end to and supported by said support for movement relative thereto about a horizontal axis to raise and lower its hook end and in a generally horizontal direction to thereby vary the distance of its hook end from said support, resilient means associated with each lever and opposing said horizontal movement, means for impressing a door lifting force on the upper lever acting on the latter in a direction to raise its hook end and to move the latter horizontally toward said support, and a connection between said levers for causing the hook end of the lower lever to share in the up and down movements of the hook end of the upper lever.

4. A coke oven door machine comprising a support, an upper hook lever and a lower hook lever, each supported by said support and each being formed at one end with a door engaging hook and being connected at its other end to said support for movement relative thereto about a horizontal axis to raise and lower its hook end and in a generally horizontal direction to thereby vary the distance of its hook end from said support, resilient means associated with each lever and opposing said horizontal movement, means positively limiting the extent of horizontal movement of the upper lever, means for impressing a door lifting force on the upper lever acting on the latter in a direction to raise its hook end and to move the latter horizontally toward said support, and a connection between said levers for causing the hook end of the lower lever to share in the up and down movements of the hook end of the upper lever.

JOEL SANFORD POTTER.