April 1, 1958 N. BARDSLEY ET AL 2,828,871

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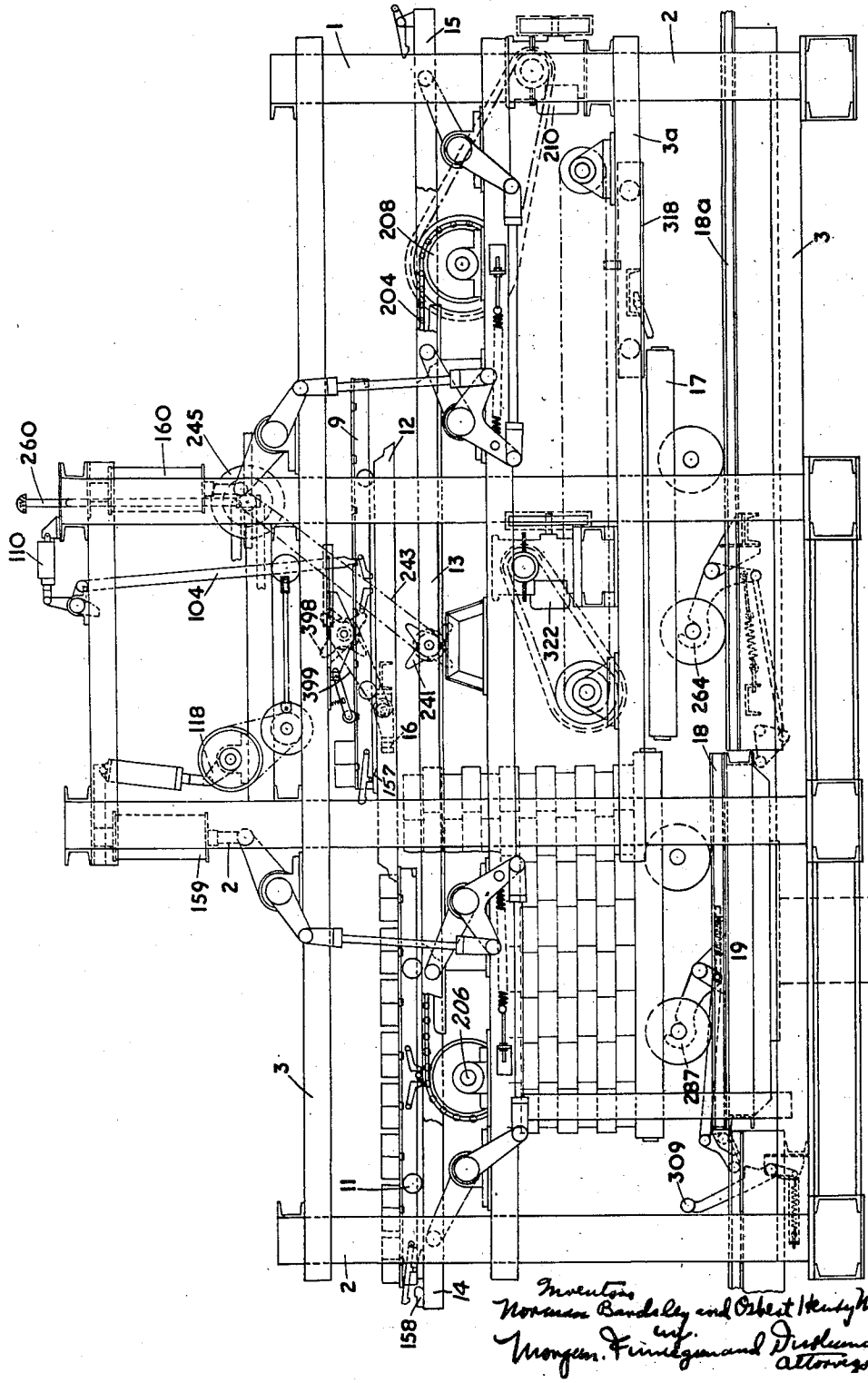

Fig. 1

Inventors
Norman Bardsley and Osbert Henry Nichols.
by Morgan, Finnegan and Durham
their attorneys.

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MECHANICAL STACKER

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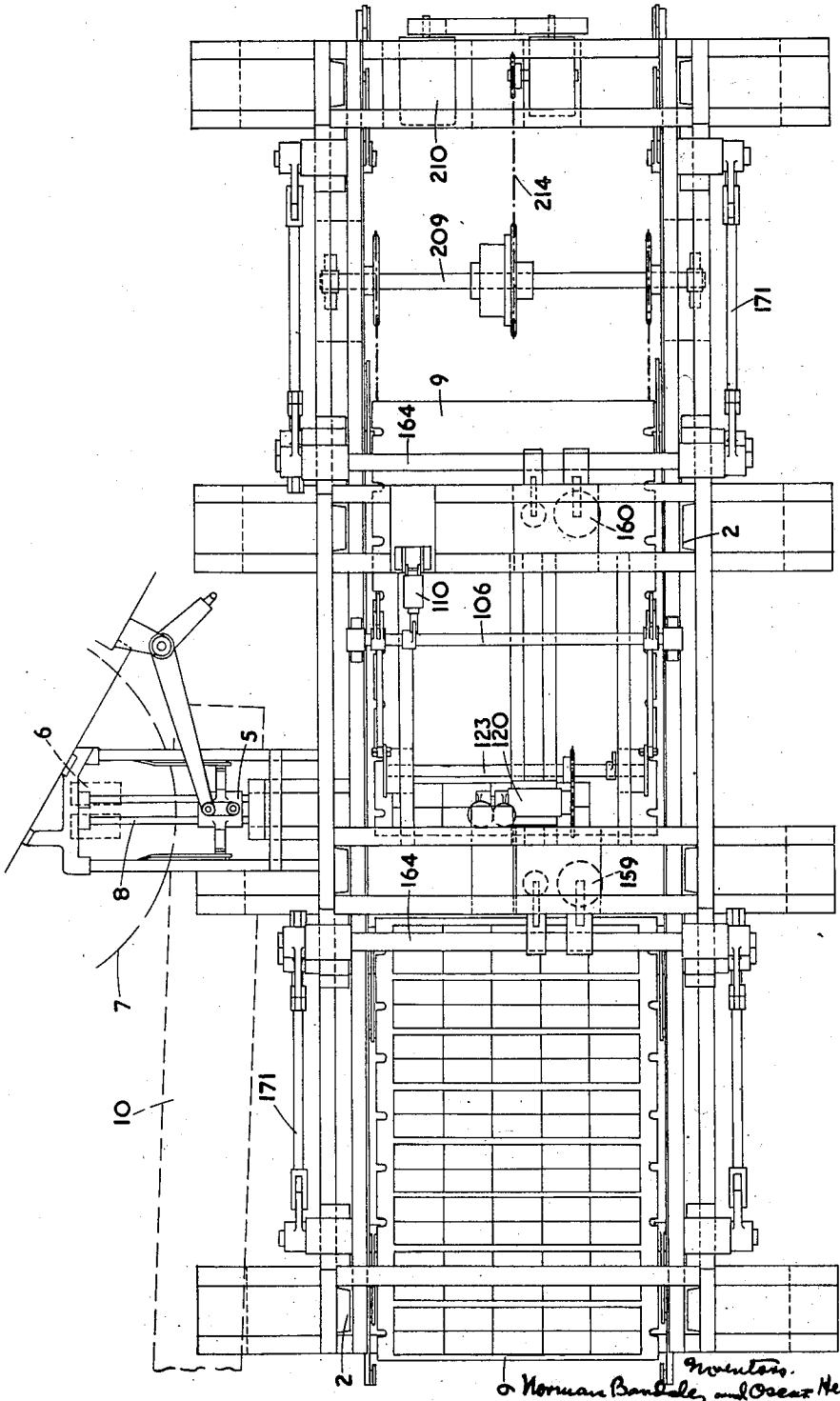

Fig. 2

Inventors.
Norman Bardsley and Oscar Henry Nichols
by Morgan Finnegan and Durham
attorneys.

April 1, 1958 N. BARDSLEY ET AL 2,828,871

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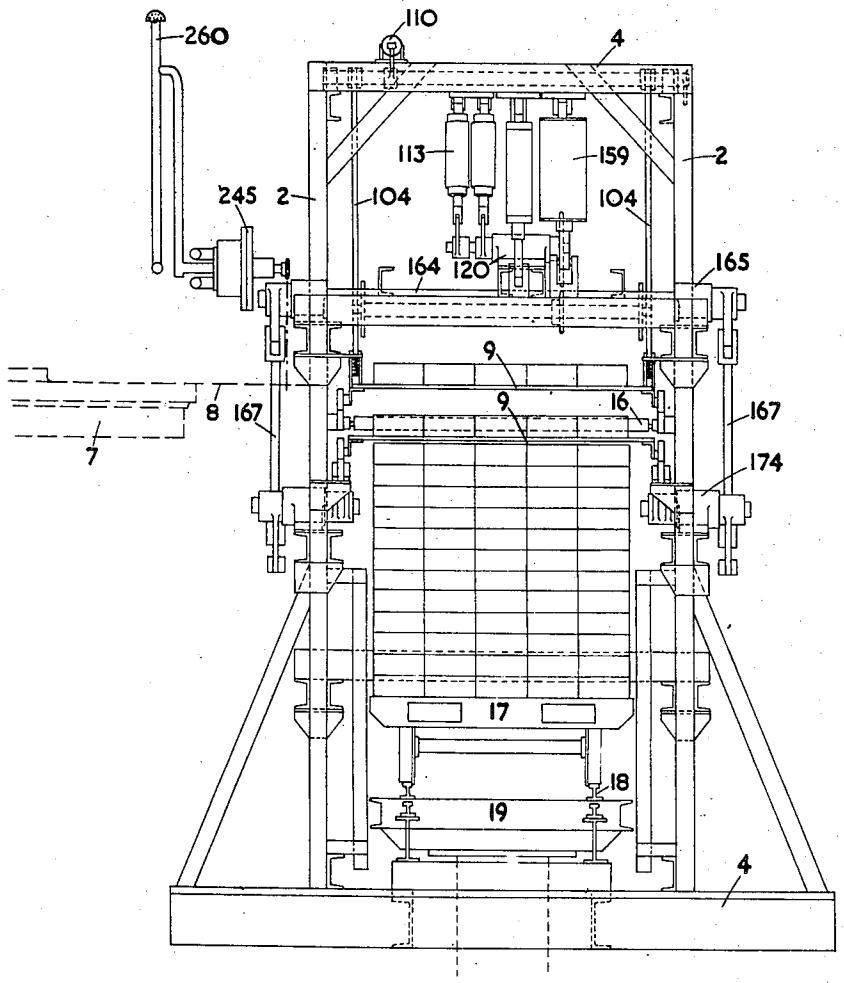

Fig. 3

Inventors:
Norman Bardsley and Osbert Henry Nichols.
by
Morgan, Finnegan and Durham
Attorneys.

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MECHANICAL STACKER

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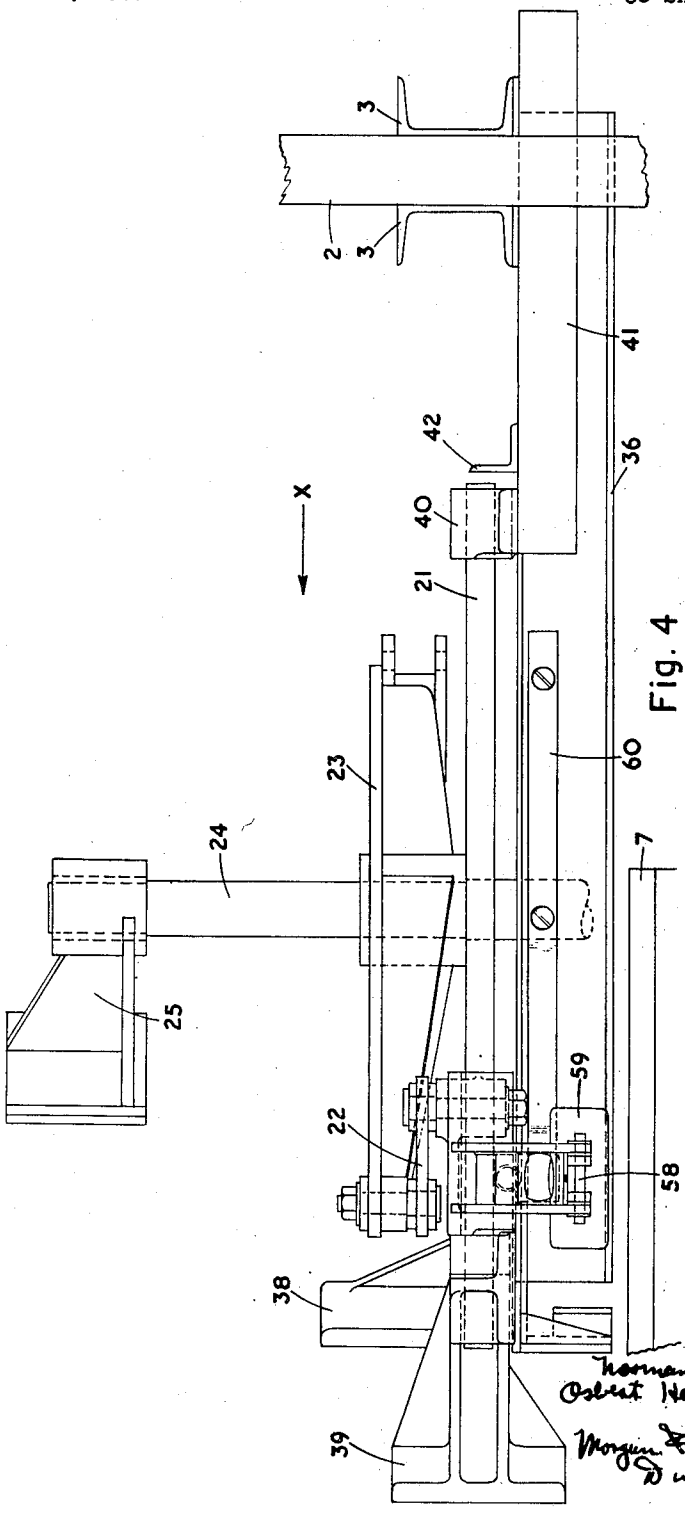

Fig. 4

Inventors.
Norman Bardsley and
Osbert Henry Nichols
by
Morgan Finnegan and
Durham
Attorneys.

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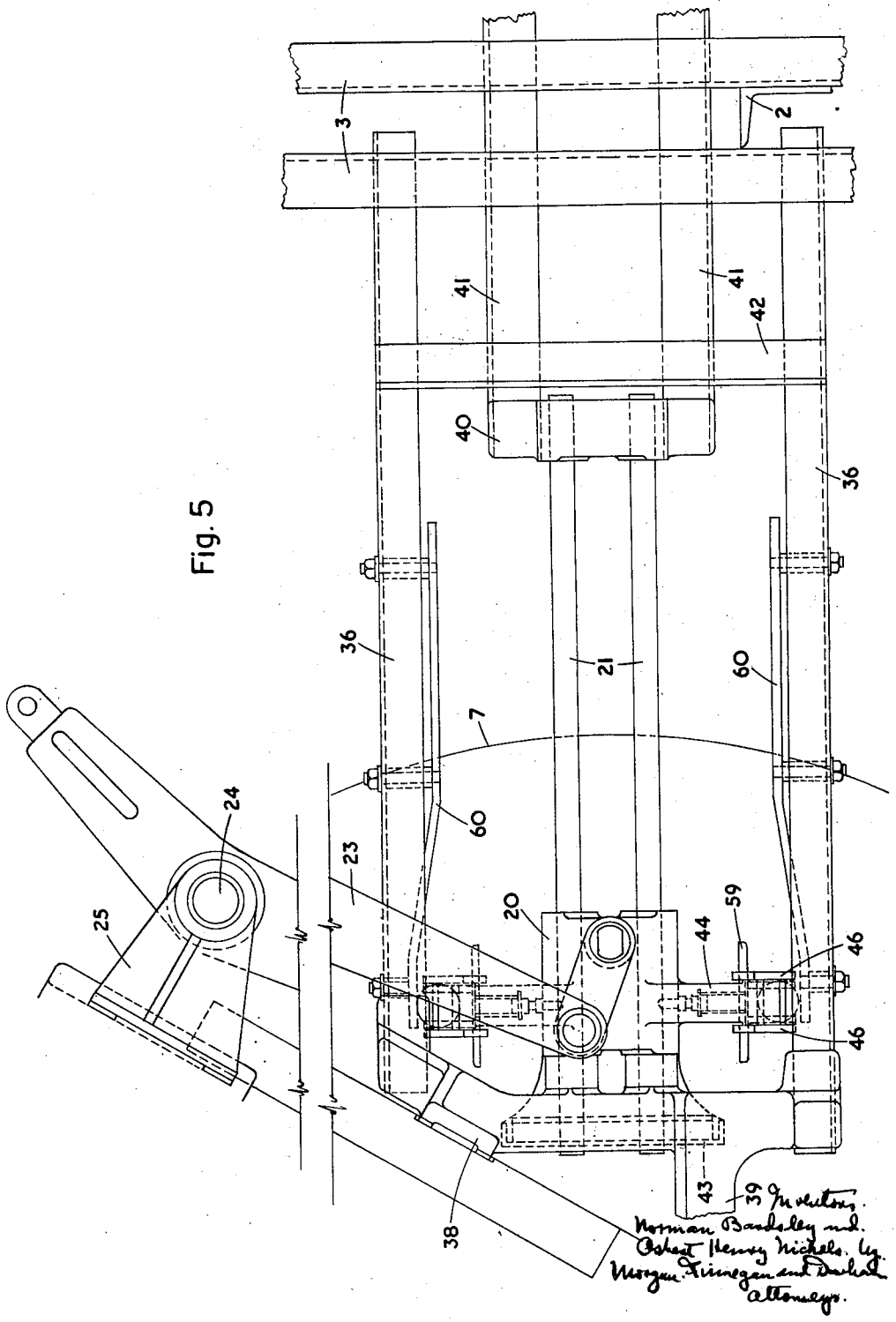
Fig. 5



Inventors.
Norman Bardsley and.
Osbert Henry Nichols. by.
Morgan Finnegan and Durham
Attorneys.

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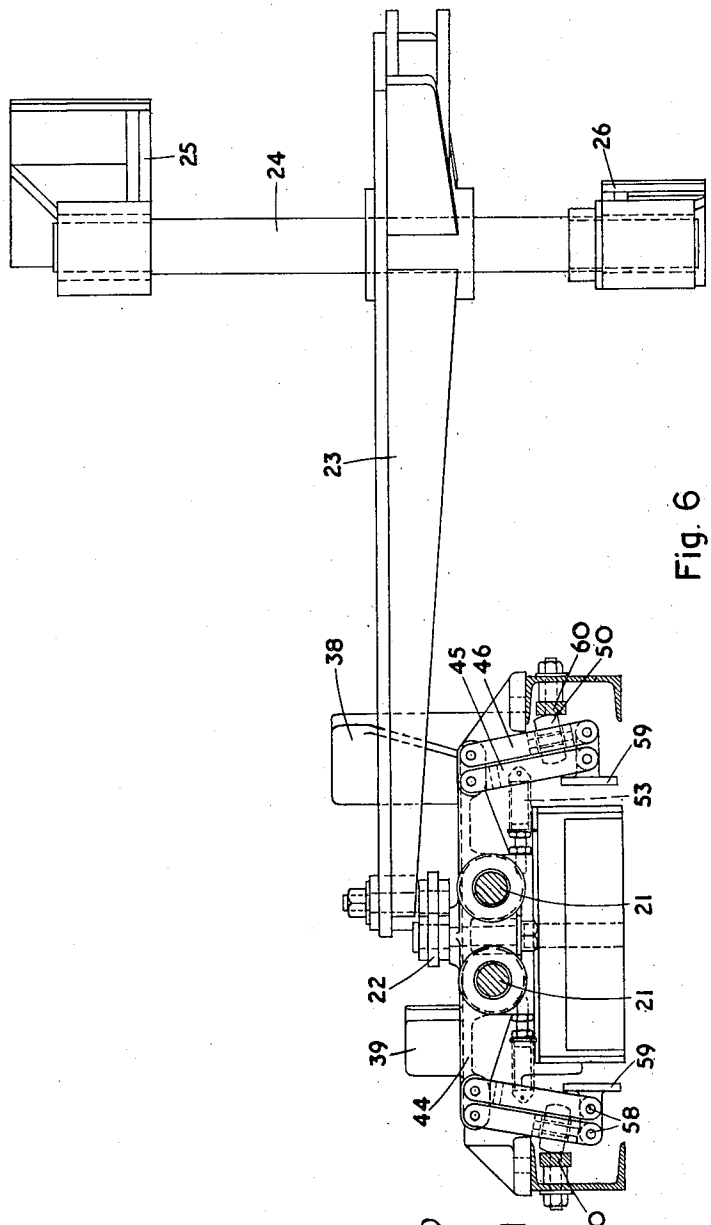

Fig. 6

Inventors.
Norman Bardsley and Osbert Henry Nicholls
by
Morgan, Finnegan and Durham
Attorneys.

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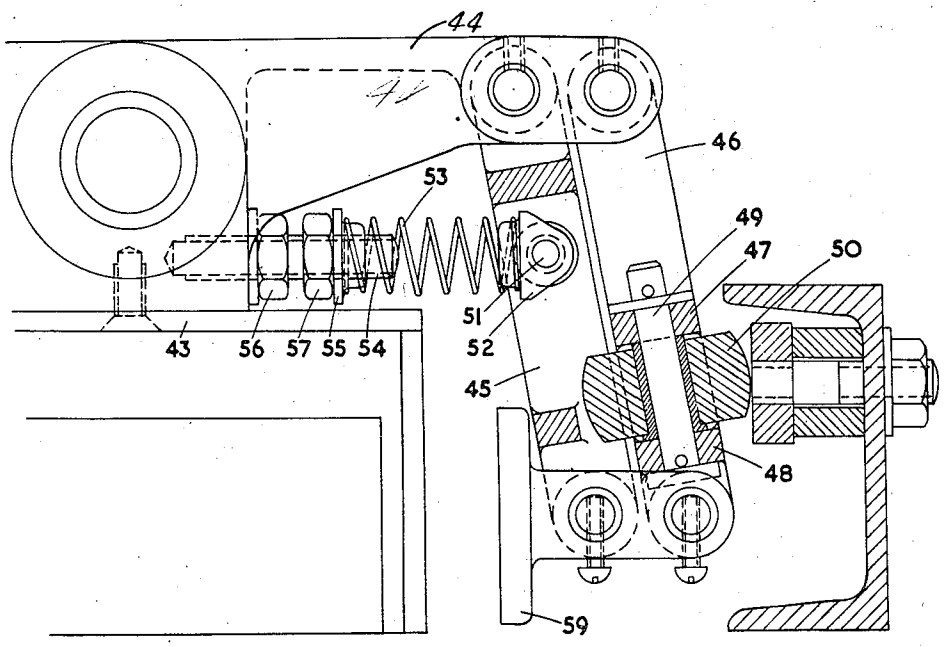

Fig. 7

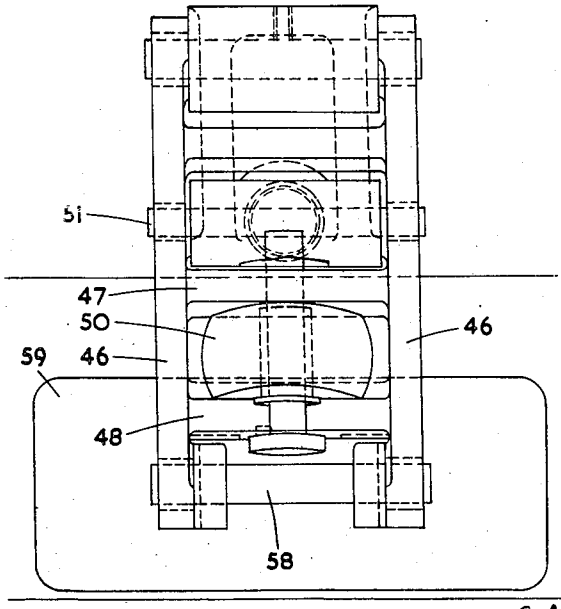

Fig. 8

Inventors
Norman Bardsley
and
Osbert Henry Nicholas by
Morgan, Finnegan and Durham
Attorneys

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MECHANICAL STACKER

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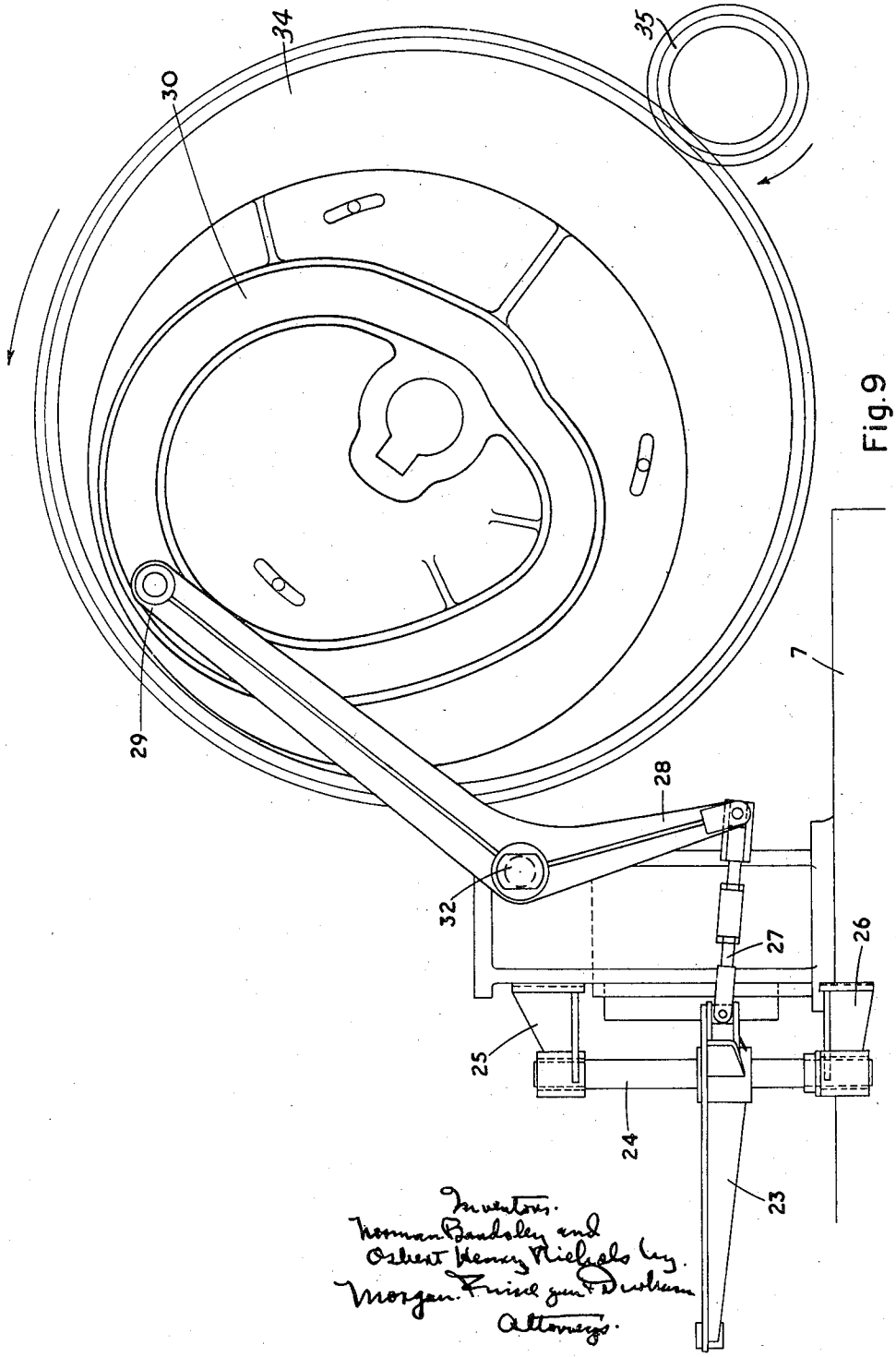

Fig.9

Inventors.
Norman Bardsley and
Osbert Henry Nicholls by.
Morgan, Finnegan & Durham
Attorneys.

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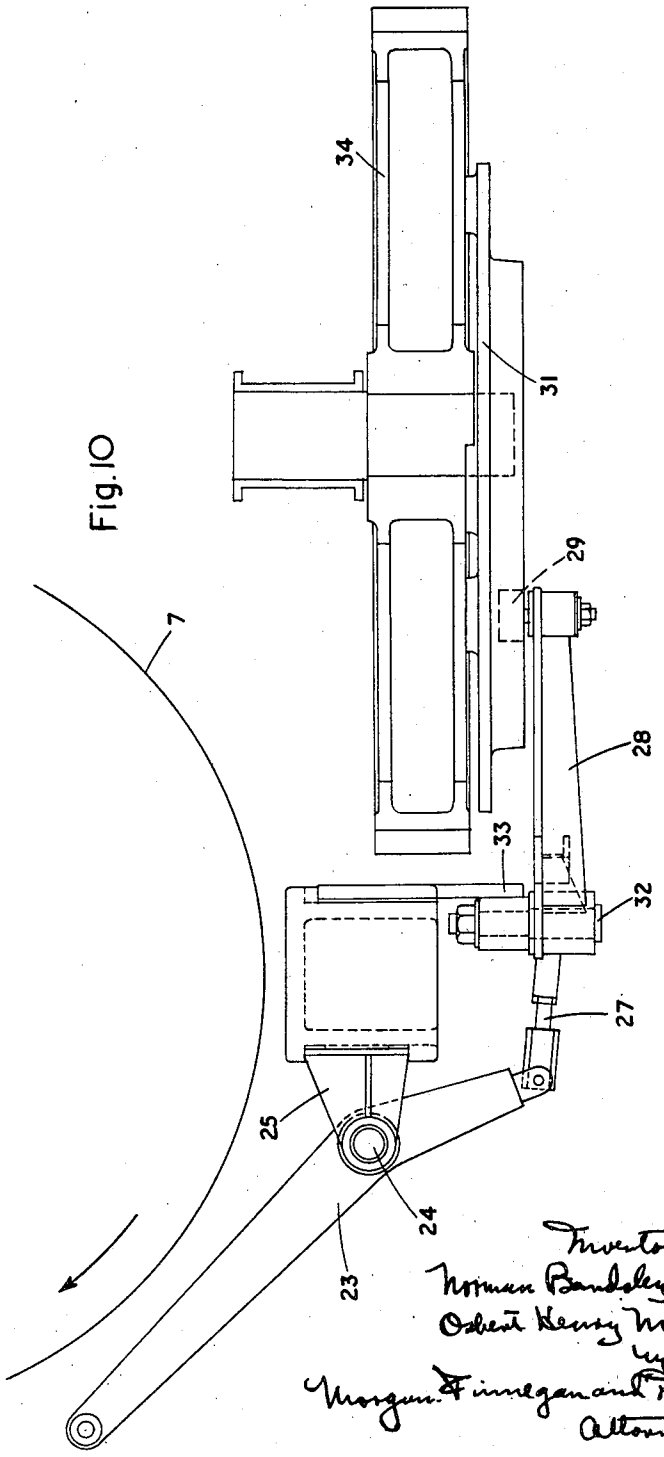
Fig. 10



Inventors.
Norman Bardsley and
Osbert Henry Nichols.
By
Morgan, Finnegan and Durham
Attorneys.

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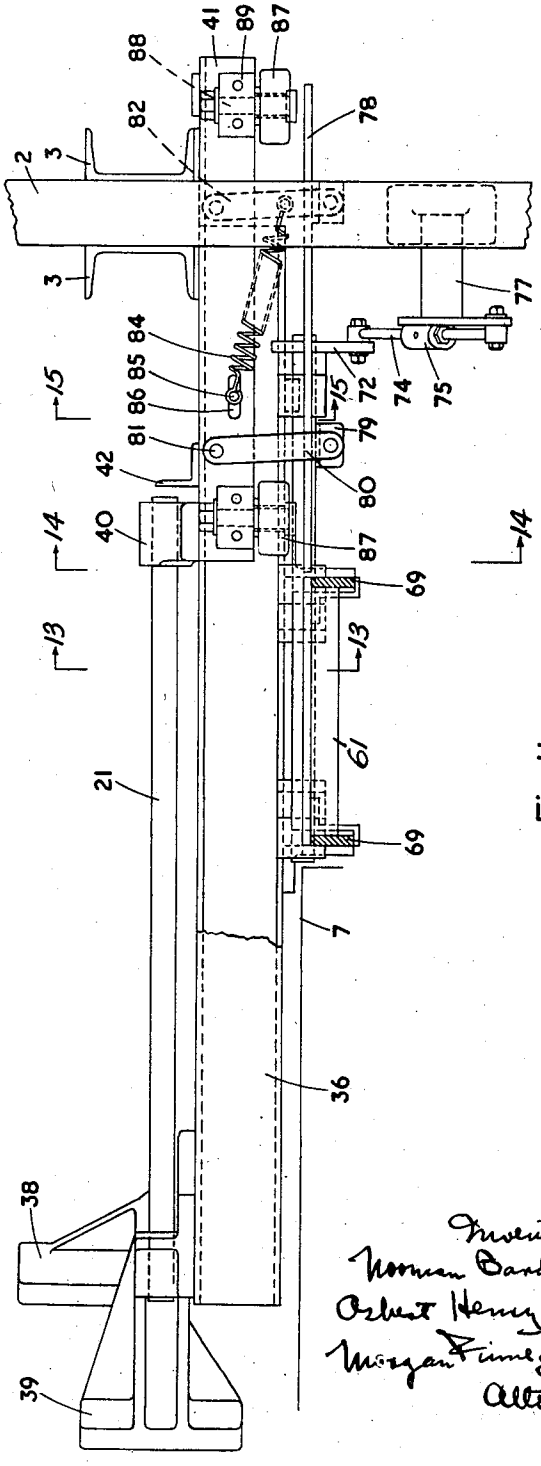

Fig. 11

Inventors.
Norman Bardsley and
Osbert Henry Nichols by
Morgan Finnegan and Durham
Attorneys.

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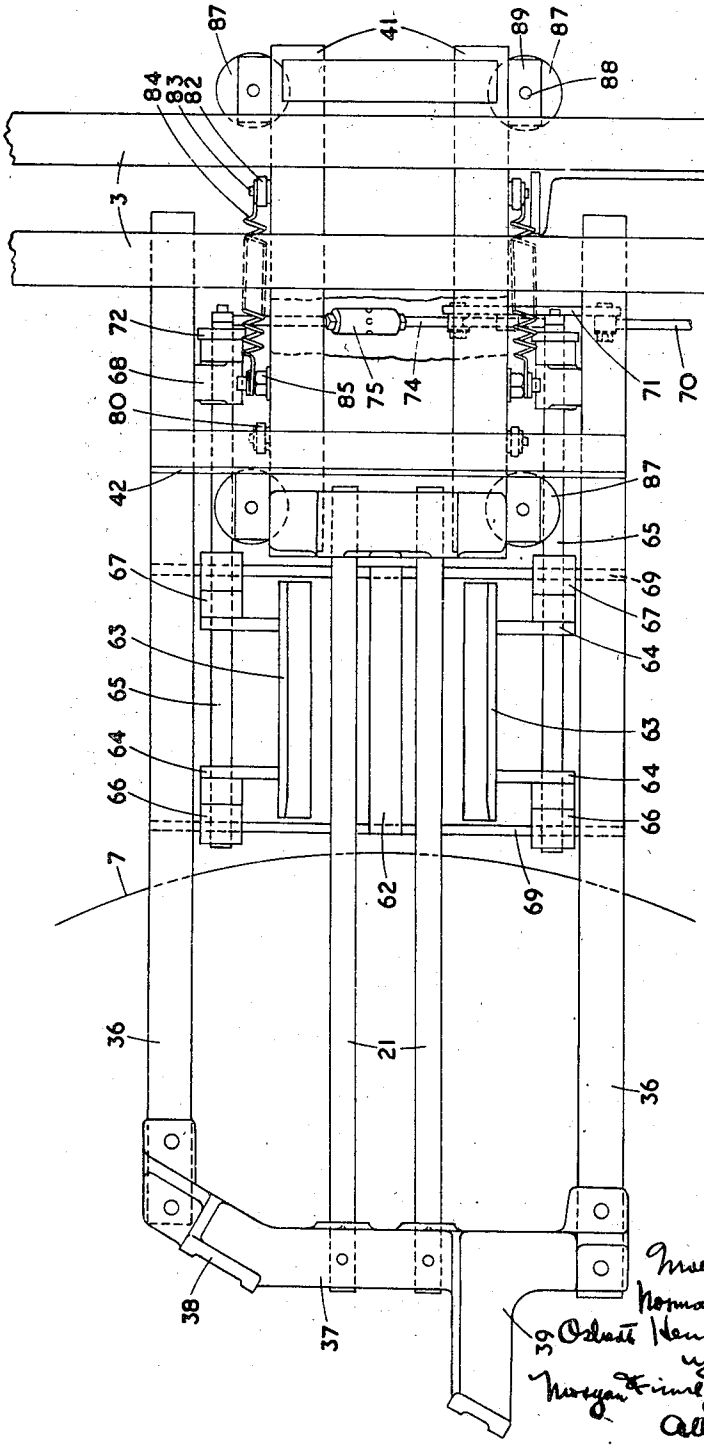

Fig. 12

Inventors.
Norman Bardsley and
Osbert Henry Nicholls.
By
Morgan Finnegan & Durham
Attorneys.

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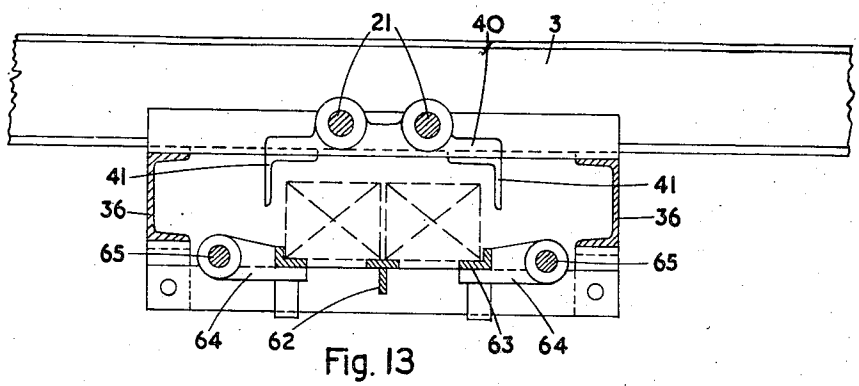

Fig. 13

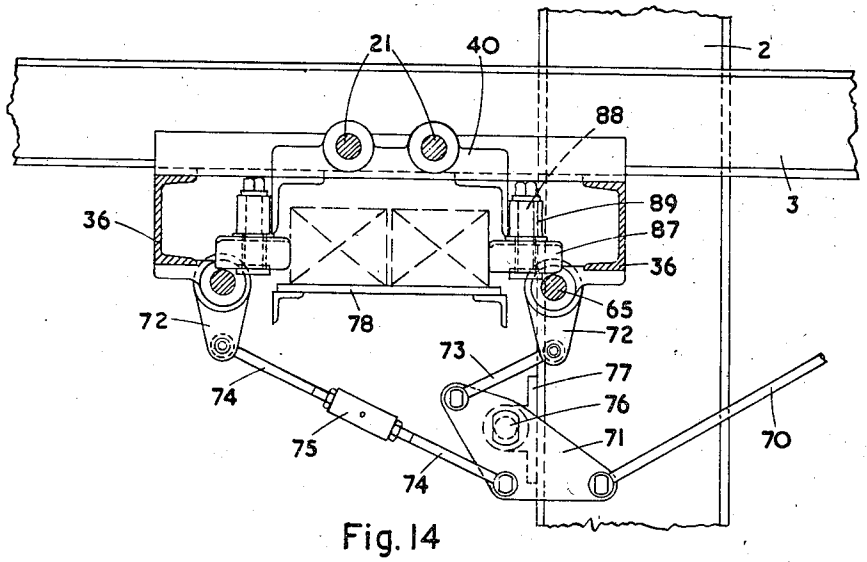

Fig. 14

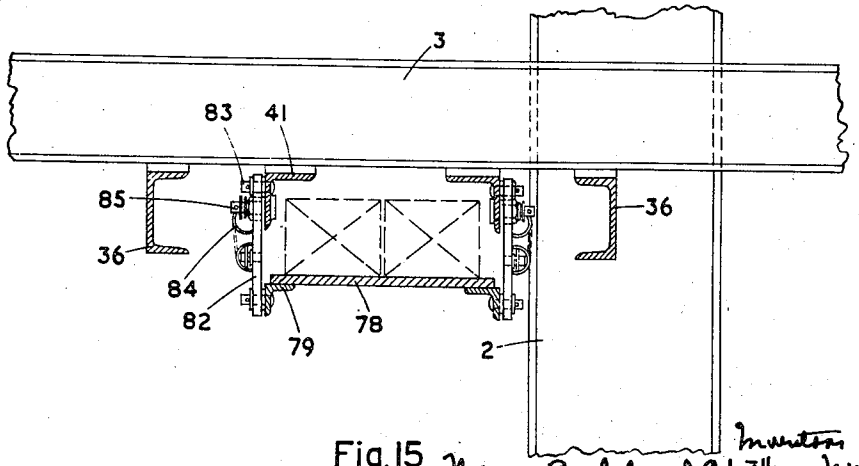

Fig. 15

Inventors
Norman Bardsley and Osbert Henry Nicholls
by
Morgan Finnegan and Durham
Attorneys.

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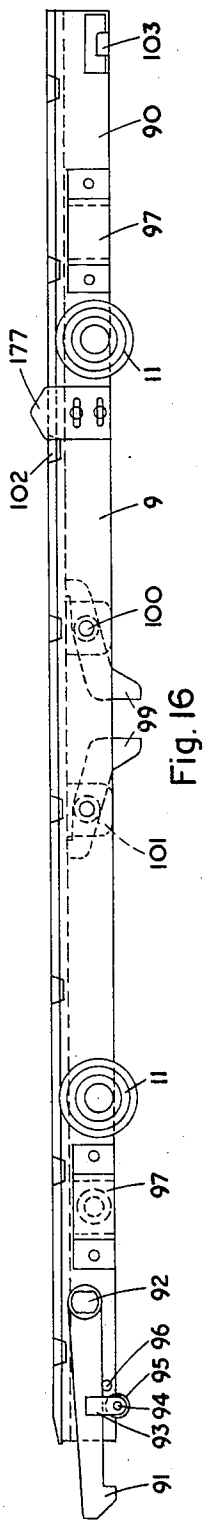

Fig. 16

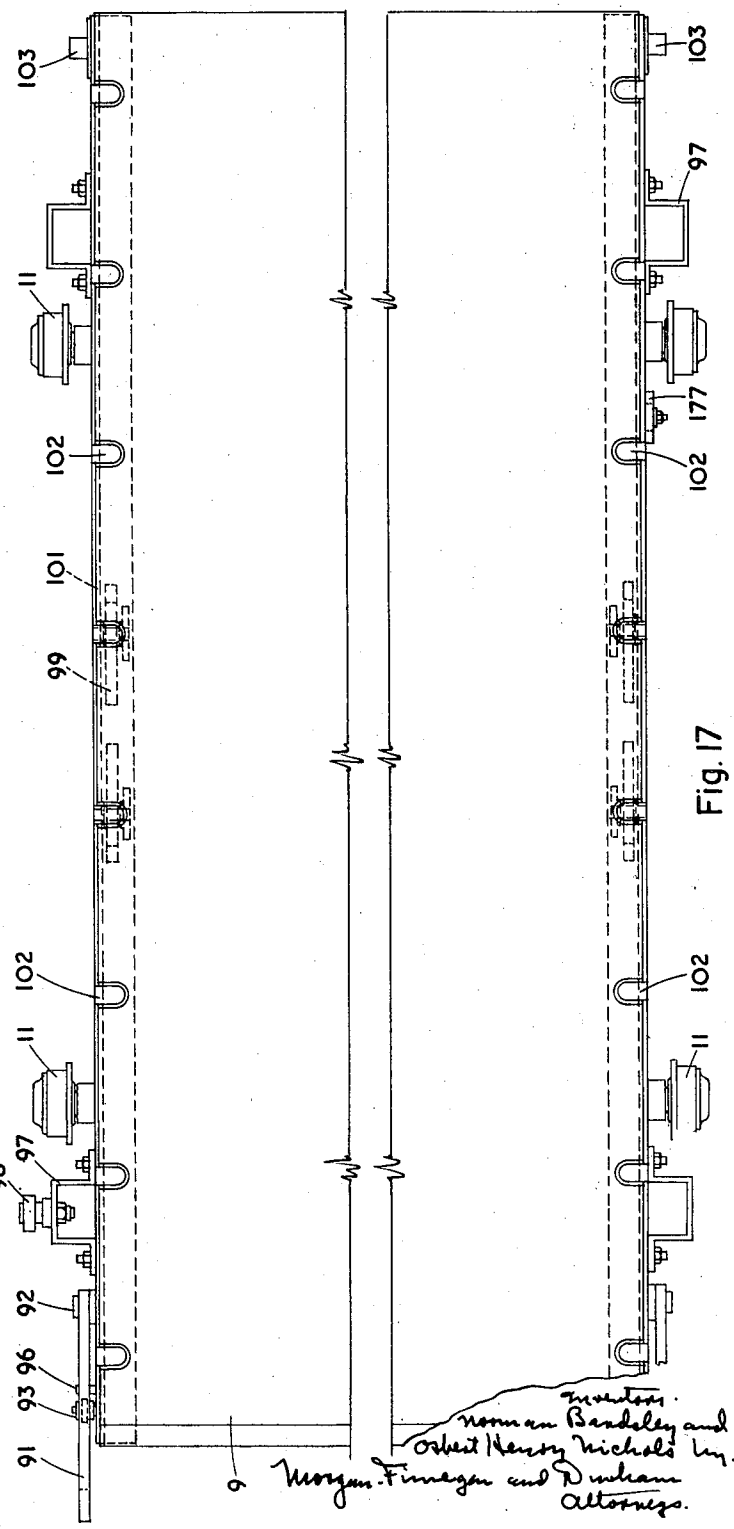

Fig. 17

Inventors.
Norman Bardsley and
Osbert Henry Nicholls by
Morgan, Finnegan and Durham
Attorneys.

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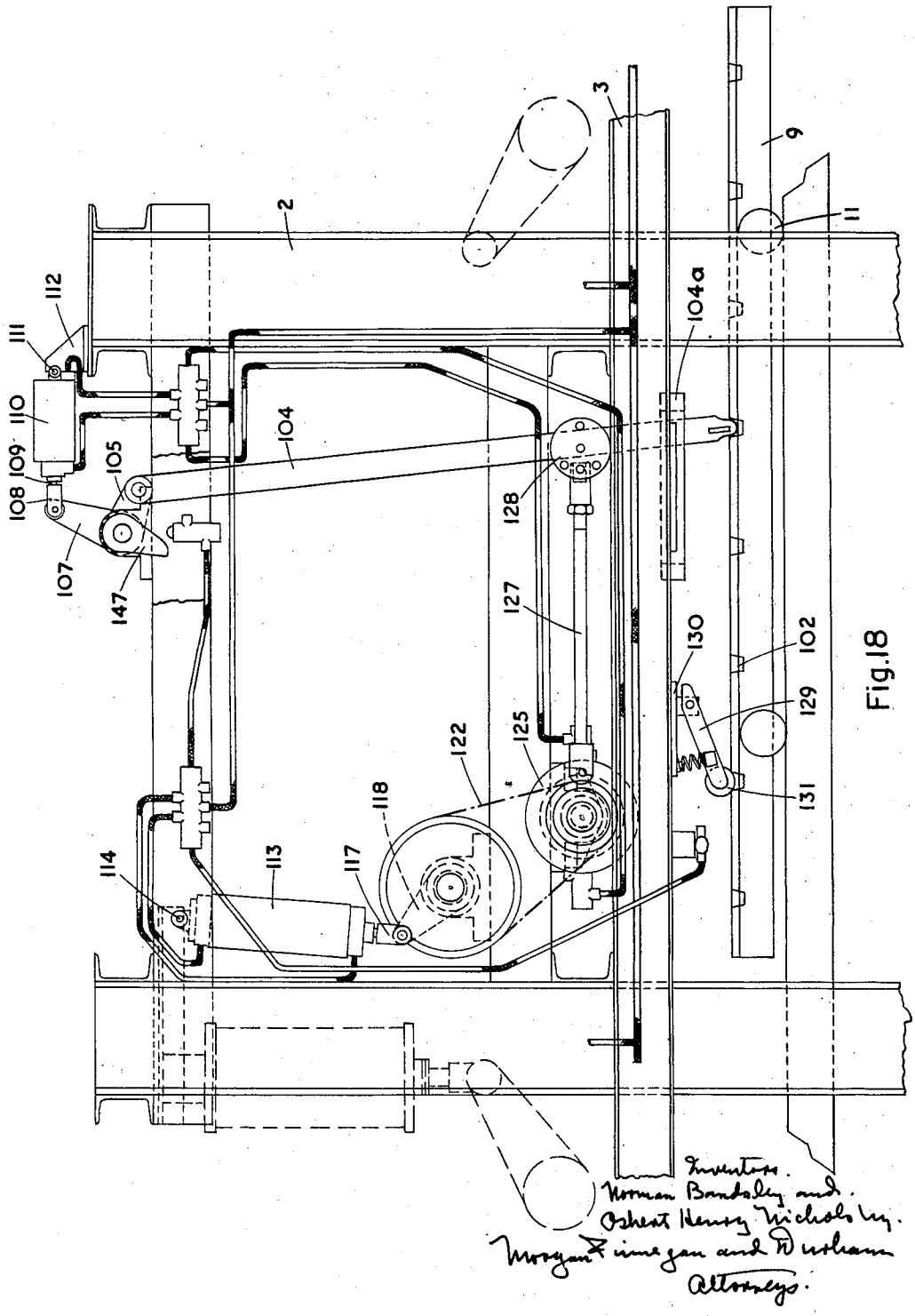

Fig.18

Inventors.
Norman Bardsley and
Osbert Henry Nicholls
Morgan Finnegan and Durham
Attorneys.

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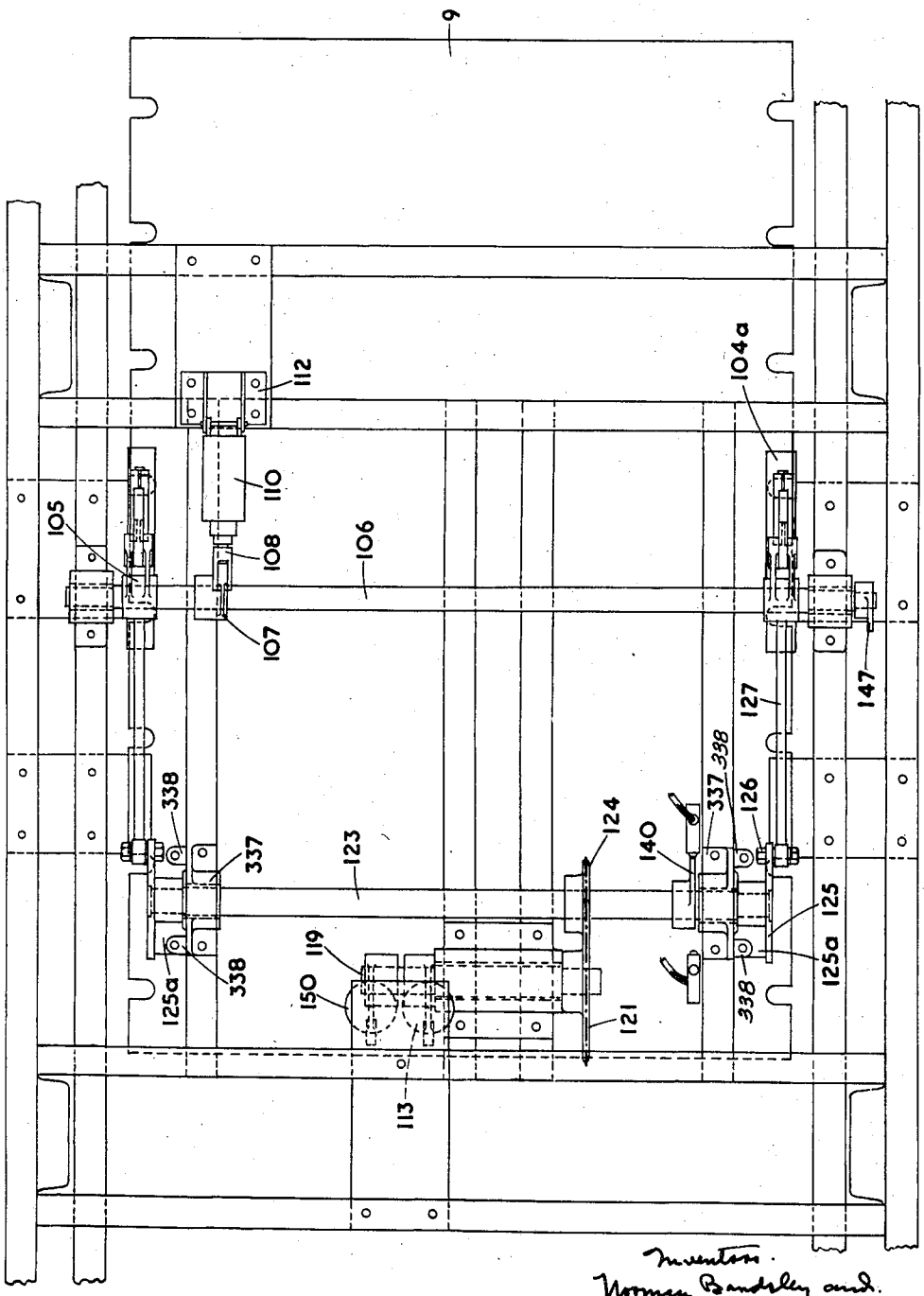

Fig. 19

Inventors.
Norman Bardsley and.
Osbert Henry Nichols by
Morgan, Finnegan and Durham
Attorneys.

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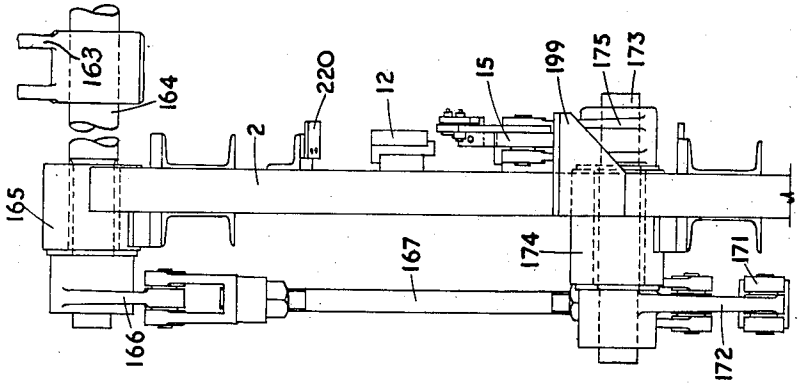

Fig. 27

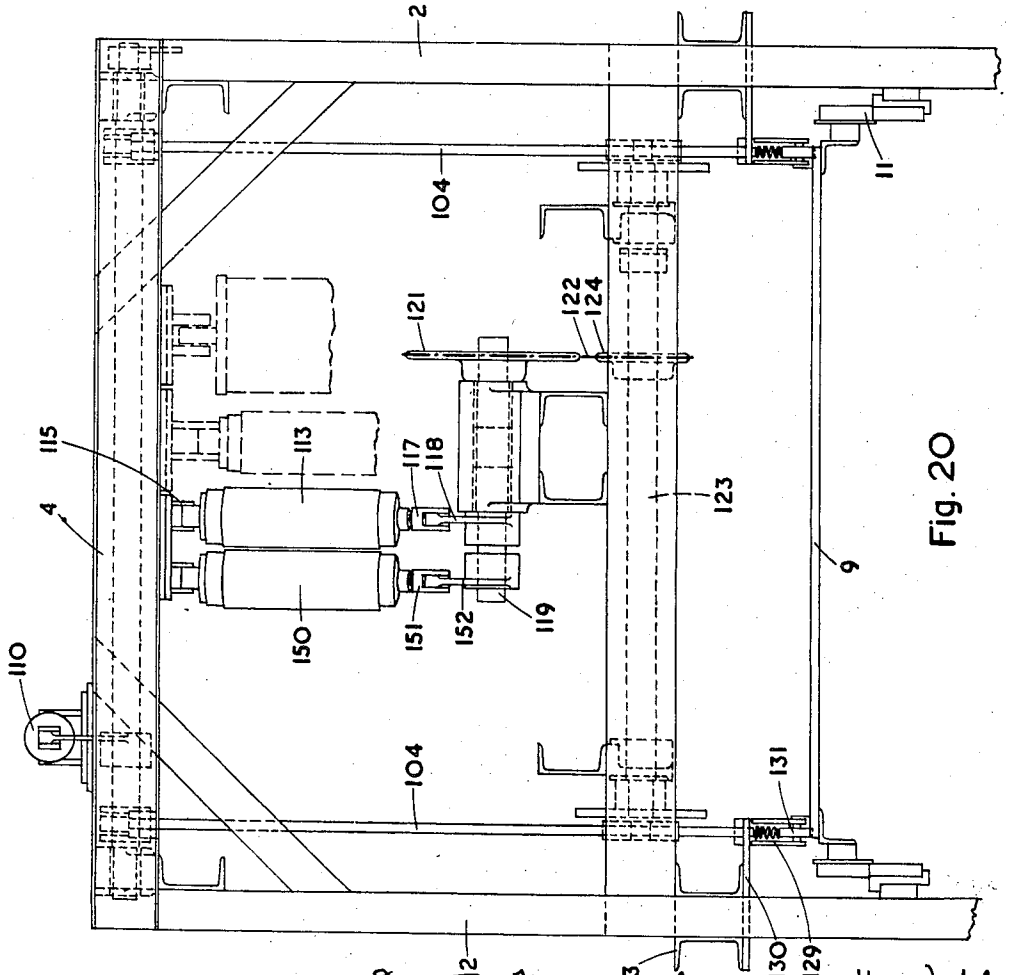

Fig. 20

Inventors: Norman Bardsley and Robert Henry Nichols.
by Morgan Finnegan and Durham attorneys.

April 1, 1958 N. BARDSLEY ET AL 2,828,871

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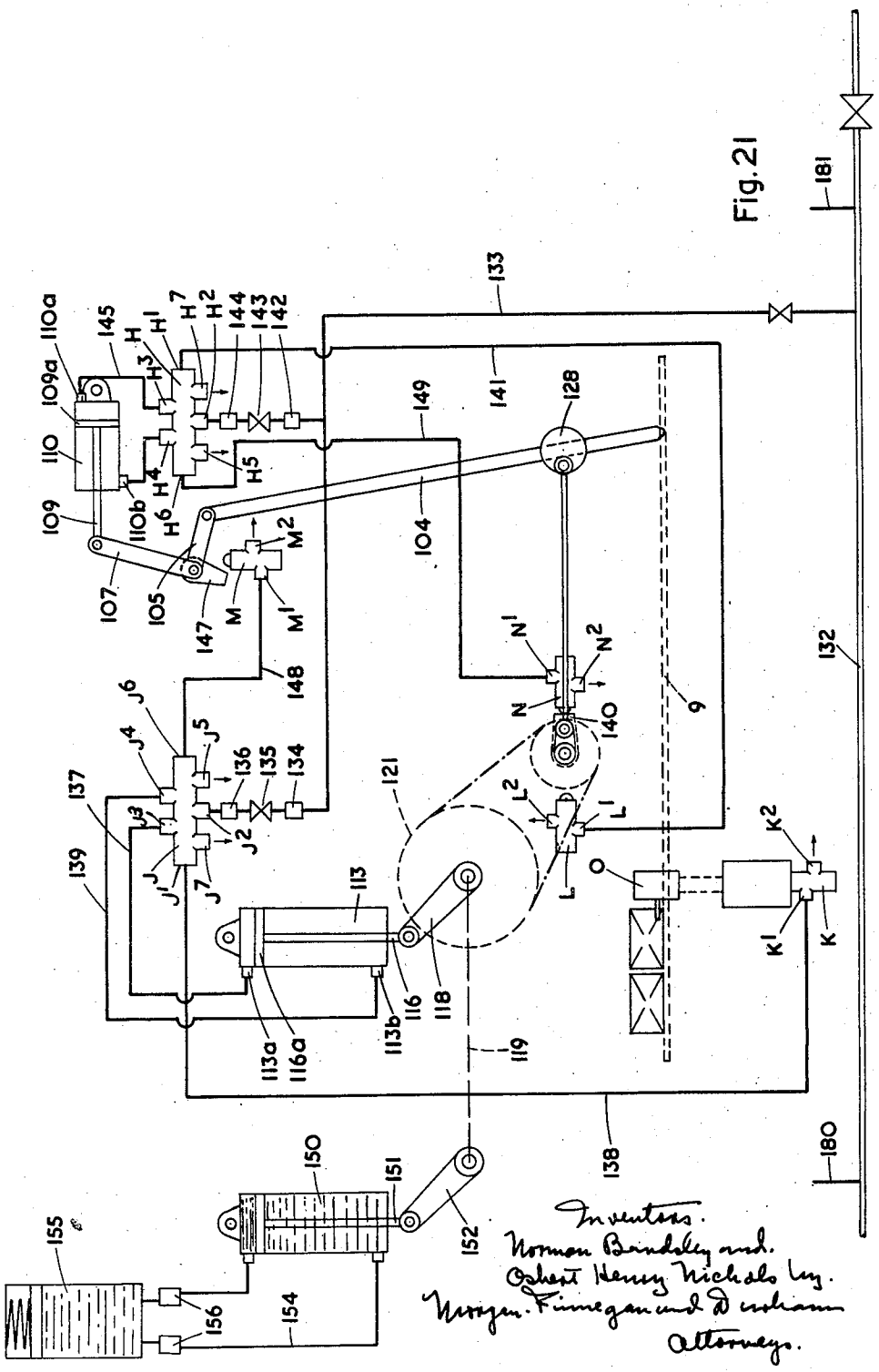
Fig. 21



Inventors.
Norman Bardsley and.
Robert Henry Nicholls Esq.
Morgan Finnegan and Durham
Attorneys.

April 1, 1958 N. BARDSLEY ET AL 2,828,871

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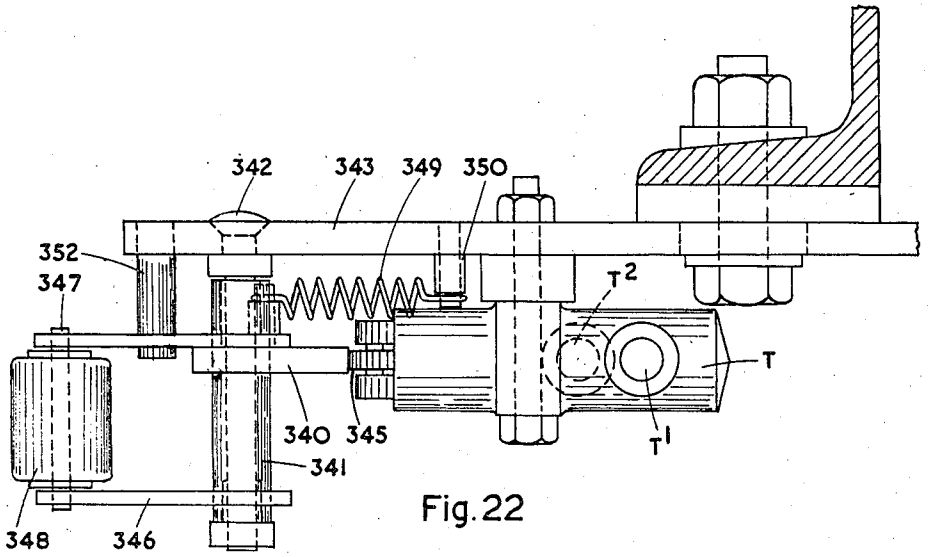

Fig. 22

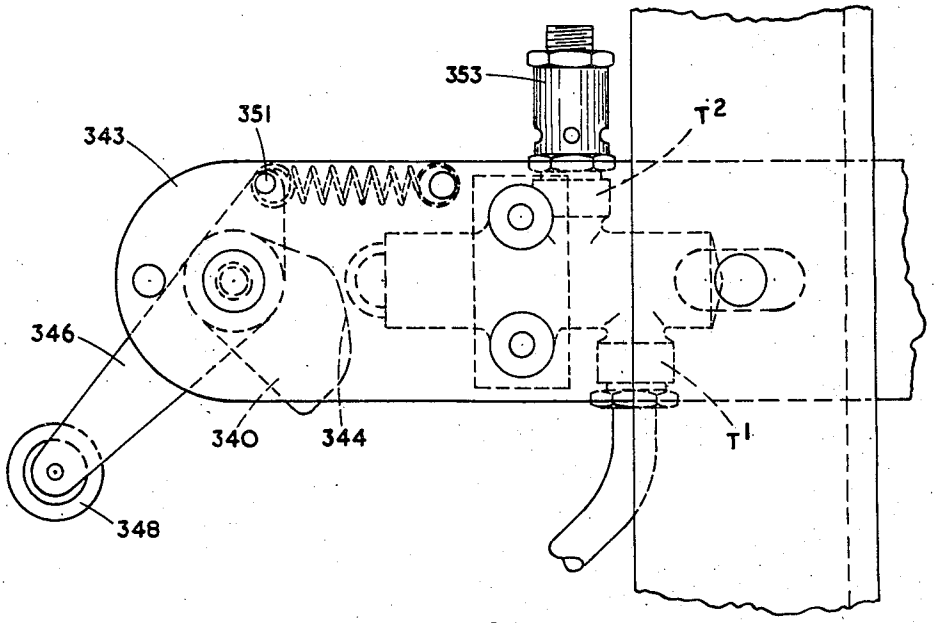

Fig. 23

Inventors.
Norman Bardsley and
Osbert Henry Nicholls Ley.
Morgan, Finnegan and Durham
Attorneys

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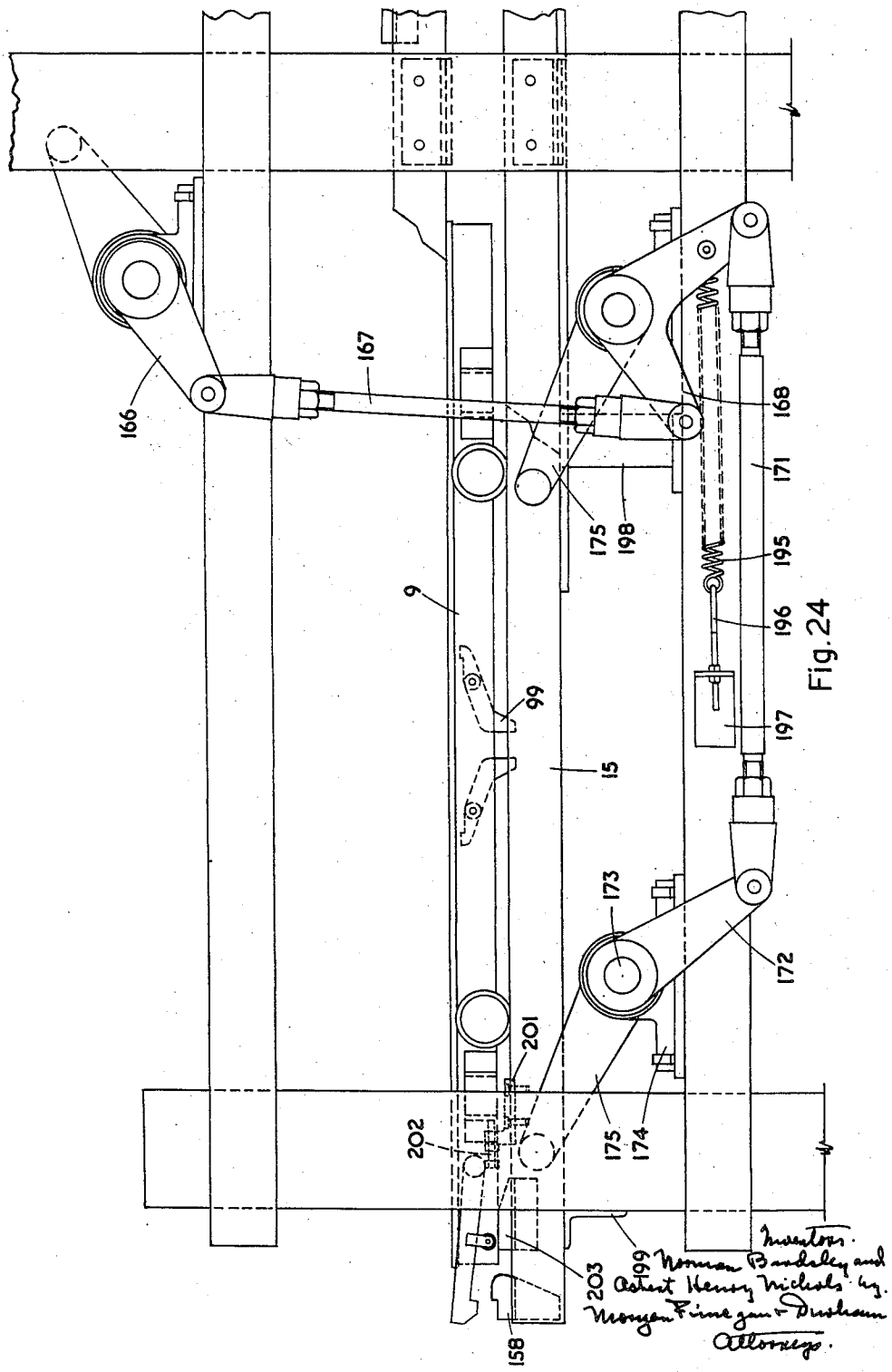

Fig. 24

Inventors.
Norman Bardsley and
Ashert Henry Nichols by
Morgan Finnegan Durham
Attorneys.

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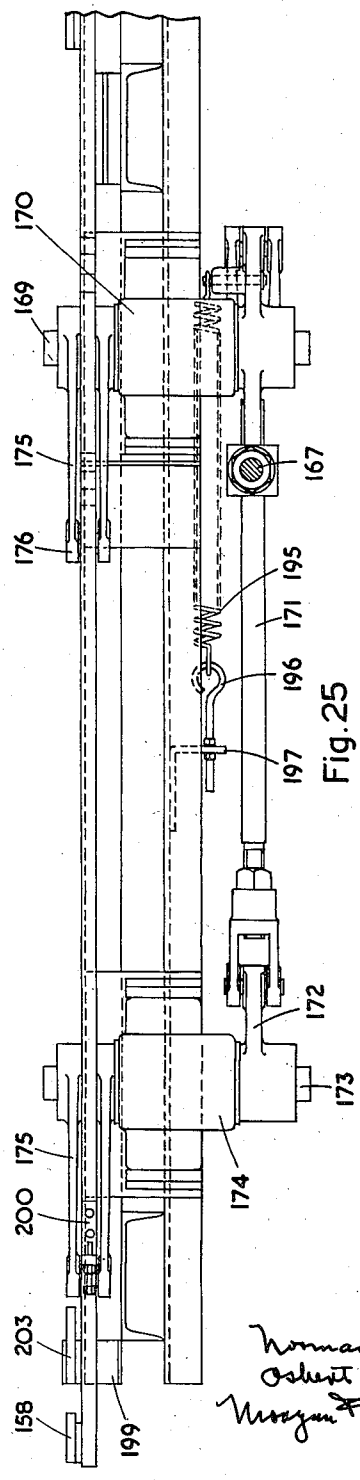

Fig. 25

Inventors:
Norman Bardsley and
Osbert Henry Nichols Ley.
Morgan Finnegan & Durham
Attorneys

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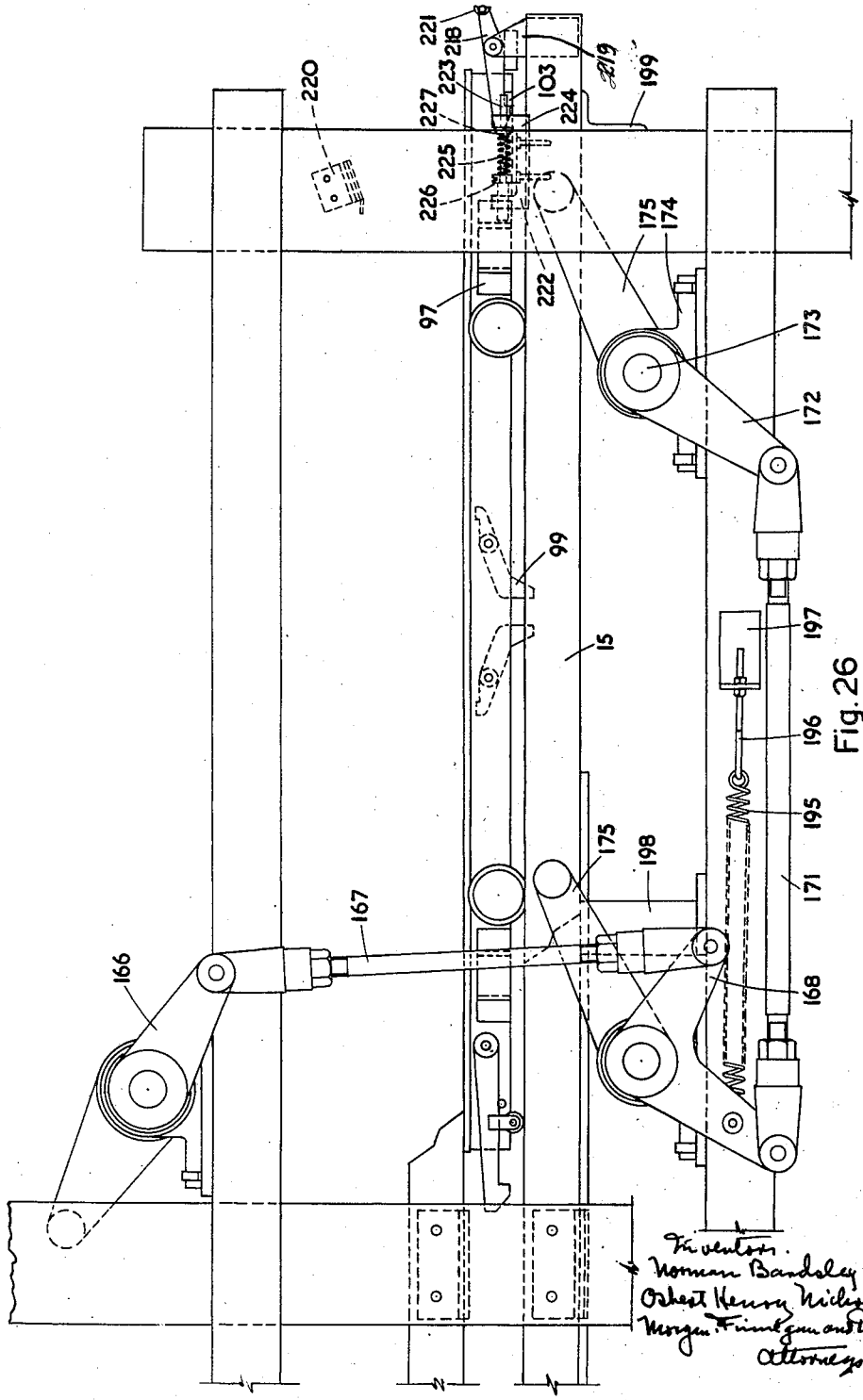

Fig. 26

Inventors
Norman Bardsley and
Osbert Henry Nicholsby
Morgan, Finnegan and Durham
Attorneys

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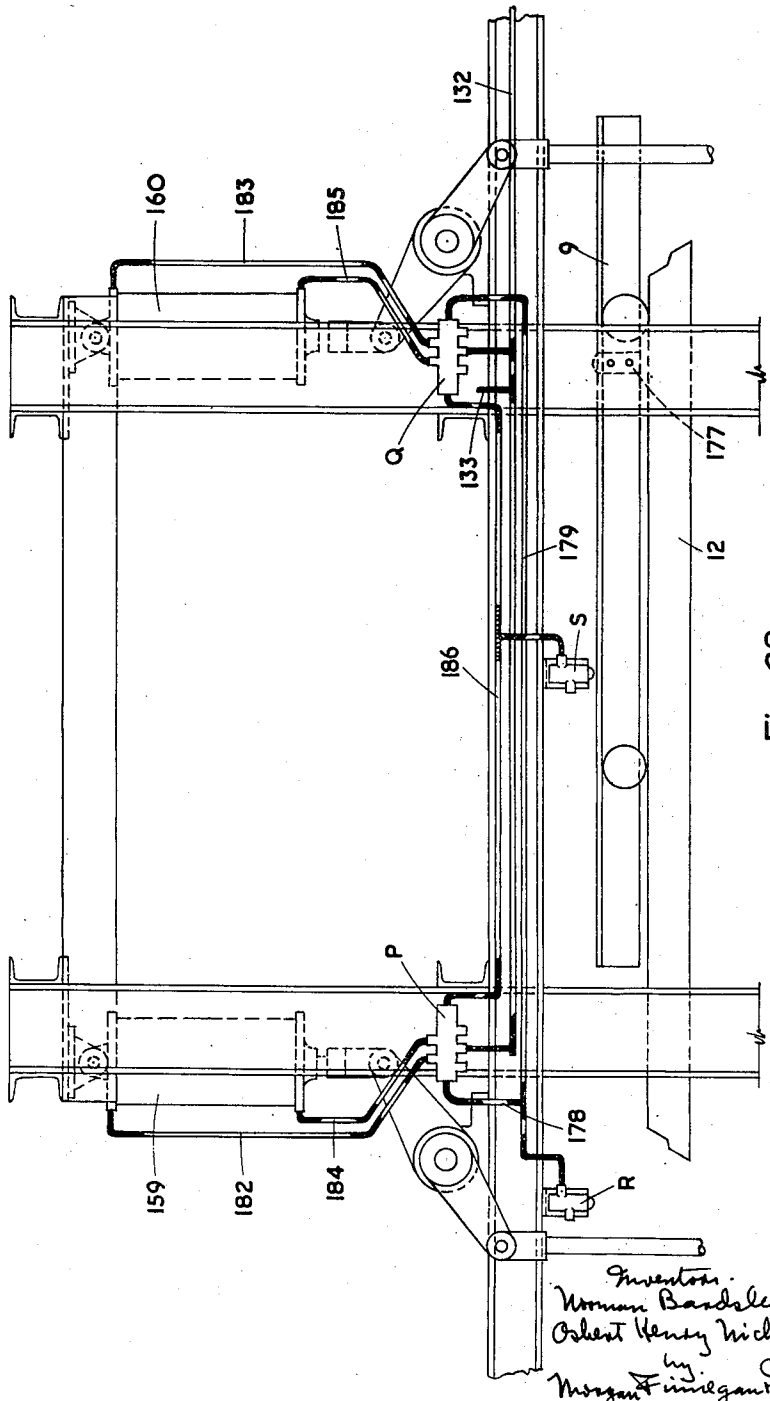

Fig. 28

Inventors.
Norman Bardsley and
Osbert Henry Nichols.
by
Morgan Finnegan Durham
Attorneys

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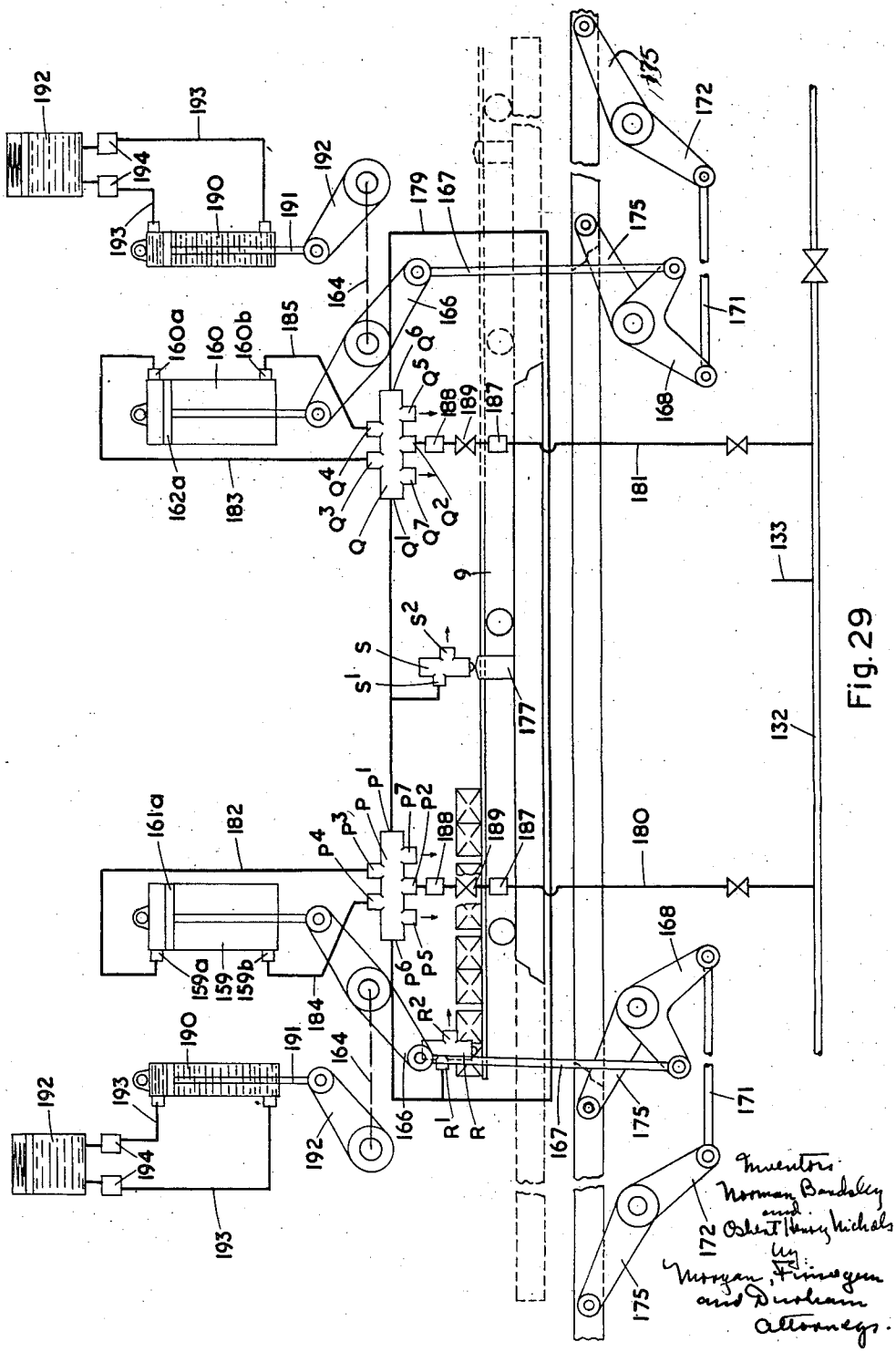

Fig. 29

Inventors
Norman Bardsley
and
Robert Henry Nichols
by
Morgan, Finnegan
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April 1, 1958 N. BARDSLEY ET AL 2,828,871

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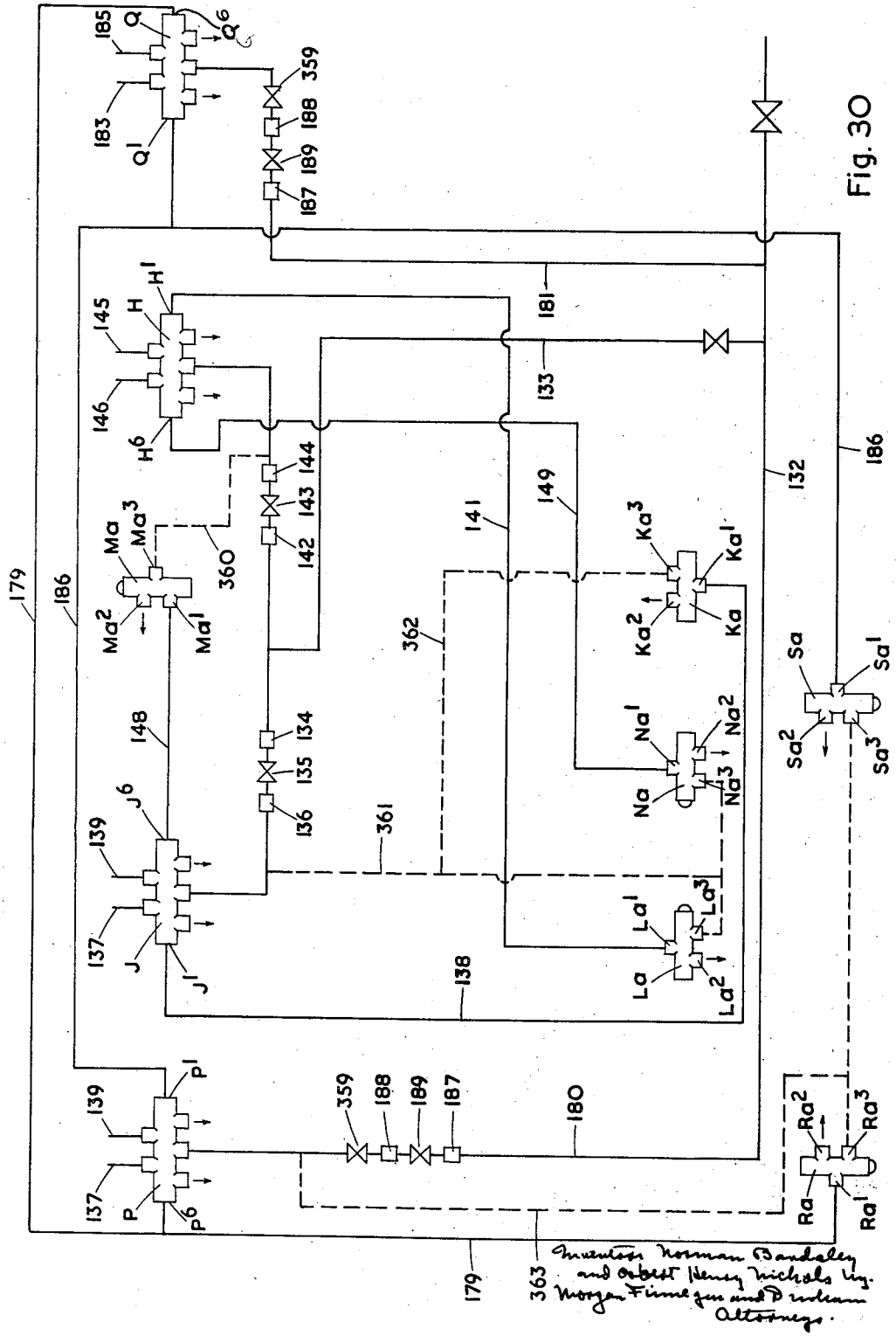

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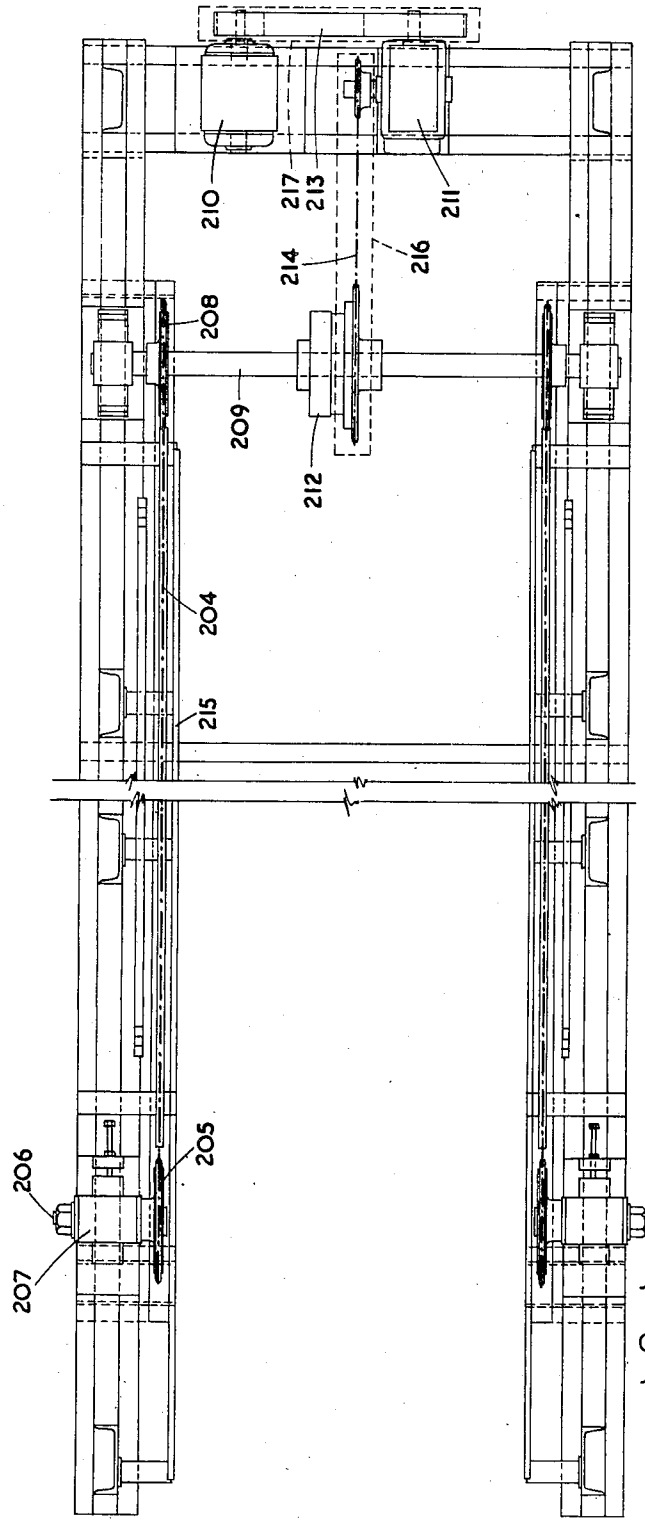

Fig. 31

Inventors:
Norman Bardsley
Robert Henry Nichols
by
Morgan, Finnegan
and Durham
Attorneys

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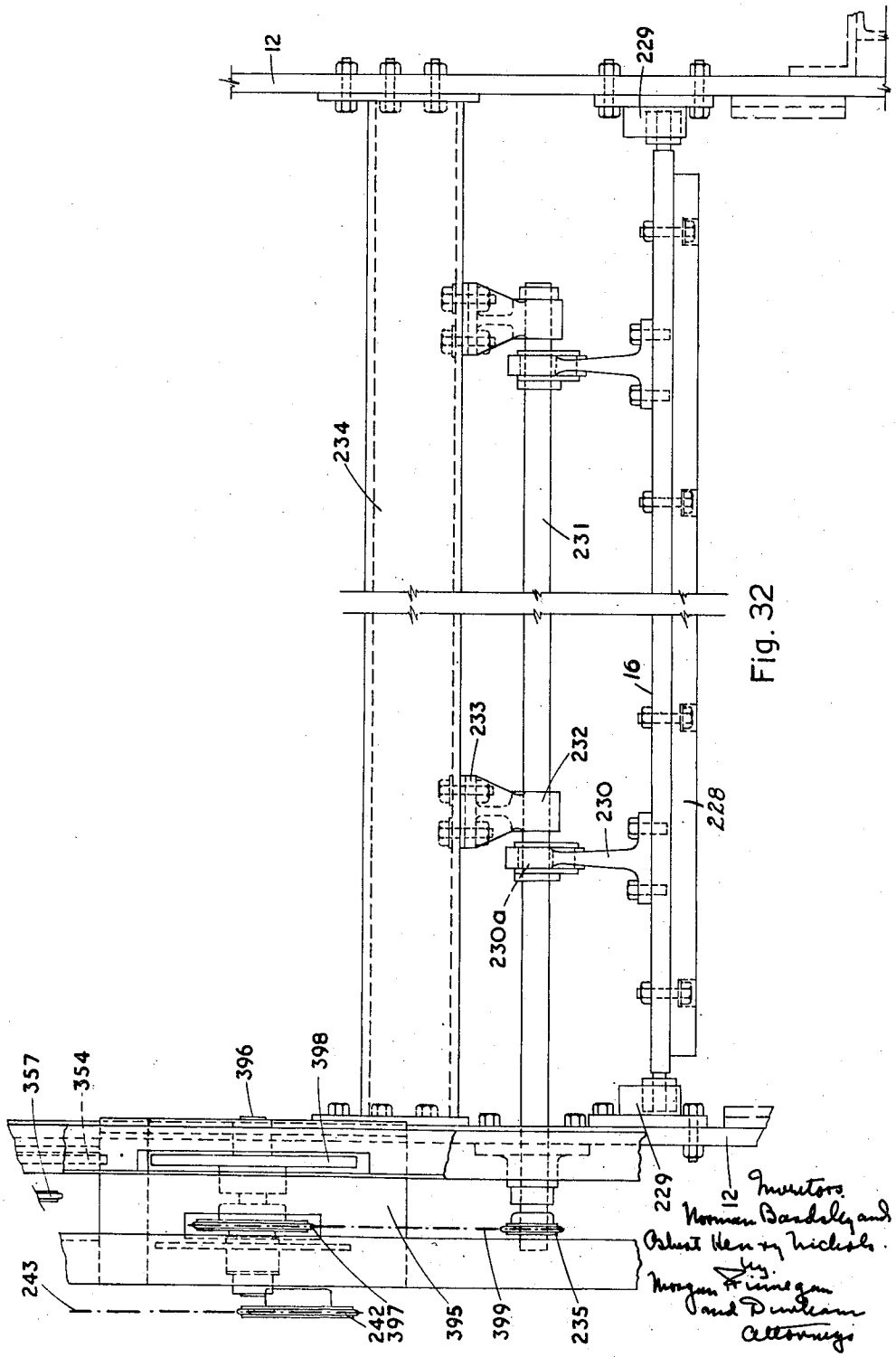

Fig. 32

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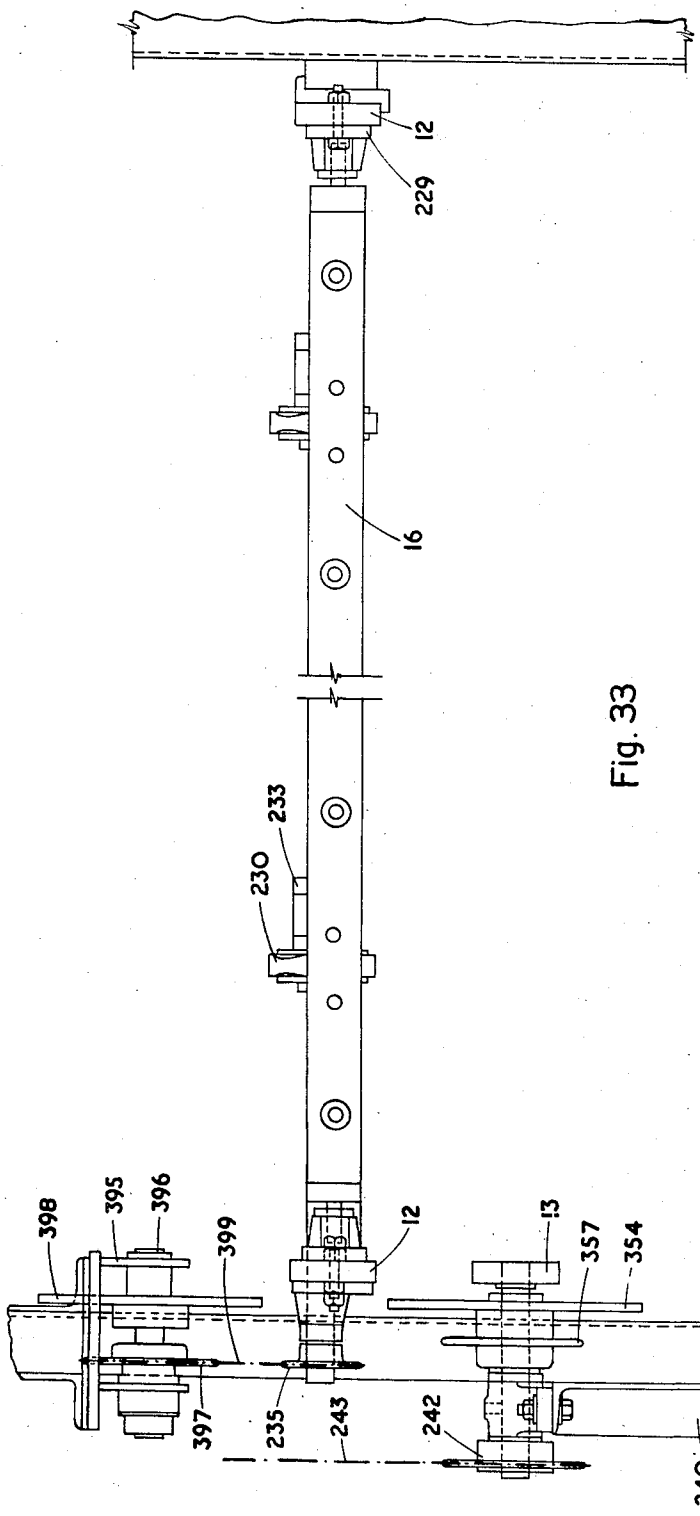

Fig. 33

Inventors.
Norman Bardsley
and
Robert Henry Nichols
by.
Morgan.
Finnegan and
Durham
Attorneys.

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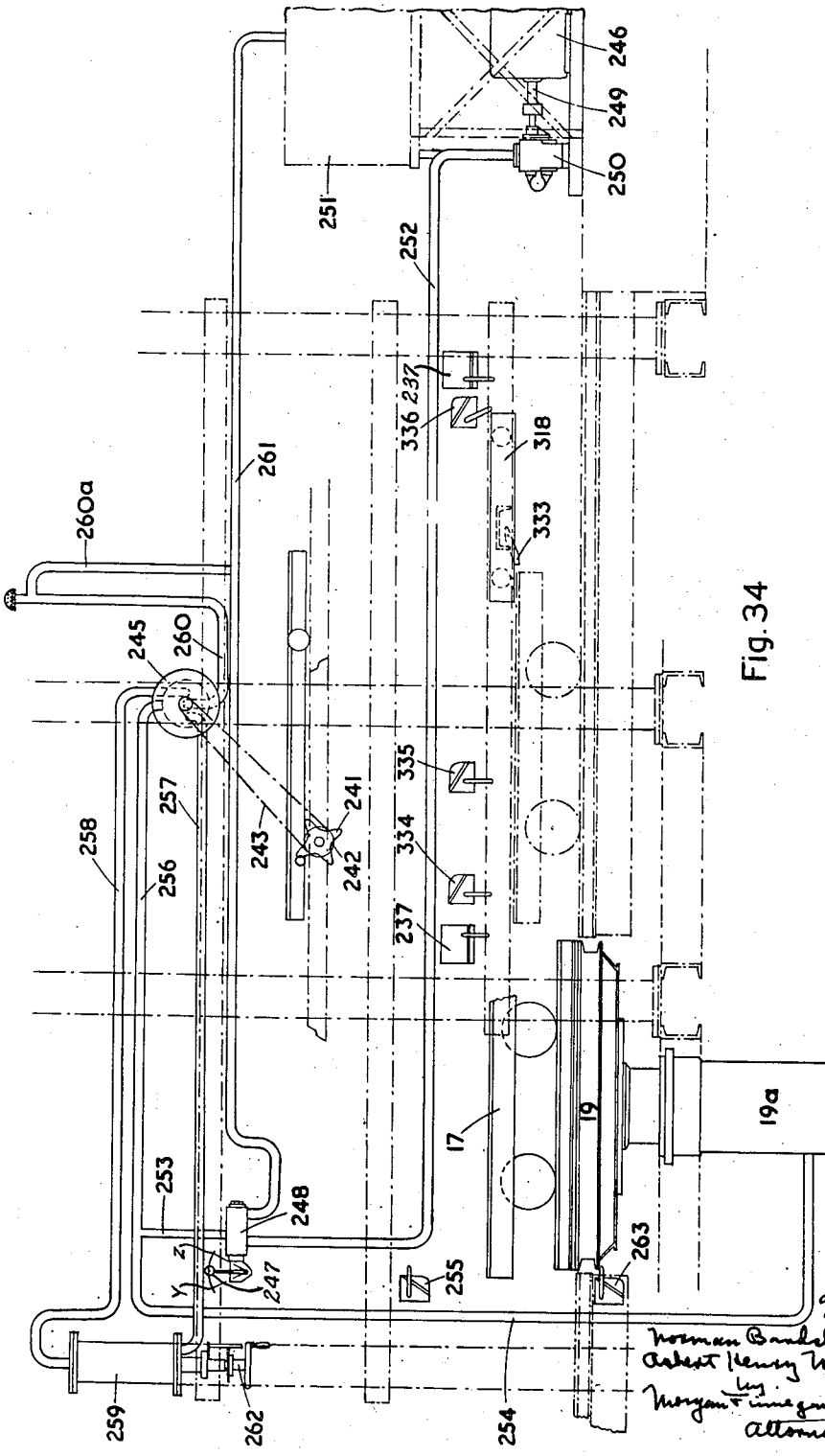

Fig. 34

Inventors
Norman Bardsley and
Robert Henry Nicholls.
by
Morgan Finnegan & Durham
Attorneys.

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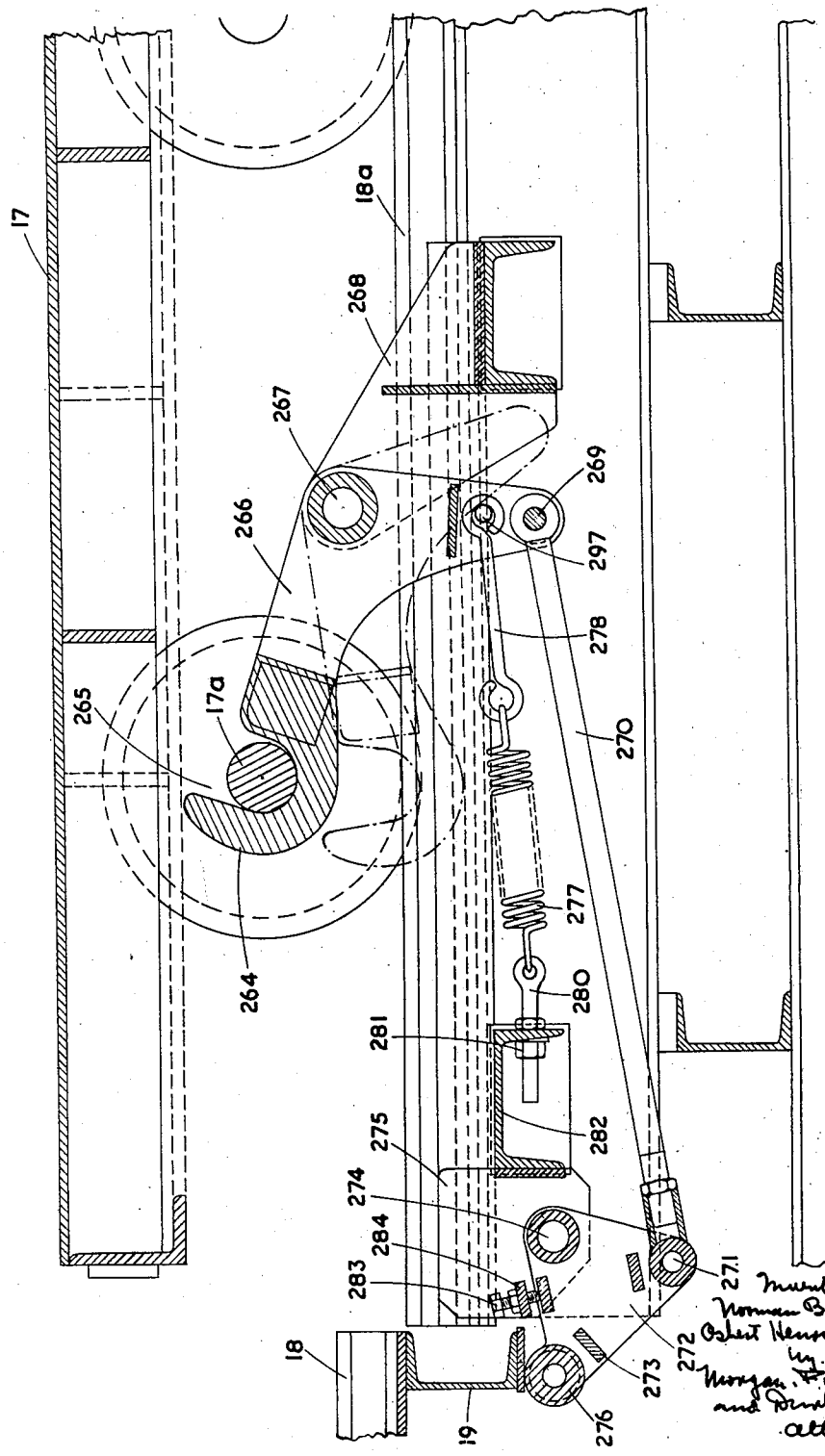

Fig. 35

Inventors
Norman Bardsley and
Robert Henry Nichols
by
Morgan, Finnegan
and Durham
Attorneys

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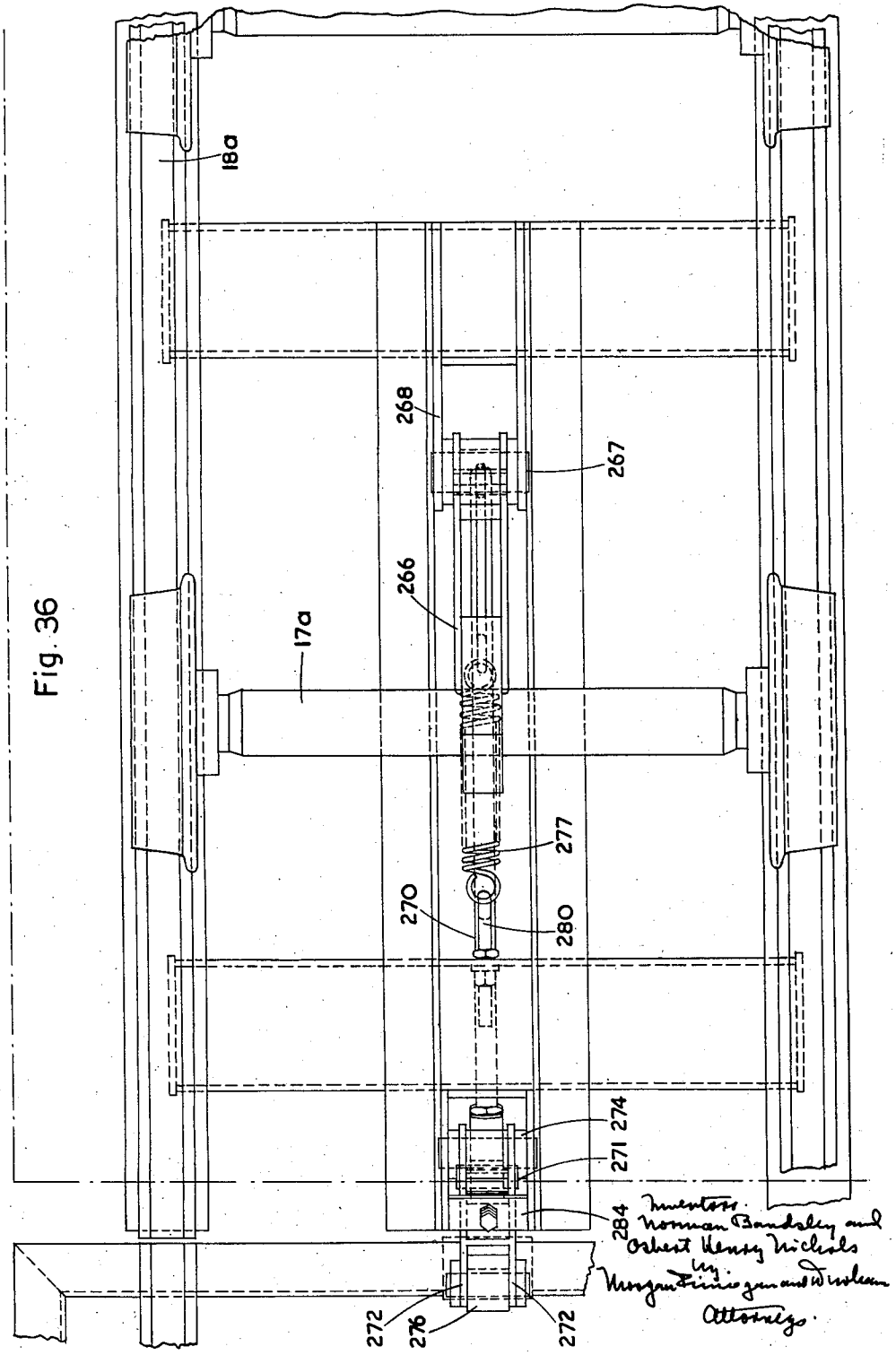
Fig. 36



Inventors.
Norman Bardsley and
Osbert Henry Nicholls
by
Morgan Finnegan and Durham
Attorneys.

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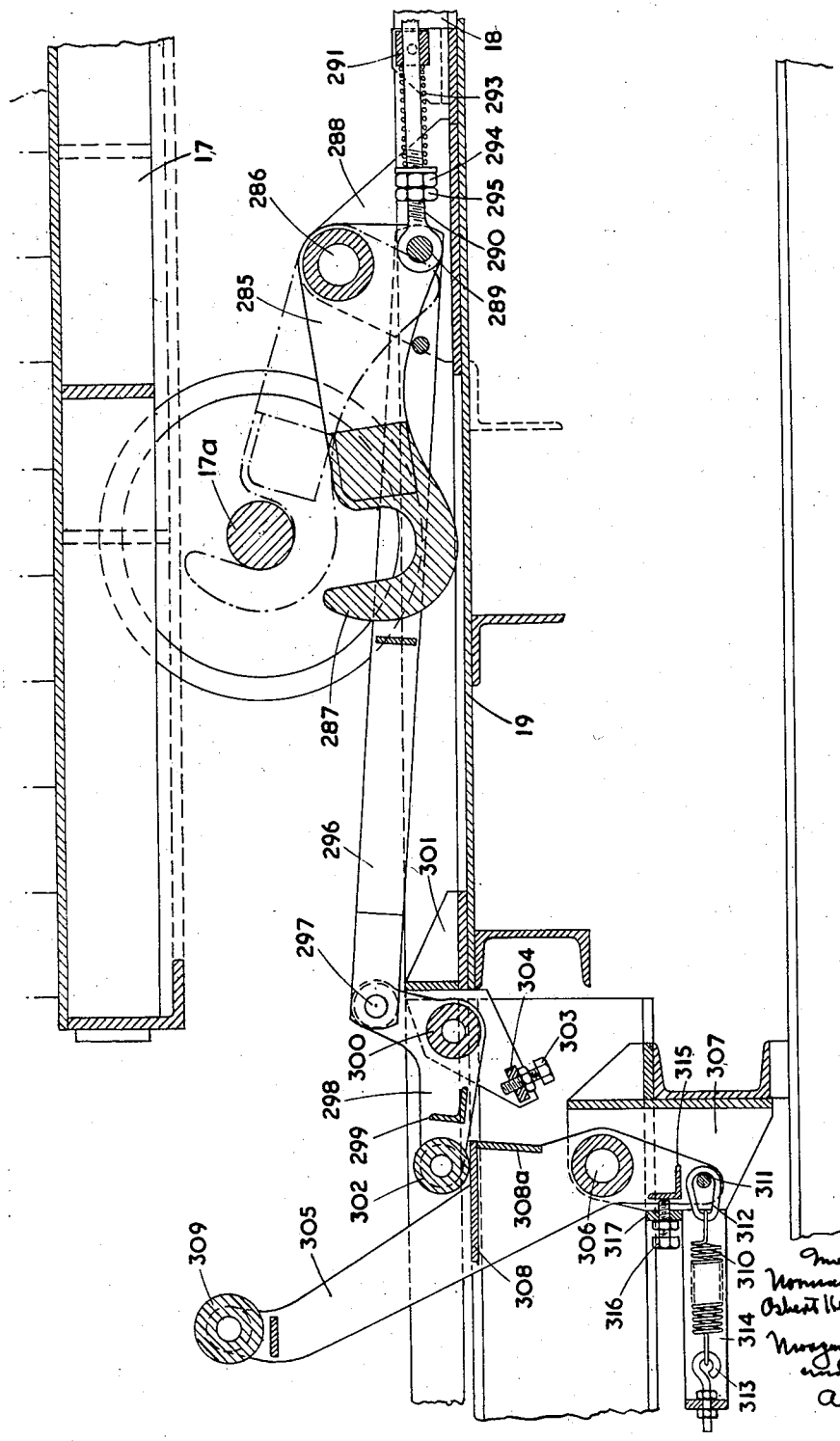

Fig. 37

Inventors:
Norman Bardsley
Osbert Henry Nicholls
Morgan, Finnegan and Durham
Attorneys.

April 1, 1958 N. BARDSLEY ET AL 2,828,871

MECHANICAL STACKER

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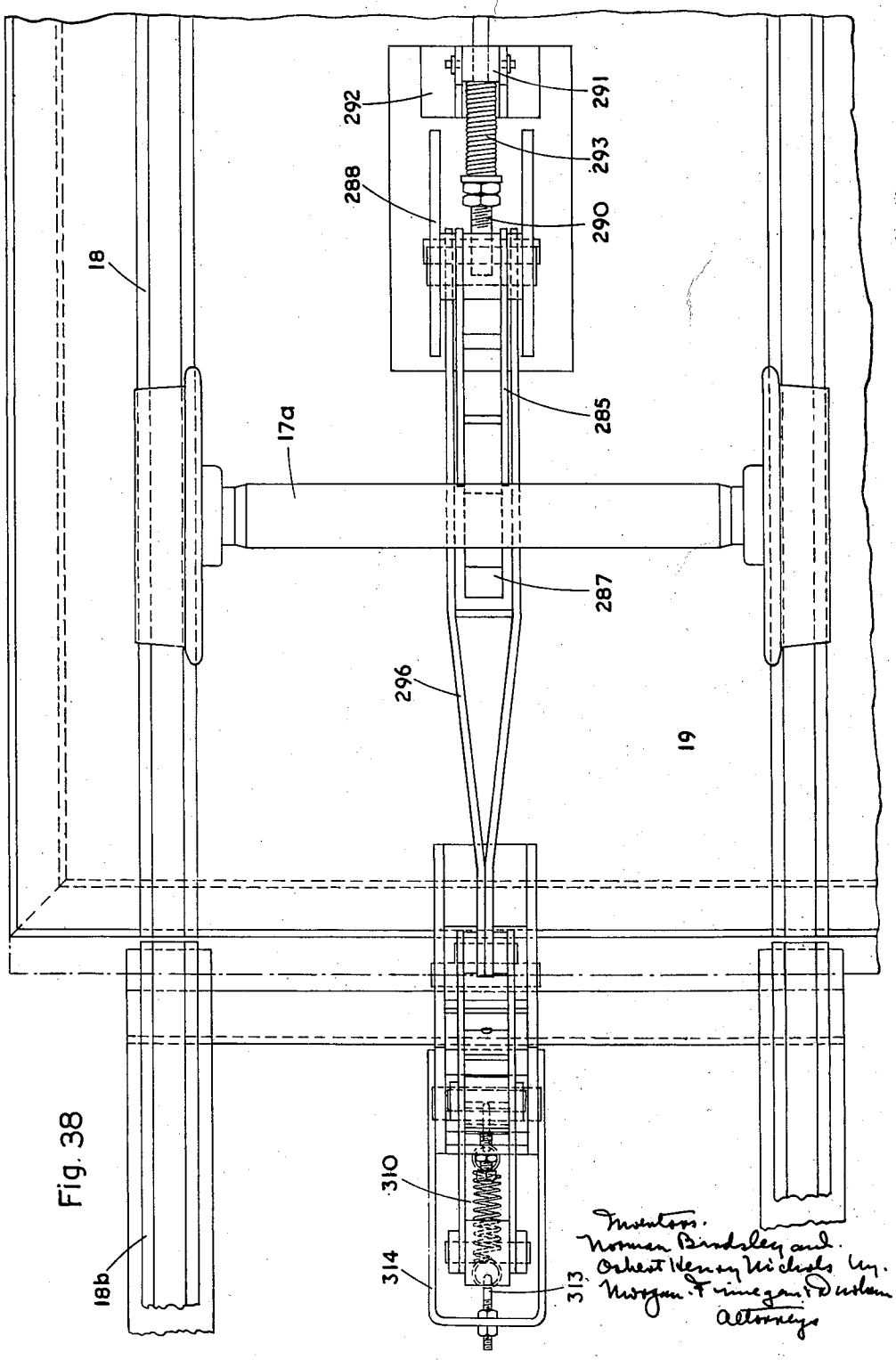

Fig. 38

Inventors.
Norman Bardsley and
Orbert Henry Nichols by
Morgan, Finnegan & Durham
Attorneys

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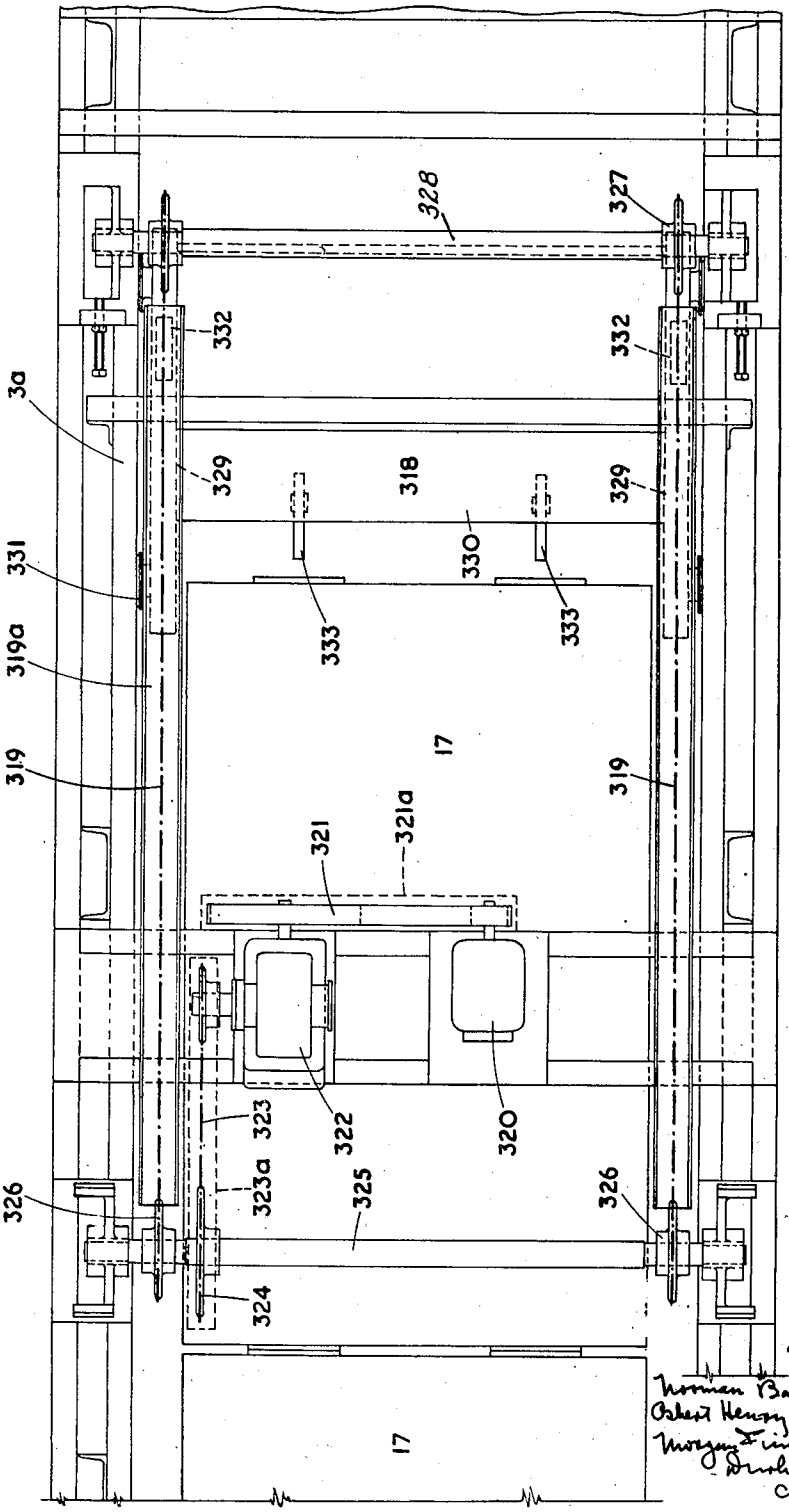

Fig 39

Inventors
Norman Bardsley and
Robert Henry Nicholls
by
Morgan Finnegan
Durham
Attorneys.

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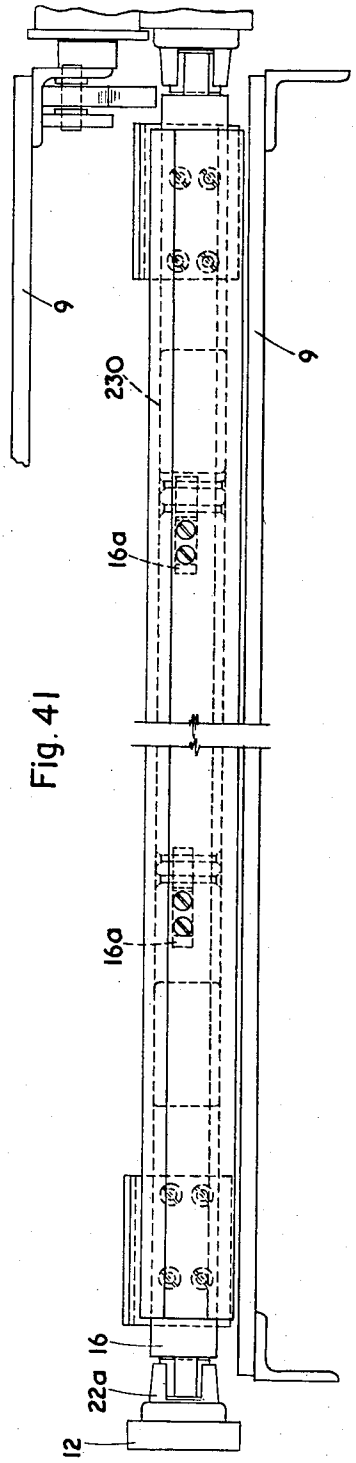

Fig. 41

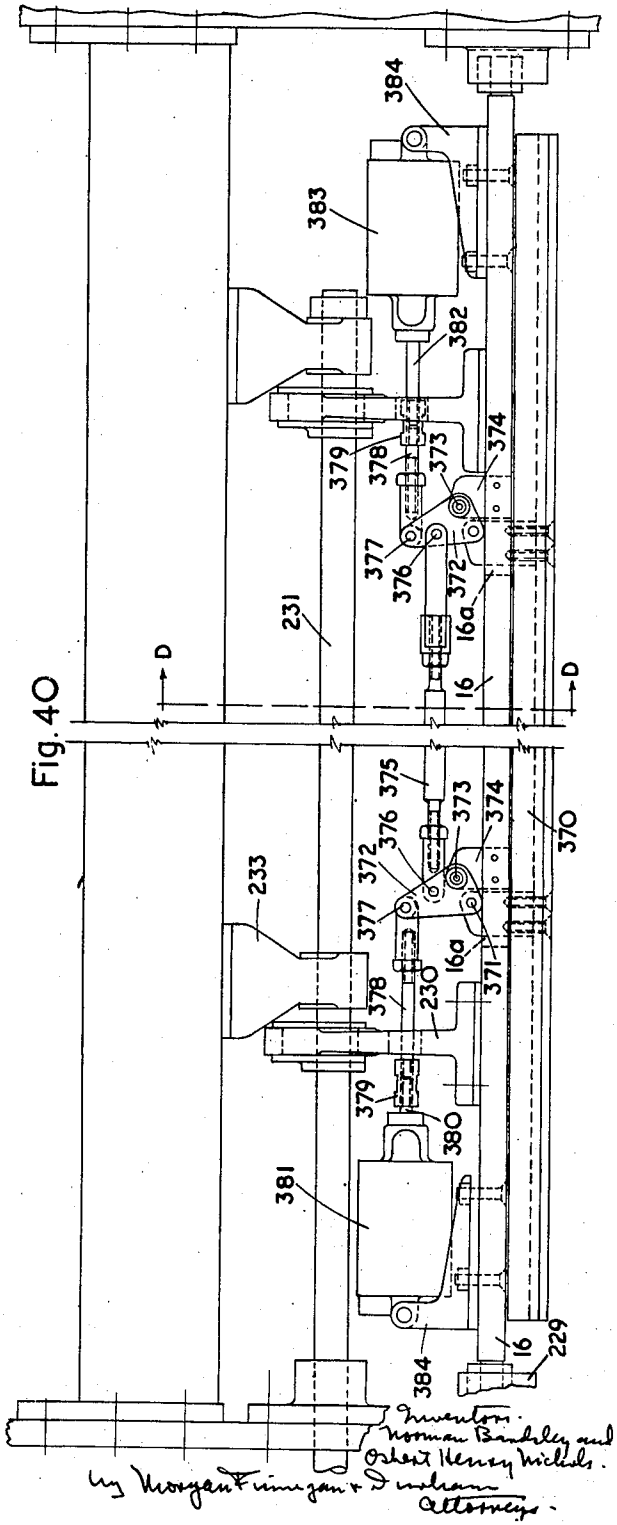

Fig. 40

Inventors.
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Osbert Henry Nicholls.
by Morgan Finnegan & Durham
Attorneys.

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MECHANICAL STACKER

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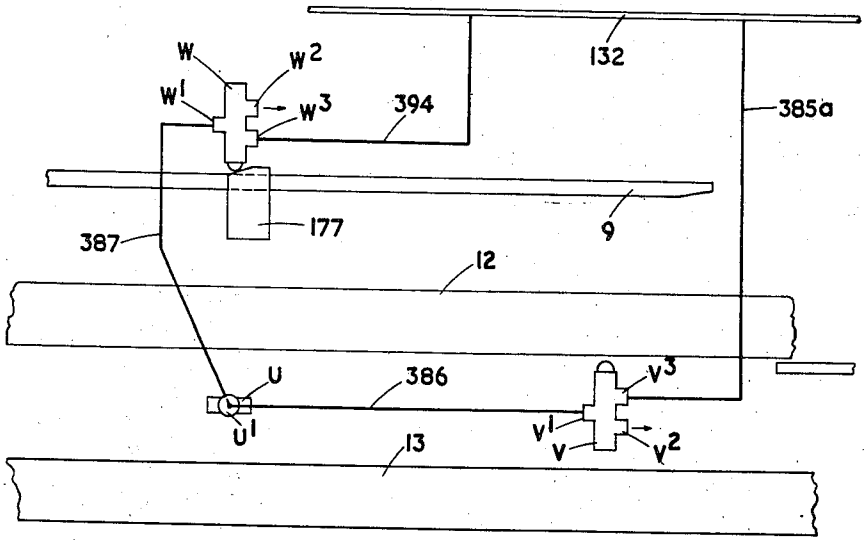

Fig. 44

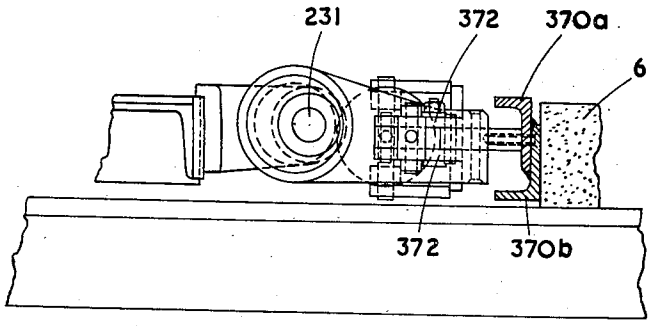

Fig. 42

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April 1, 1958 N. BARDSLEY ET AL 2,828,871

MECHANICAL STACKER

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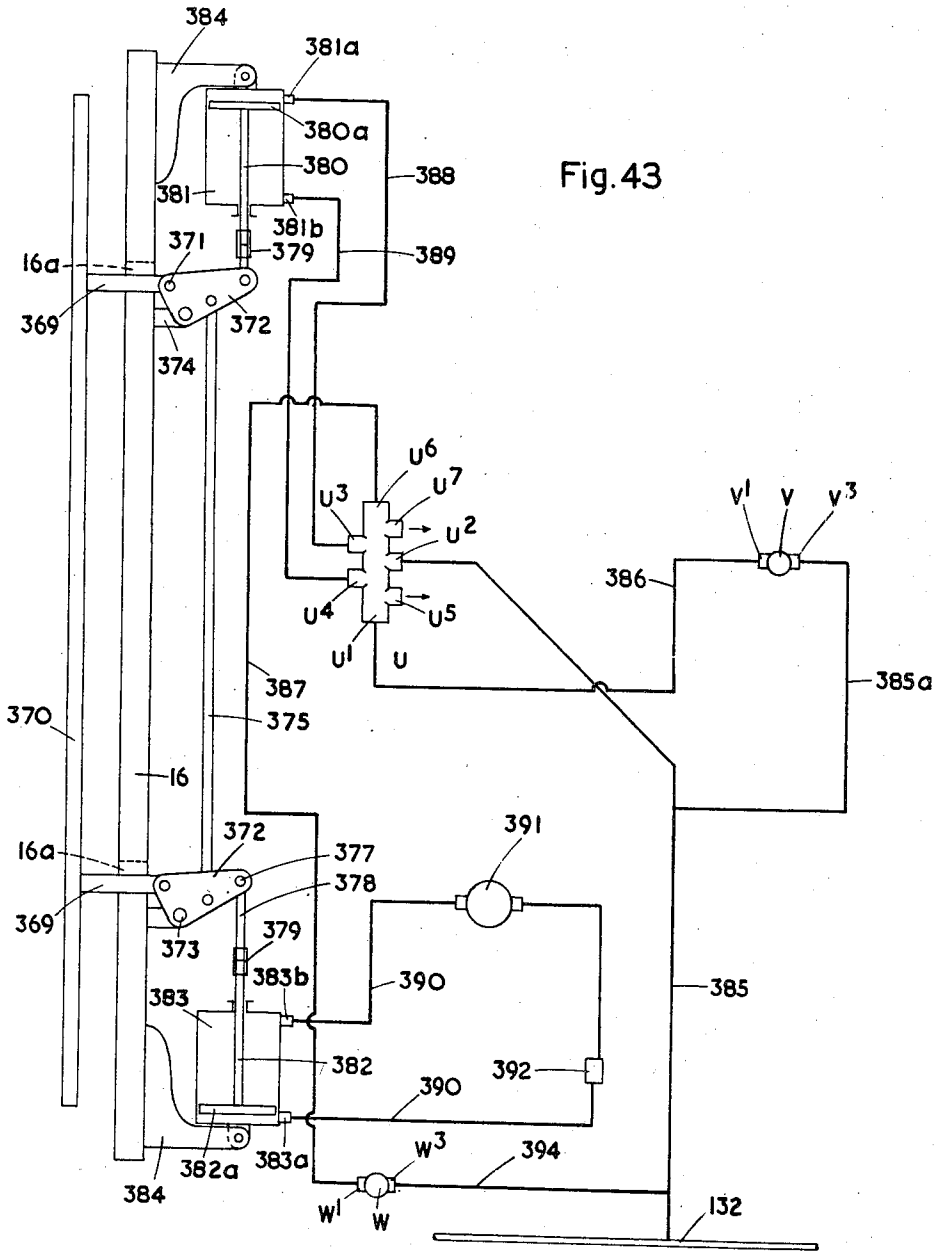

Fig. 43

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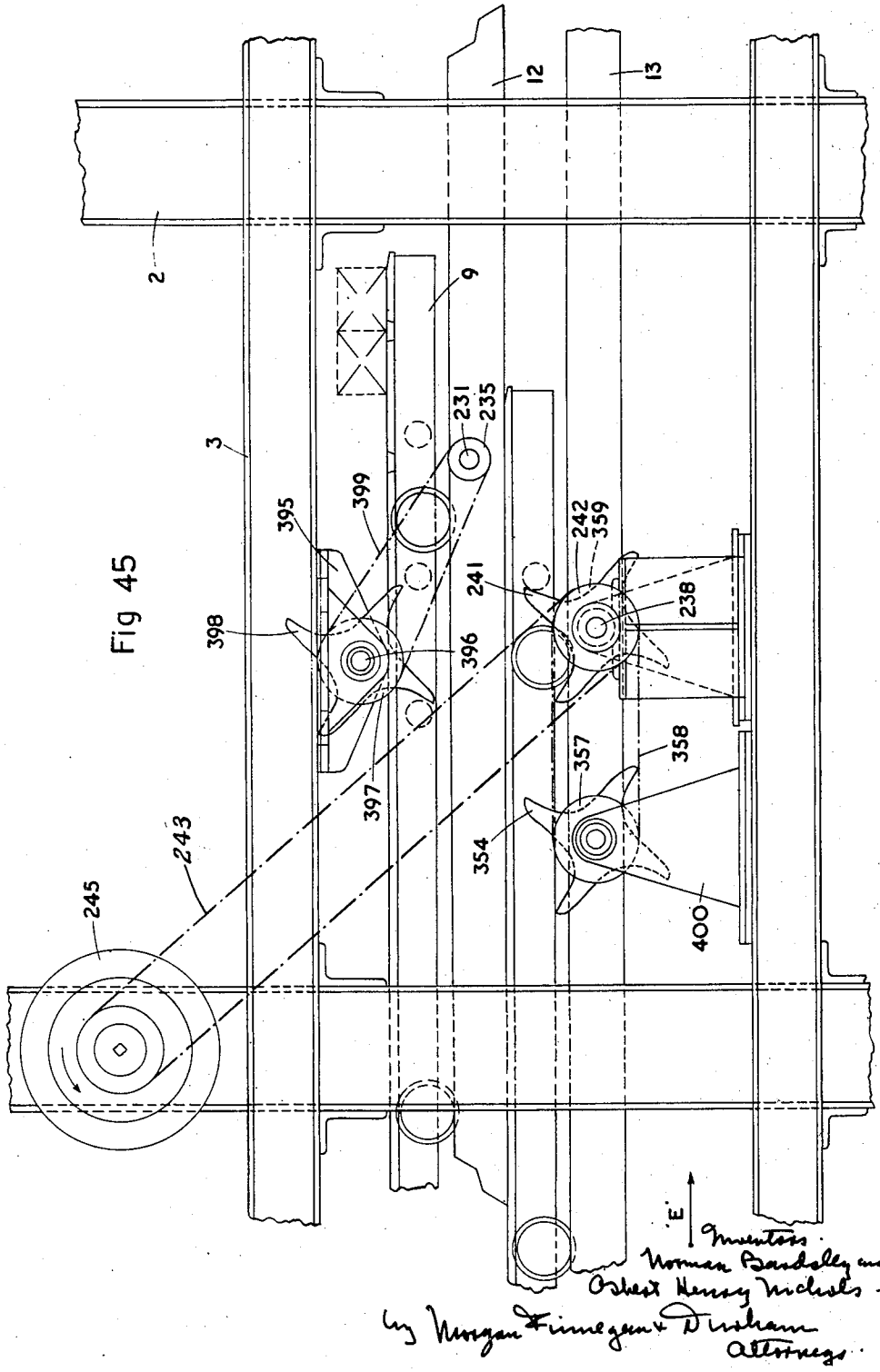

Fig 45

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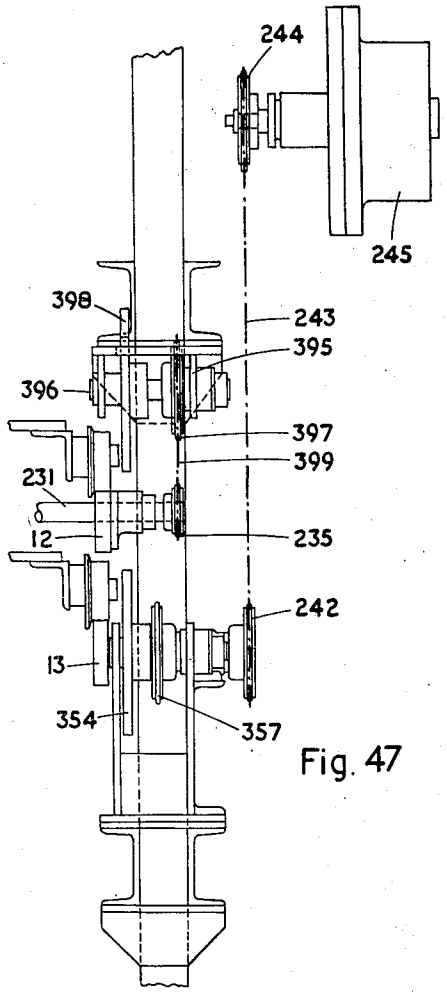

Fig. 47

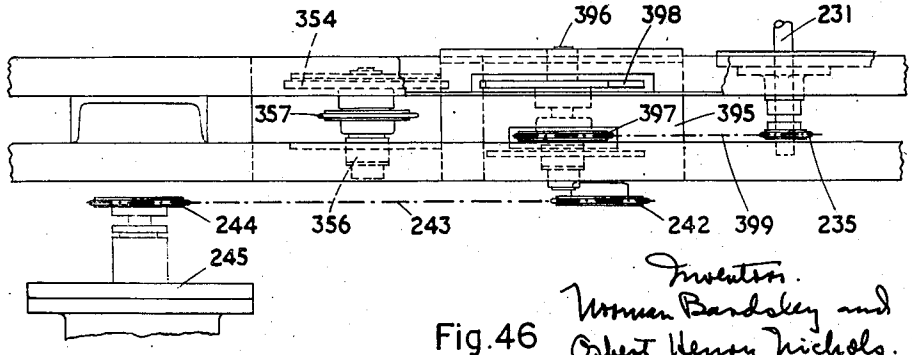

Fig. 46

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United States Patent Office 2,828,871 Patented Apr. 1, 1958

2,828,871

MECHANICAL STACKER

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Application January 29, 1953, Serial No. 333,915

28 Claims. (Cl. 214—6)

The invention consists of a mechanical stacker, that is to say, an apparatus for handling articles which are capable of being stacked, for example, briquettes and bricks, and stacking them, for example, on a wagon or truck.

The operation or operations of removing articles which are capable of being stacked, particularly bricks or briquettes, from one position and stacking them in another position, has never been performed wholly by mechanical means. The bricks or briquettes have been handled by operatives at one or more stages in the removal of the bricks or briquettes from their original position until they are formed into a stack or stacks. Thus, in the removal of bricks or briquettes from a press-table, the use of automatic gripping and lifting means is known for removing the articles from the press-table to another position which is clear of the press-table, and the use of such means may avoid accidents in that the articles are removed mechanically and not manually from the press-table. However, where the articles so removed from the press-table are to be arranged in stacks on wagons, for example, then the articles are stacked by hand on the wagons.

It is an object of the invention to provide means whereby articles which are capable of being readily stacked, particularly articles such as briquettes or bricks having the form of rectangular prisms, may be moved from one position and stacked in another position without manual handling of the articles. Thus, briquettes or bricks may be moved from a press-table and stacked in regular formation on a wagon or truck without the briquettes or bricks being touched by hand.

According to the invention, apparatus for mechanically stacking articles, such as briquettes, bricks or the like, in superposed layers on a wagon or truck, comprises means for continuously loading pallets or carriers with the articles, means for moving the pallets or carriers during loading so that the articles are deposited in regular manner as in rows, means for moving the loaded pallets or carriers to an unloading position, means for removing the articles from the loaded pallets or carriers on to a wagon or truck, means for varying the vertical position of the wagon or truck whereby the articles are stacked on the wagon or truck in superposed layers, means for returning the empty pallets or carriers to the loading position, and driving means whereby the above operations are effected in timed sequence.

According to the invention furthermore, the means for loading a pallet or carrier may comprise a push member which slides the articles from one position on to the pallet or carrier, the pallet or carrier being moved in timed sequence with the loading movements of the push member so that a layer of the articles is provided in regular formation, as in rows, on the pallet or carrier.

According to the invention moreover, the means, hereinafter referred to as the pallet pitching mechanism, for moving the pallet in synchronism with the push member, comprises a system of levers and links including at least

one arm which is adapted to be brought into and out of engagement with a pallet and to be swung through an arc the angle of which may be adjusted. The pallet pitching mechanism moves the pallet in a straight line and the positive and negative accelerations imparted by the mechanism to the pallet are gentle, so that there is no appreciable tendency for the articles on the pallet to move in relation to the pallet during the pitching motion.

The means for moving the loaded pallets or carriers to the unloading position and the means for returning the empty pallets or carriers to the loading position, may include movable tracks on which the pallets or carriers are supported.

The means for varying the vertical position of the wagon or truck may comprise a hydraulic hoist which is automatically lowered through equal distances after each layer of articles is transferred from a pallet or carrier to the wagon or truck.

The means for removing the articles from the pallets or carriers on to the wagon or truck may comprise an adjustable member for scraping the articles from a loaded pallet or carrier onto the wagon or truck. The position of the member may be automatically varied so that the layers of the articles on the wagon or truck are staggered so as to produce a stack which is "internally bound." The adjustable member for scraping or removing the articles from a loaded pallet or carrier may be provided with means whereby it is retracted over a determined distance as it removes the articles from the loaded carrier.

A drawbridge may be provided over which the articles are moved by the push member onto the pallet or carrier, the drawbridge being provided with means whereby the articles may be diverted from the pallet or carrier and passed, for example, to a conveyor. Such means permit inferior articles to be by-passed, sound articles only being passed onto the pallet.

In carrying the invention into effect, by way of example, in its application to an apparatus for removing briquettes of iron ore from a press-table, and loading the briquettes on to wagons, the apparatus comprises:

(1) A pushing gear which may be mounted on the press-table and which serves to move the briquettes from the press-table to the pallet;

(2) A slide provided with a drawbridge over the surface of which the briquettes are moved from the press-table to the pallet, by the pushing gear;

(3) A mechanical handling gear with pallet pitching mechanism for moving the pallets forwardly at intervals during loading, means for moving the pallets from their loading positions to their unloading positions and vice versa, means for unloading the briquettes from the pallets and for transferring the briquettes to a wagon;

(4) A hydraulic hoist on which the wagon is carried during the loading operation, that is to say, during the operations of transferring the loads from the pallets on to the wagon, and means for lowering the wagon the requisite distance as each layer of briquettes is stacked thereon;

(5) Means for moving the loaded wagon off the hydraulic hoist and simultaneously replacing the loaded wagon with an empty wagon; this means advantageously comprises a chain and pawl gear.

One construction of such an apparatus for removing iron ore briquettes from a press-table and loading them on to a wagon, is diagrammatically illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a side view of the main part of the apparatus;

Figure 2 is a corresponding plan, part only of the briquette pusher gear being shown;

Figure 3 is a front end view of the main part of the apparatus;

Figure 4 is a side view of the briquette pusher on its slide bars;

Figure 5 is a plan of Figure 4;

Figure 6 is a view of Figure 4 in the direction indicated by the arrow X;

Figure 7 is a view, partly in section, and on a larger scale, of part of the pusher illustrated in Figure 4;

Figure 8 is a part side view of the briquette pusher;

Figure 9 is a side view of the drive of the briquette pushing gear;

Figure 10 is a plan view of the drive shown in Figure 9;

Figure 11 is a side view, cut away in part, of the slide and drawbridge, the pusher and its cooperating cams being omitted;

Figure 12 is a plan of Figure 11;

Figures 13, 14 and 15 are sections on the lines 13—13, 14—14 and 15—15 respectively of Figure 11;

Figure 16 is a side elevation of a pallet;

Figure 17 is a plan of a pallet;

Figure 18 is a side view, Figure 19 is a corresponding plan, and Figure 20 is an end view, of part of the apparatus showing the pallet pitching mechanism;

Figure 21 is a diagram of the pneumatic circuit of the pallet pitching mechanism;

Figures 22 and 23 are a side elevation and plan respectively of a spring-pressed cam for actuating a pilot valve;

Figure 24 is an elevation of part of the operating mechanism of the front movable track;

Figure 25 is a plan taken from above the front movable track in the position shown in Figure 24;

Figure 26 is an elevation of part of the operating mechanism of the rear movable track;

Figure 27 is a part end view taken in the direction of the arrow in Figure 26;

Figure 28 shows the valves and air lines of the track operating mechanism;

Figure 29 is a diagram of the pneumatic circuit of the track operating mechanism;

Figure 30 is a diagram of modified forms of the pneumatic circuits of the pallet pitching mechanism and the track operating mechanism, shown in combination;

Figure 31 is a view of the pallet traverse mechanism;

Figure 32 is a plan of the plough locating mechanism;

Figure 33 is a front view of the plough and its locating mechanism;

Figure 34 is a diagram of the hydraulic circuit of the hoist;

Figure 35 is a vertical section through the stop and release mechanism of the empty wagon;

Figure 36 is a plan of the mechanism shown in Figure 35;

Figure 37 is a vertical section through the stop and release mechanism, in the disengaged position, for locating and holding a wagon on the hoist;

Figure 38 is a plan of the mechanism illustrated in Figure 37;

Figure 39 is a plan of the wagon pushing mechanism;

Figure 40 is a plan view of a modified form of plough;

Figure 41 is a front elevation of the plough of Figure 40;

Figure 42 is a section on the line D—D of Figure 40;

Figure 43 is a diagrammatic plan view of the modified form of plough and its pneumatic circuit;

Figure 44 is a diagrammatic side view of the pneumatic circuit shown in Figure 43;

Figure 45 is an elevation of a further modification of the means for actuating the rotary valve;

Figure 46 is a plan of the modification shown in Figure 45; and

Figure 47 is a view in the direction of the arrow E of Figure 45.

In Figures 1, 2 and 3, the hydraulic and pneumatic circuits with their valves and switch gear have, for the sake of clarity, been omitted. For the same reason, other members have also been omitted from these figures; the members so omitted are shown in other figures.

The apparatus comprises a main framework 1 substantially rectangular in outline and including vertical members 2, longitudinal members 3 and transverse members 4. Pushing-mechanism 5 is provided on one side of the apparatus for removing pairs of briquettes 6 from a press-table 7 over a slide 8 provided with a drawbridge on to a pallet 9 located within the main framework 1. A band conveyor 10 is provided below the drawbridge of the slide 8; badly formed or damaged briquettes may then be by-passed on to the band conveyor 10 by opening the drawbridge of the slide 8.

The pallets 9 are provided with runners 11 to travel on tracks, the tracks comprising an upper fixed track 12 and a lower fixed track 13, both centrally disposed within the main framework 1, and a front movable track 14 and a rear movable track 15. The briquettes 6 are scraped off a loaded pallet 9 by a plough 16 as the pallet is traversed rearwardly over the lower fixed track 13, and the briquettes are thereby loaded on to a wheeled wagon 17 resting on the rails 18 on a hydraulic hoist 19.

Briquette pushing mechanism and slide

The briquette pushing mechanism 5, which is indicated generally in Figure 2, is shown in detail in Figures 4 to 8, whilst the drive of the pushing mechanism is shown in Figures 9 and 10. The pusher 20 is mounted for reciprocation on the slide bars 21 of the slide 8. The link 22 is at one end pivotally mounted on the pusher 20 and at the other end is pivotally connected to one end of a horizontally disposed pusher arm 23, the pusher arm 23 being keyed to a vertical rocker spindle 24 mounted in brackets 25 and 26. The end of the pusher arm 23 remote from the pusher 20 is pivotally connected through an adjustable link assembly 27 to one end of a cam lever 28, the other end of the cam lever 28 being provided with a cam follower 29 which is in engagement with a cam groove 30 provided on a member 31. The cam lever 28 is mounted, at a position intermediate of its length, to rotate on a pin 32 carried by a bracket 33. The member 31 is adjustably bolted through slots to a spur wheel 34 which is driven by a spur pinion 35, the spur pinion itself being driven by any suitable means.

The two slide bars 21, on which the pusher 20 is mounted, are carried in the slide 8, the main framework of which is formed by two members 36 of channel section which are integral with a longitudinal member 3 of the main framework 1 at their forward ends and at their rear ends are integral with a cross-member 37 which is carried by brackets 38 and 39. The rear ends of the slide bars 21 are rigidly mounted on the cross-member 37 whilst their forward ends are mounted in a bracket 40 provided on two members 41, the members 41 being integral with a cross-member 42, and with longitudinal members 3 of the main framework 1.

The pusher 20 is provided with a boot 43 against which the briquettes bear as they are pushed off the press-table 7 through the slide 8 towards a pallet 9. The boot 43 is advantageously faced with rubber. A lateral bracket or arm 44 projects from each side of the pusher 20, each arm having mounted thereon at a position adjacent its outer end a gripper comprising a pair of inner links 45 and a pair of outer links 46. Each of the two pairs of outer links 46 are interconnected by ties 47 and 48 in which a pin 49 carrying a roller 50 is mounted.

A pin 51 mounted between the two links of each pair of inner links 45, carries a rotably mounted spring bar 52 to which is attached one end of a compression spring 53. The other end of the spring 53 extends over the outer end of a stud 54 to engage with a washer 55 provided on the stud. The stud 54 is threaded into the body of the pusher 20 and is retained in position by a

lock-nut 56. The washer 55 bears against a nut 57, the rotation of which serves to vary the degree of compression on the spring 53.

The springs 53 urge the links 45 and 46 outwardly and maintain each of the two rollers 50 in contact with a cam 60 mounted on each of the two members 36.

A pin 58 is provided between the lower ends of each pair of links 45 and of each pair of links 46, two compacting or gripping members 59, one on each side of the pusher 20, being mounted on the pins 58.

The slide 8 incorporates a drawbridge 61 (Figures 11 to 13) on to and over which the briquettes are pushed directly from the press-table 7 by the pusher 20. The drawbridge 61 comprises a central member 62 and two side members 63. Each of the two side members 63 is secured to two arms 64 which are rigidly mounted on a spindle 65, each of the spindles 65 being mounted to rotate in bearings 66, 67 and 68, the bearings 66 and 67 being mounted on cross-members 69 which also carry the central member 62. As two briquettes are pushed from the press-table 7 on to the drawbridge 61, the outer edges of the briquettes rest on the side members 63 whilst the inner and adjacent edges of the two briquettes rest on the central member 62. Rotation of the two spindles 65 to lower the arms 64 opens the drawbridge 61. The means supporting the outer edges of the two adjacent briquettes are thus removed and the two briquettes drop, one on each side of the central member 62, on to the continually moving band conveyor 10 (Figure 2).

The two spindles 65 are rotated to open and close the drawbridge 61 by an operating rod 70 (Figure 14) which is pivotally connected to a quadrant plate 71. Each of the spindles 65 has rigidly mounted thereon a lever 72, one of the levers 72 being connected to the quadrant plate 71 by a rod 73 and the other lever 72 being connected to the plate 71 through two rods 74 and an intermediate coupler 75. The quadrant plate 71 is mounted to rotate on a pin 76 carried in a bracket 77 secured to a vertical member 2 of the main framework 1. Means, such as a hand lever and crank, are connected to the rod 70 for operation of the drawbridge 61. Advantageously, the hand lever rests normally in the dead centre position, with the drawbridge closed. Auxiliary means, such as a spring, may also be provided to urge the drawbridge 61 into the closed position.

From the drawbridge 61, the briquettes are pushed on to a tray 78 (Figures 11 and 15) which is carried by four brackets 79, two towards the rear end of the tray and two towards the forward end of the tray. Each of the two brackets 79 carrying the rear end of the tray 78 is mounted at the lower end of a link 80 which pivots at its upper end on a pin 81 mounted in one of the members 41. Each of the two brackets 79 carrying the forward end of the tray 78 is likewise mounted at the lower end of its own link 82, each of the two links 82 being pivotally mounted at its upper end on a pin 83 mounted in one of the members 41. A tension spring 84 is provided on each side of the tray 78 and is attached by its forward end to the link 82, the rear end of each tension spring being engaged by a corresponding bolt 85 mounted in a longitudinal slot 86 provided in each of the members 41. By adjusting the position of the bolts 85 in the slots 86, the initial tensions in the springs 84 may be varied as necessary. As the briquettes are pushed forwardly over the tray 78, the tray is drawn slightly forwardly in the direction of the pallet being loaded by the friction between the bases of the briquettes and the surface of the tray 78 and the springs 84 are thereby subjected to further stress. Upon cessation of thrust by the pusher, the tray 78 is returned by the springs 84 into its normal position adjacent to or in contact with the forward ends of the members 62 and 63 of the drawbridge 61. This return motion given to the tray 78 by the springs 84, brings the forward end of the foremost pair of briquettes on the tray 78 out of contact with the rearward ends of the last pair of briquettes pushed on to the pallet 9 which is being loaded. When the pallet is then moved forwardly by the pitching mechanism upon the completion of a double row, displacement of the last pair of briquettes in the double row by the foremost pair on the tray 78 will not occur.

Two pairs of rollers 87, one pair at each end of the tray 78, are mounted on vertical pins 88 in bearings 89 secured to the two members 41. The rollers 87 bear against the outer lateral surfaces of the briquettes and maintain the double row of briquettes closely together as the briquettes are pushed forward on to a pallet 9.

The briquettes are ejected in pairs from moulds formed in the press-table 7 itself. The press-table 7, of known construction, is intermittently rotated through a definite angle, and the moulded briquettes are carried upwardly from the moulds to the level of the upper surface of the press-table 7 by plungers located vertically below the slide 8. The reciprocatory motion of the pusher 20 is synchronised with the motion of the press-table 7 whereby the pusher 20 is in or near its rearmost position before the briquettes are lifted from the moulds to table level. The lifting plungers dwell at the upper limit of their travel for a period sufficient for the forward motion of the pusher 20 to begin and to engage the briquettes before the downward stroke of each plunger is started. Each pair of briquettes is then pushed forward by the pusher 20 towards the drawbridge 61, the briquettes being constrained to travel radially outwards over the surface of the press-table 7. As the pusher travels towards the drawbridge 61, the compacting members 59 are forced inwardly as the rollers 50 ride over the cams 60 and the two briquettes are brought into contact with one another at their inner lateral surfaces before they pass from the surface of the press-table 7 on to and over the drawbridge 61. After passing over the drawbridge 61, the pair of briquettes are pushed on to the tray 78, the briquettes being between the rear pair of rollers 87 at the forward limit of the travel of the pusher 20.

The pusher 20 then returns to collect a further pair of briquettes fed to it by the rotatiang press-table 7, the rate of travel of the pusher 20 being synchronised with the rate of rotation of the press-table. This next pair of briquettes is then pushed forward in similar manner over the drawbridge 61 with the adjacent lateral surfaces of the briquettes in contact with one another. The forward ends of this pair of briquettes contact the rear ends of the preceding pair of briquettes, which pair is thus pushed forward a distance equal to the length of one briquette. Thus the briquettes are fed intermittently in a compact double row on to a pallet 9 resting on the upper fixed track 12, the upper surface of the pallet 9 being level with the upper surface of the tray 78.

Where one or both briquettes of a pair are badly formed or damaged, the drawbridge 61 may be opened by manual operation of the rod 70 to by-pass the briquettes on to the band conveyor 10. The drawbridge 61 is then closed, either manually or automatically as, for example, by means of a spring, before the next pair of briquettes is pushed forward by the pusher 20.

Pallet and pallet pitching mechanism

Each of the two pallets 9 (Figures 16 and 17) is provided with four runners 11 carried on pins mounted in the depending sides 90 of the pallet. At its forward end, each pallet is provided on each side with a hooked connecting latch 91 pivotally mounted at its rearward end on a pin 92, the forward ends of the latches 91 projecting beyond the front end of the pallet. Two depending arms 93 are rigidly secured to each latch 91 and a pin 94, on which is provided a roller 95, is mounted between the two arms 93. In their normal position, the latches 91 rest under their own weight on pins 96 which project outwardly from the sides 90 of the pallet.

Four laterally projecting brackets 97 are provided on each pallet, and on the particular bracket 97 which lies at

the forward end of the pallet and on the side 90 adjacent to the press-table 7, a roller 98 is mounted.

A pair of oppositely directed, traverse pawls 99 are provided on each side of the pallet to project below the lower edges of the sides 90. The pawls are mounted on pins 100, one end of each pin being mounted in bearings in the sides 90 whilst the other end of each pin is mounted in bearings in a bracket 101.

Notches 102 are provided in spaced relation in the longitudinal edges of the pallet 9, in which notches members of the pallet pitching mechanism engage to move the pallet forwardly through the requisite distances when the briquettes are being loaded on the pallet by the briquette pushing gear 5.

A pair of pins 103 project outwardly from the sides 90 at the rear end of the pallet and when a pallet is being loaded, the pins 103 are engaged by the hooked connecting latches 91 of an empty pallet to draw the empty pallet into position for loading.

A cam tappet 177 is provided on one side of the pallet 9 to operate valves to actuate the track operating mechanism as hereinafter described, the tappet 177 being advantageously provided so that its precise position may be readily adjusted.

The briquettes 6 are pushed, by the briquette pushing gear 5, as a compact double row on to a pallet 9 resting on its runners 11 on the upper fixed track 12. The movement of the briquettes on to the pallet is intermittent, the briquettes being pushed across the surface of the pallet 9 through a distance equal to the length of a briquette, which period of movement is followed by a dwell during which the pushing gear 5 makes a reciprocatory movement to bring forward another pair of briquettes. The double row of briquettes is then pushed forward again through a distance equal to the length of the briquette. When a double row of briquettes has been laid transversely across the surface of the pallet 9, the pallet 9 is moved forwardly on the upper fixed track 12 so that a further double row of briquettes may be laid across the pallet, the distance through which it is necessary to move the pallet forwardly, being determined by the width of the briquettes. This forward movement of the pallet must be completed during the period of dwell of the briquettes, that is to say, during the period taken by the pusher 20 to travel from the limit of its forward travel to the position at which the front ends of the next pair of briquettes brought forward by the pusher contact the rear ends of the immediately preceding pair of briquettes. This intermittent, forward movement of the pallets when being loaded by the pusher, is effected by the pallet pitching mechanism.

The pallet is moved forward whilst being loaded by the swinging movement of two pitching arms 104 (Figures 18 to 21) when in engagement with an oppositely disposed pair of the notches 102 provided along the longitudinal edges of each pallet. The centre lines of adjacent notches 102 are spaced apart by a distance which is substantially equal to the distance through which the pallet is to be moved for the laying of the double rows of briquettes; the minimum value of this distance is determined by the width of the briquettes. Each pitching arm 104 swings in a slotted guide bracket 104*a* and is pivotally connected at its upper end to a forked lever 105 which is keyed to a transverse shaft 106. The shaft 106 may be given a rotary movement by means of a keyed lever 107 which is pivotally connected to the fork end 108 of the piston rod 109 of a double-acting air cylinder 110, the air cylinder 110 being pivotally mounted at its trunnion end on a pin 111 carried in a bracket 112. Actuation of the air cylinder 110 serves a lift and lower the pitching arms 104 to bring them out of and into engagement with the notches 102.

The swinging movement is imparted to the pitching arms 104 by a double-acting air cylinder 113 pivotally suspended at its trunnion end from a pin 114 mounted in a bracket 115. The projecting end of the piston rod 116 of the air cylinder 113 is provided with a fork 117 by which the piston rod is pivotally connected to a lever 118 keyed on a short transverse shaft 119 mounted in a bearing 120. A sprocket 121 is keyed to the short transverse shaft 119 and rotary movement of the shaft 119 is transmitted through the sprocket wheel 121, a sprocket 124 keyed on the shaft 123, and a roller chain 122, to a crankshaft 123 mounted in bearings 337.

A crank disc 125 is keyed on each end of the crankshaft 123 and each crank disc 125 is connected to its respective pitching arm 104 through a crank pin 126, a connecting rod 127 of adjustable length, and a clamp 128.

The ratios of the sprockets 121 and 124 are related to the stroke of the piston 116*a* of the air cylinder 113 in such manner that one stroke of the piston 116*a* is effective to rotate the shaft 123, and with it the crank discs 125, through an angle of about 180°, thus moving each pitching arm 124 from one limit of its swing to the other limit of its swing.

Each crank disc 125 reciprocates through the same angle of 180° with every two successive strokes of the piston 116*a*. In order that the rotation of the crank disc 125 may be limited to 180° and may not be influenced by any slackness in the chain 122, it is advantageous to provide a projecting member 125*a* on one or both of the crank discs and corresponding limit stops 338. The limit stops 338 and/or the projecting members 125*a* may be made adjustable in order that the angle of rotation of 180° may be increased or decreased slightly where this is found necessary for effective control of the pilot valves hereinafter described.

Another suitable method of adjusting the angle of rotation of the crank discs 125 consists in threading a bolt through each of the limit stops 338, the shank end of which then comes to bear on the projecting member 125*a* and so acts as the limit stop. This method of adjusting the angle of rotation may be used alone, in which case the limit stops 338 forming a pair are advantageously separated by an angle which is more than 180°, or the method may be used where the limit stops 338 and/or projecting member 125*a* are adjustable.

The angle of swing of each pitching arm 104 may be adjusted by altering the position of the clamp 128 on the arm 104 and the precise location of the swing may be altered by adjusting the length of the connecting rod 127.

Whilst the pitching arms 104 are lifted upwardly and out of a pair of oppositely disposed notches 102 and are then swung rearwardly to be engaged in the next pair of oppositely disposed notches 102, the pallet 9 is located and held stationary by means of two pairs of spring-loaded levers 129, each pair being pivotally mounted on a bracket 130 secured to a longitudinal member 3 of the main framework 1. A roller 131 is mounted at the lower end of each pair of levers 129 and locates and holds the pallet 9 by engaging in a notch 102. When the pallet is moved forwardly by the pitching arms 104, the rollers 131 are forced out of the notches 102 and ride over the surface of the pallet to engage in the next succeeding notches when the pitching arms 104 reach the end of their forward swing.

Operation of the two air cylinders 110 and 113, which serve to move the pallet forwardly in equally pitched stages during loading of the pallet by the pusher 20, is effected through two main air valves H and J, of the type embodying a piston, which are controlled by pilot valves K, L, M and N operated by cams or other suitable means.

When the leading pair of a double row of briquettes is nearing its final position on the pallet 9, the forward end of one of the two briquettes in the leading pair contacts the roller of a spring-loaded cam of the pilot valve K. Alternatively, the pilot valve K may be operated, as may any of the other pilot valves incorporated in the apparatus, by the forward end of one of the leading briquettes tripping a micro-switch O (Figure 21) which momen-

tarily energises a solenoid incorporated in the pilot valve K. This pilot valve K is secured to a longitudinal member 3 at a position in line with the slide 8 and on the opposite side of the main framework 1 to the slide 8.

Actuation of the pilot valve K reverses the main air valve J, air being released to exhaust through the port J^1, line 138, port K^1 and port K^2. Upon reversal of the main valve J, compressed air from the main air supply line 132, after passing into the valve J through branch line 133, air filter unit 134, reducing valve 135, air lubrication unit 136 and port J^2, is directed by the valve J through port J^3, line 137 and port 113*a* into the trunnion end of the cylinder 113. Simultaneously, air is exhausted from the opposite side of the piston 116*a* through port 113*b*, line 139, port J^4 and port J^5. Piston 116*a* is thus forced downwardly and, through the lever 118, transverse shaft 119, sprockets 121 and 124, and crankshaft 123, the crank discs 125 are rotated through an angle of approximately 180°. The pitching arms 104, which are in engagement with a pair of notches 102, are thus swung forwardly by the connecting rods 127 and the pallet is pulled forwardly into a position which permits a further double row of briquettes to be pushed on to the pallet by the pusher 20. This forward movement of the pallet, and consequently the downward stroke of the piston 116*a*, must be completed within the period of dwell of the briquettes. The reducing valve 135 will only be included in the line 133 where it is required by the pressure at which the air is supplied.

This forward movement of the pallet 9 carries that row of briquettes which actuated the pilot valve K, away from the roller of the spring-loaded cam, or from the micro-switch O, as the case may be, and the pilot valve K resets itself without affecting the direction of flow of the compressed air through the main valve J.

At or near the forward dead centre positions of the two crank discs 125, a cam lever 140 which is rigidly secured on the crankshaft 123 contacts the roller of the pilot valve L, to actuate the pilot valve itself. The main valve H is thereby reversed, air being exhausted through port H^1, line 141, port L^1 and port L^2. Simultaneously, compressed air from the branch line 133 enters the valve H through port H^2 after passing through an air filter unit 142, a reducing valve 143 and an air lubrication unit 144. The valve H directs the compressed air through port H^3, line 145 and port 110*a* into the trunnion end of the cylinder 110. At the same time, air is exhausted from the other side of the piston 109*a* through port 110*b*, line 146, port H^4 and port H^5. The piston 109*a* is forced towards the bottom of the cylinder 110 and the shaft 106 is rotated through the lever 107. This rotation of the shaft 106 serves to lift the pitching arms 104, which are at the forward limit of their swing, and to withdraw them from the notches 102. Whilst the pitching arms 104 are out of engagement with the pallet being loaded, the pallet is retained in position by the spring-pressed levers 129 as hereinbefore described.

At the end of the stroke of the piston 109*a*, a cam lever 147 rigidly secured on the shaft 106 is brought by the rotation of that shaft into contact with the roller of the pilot valve M to actuate it. Actuation of the pilot valve M reverses the main valve J, air being released to exhaust through port J^6, line 148, port M^1 and port M^2. Simultaneously, valve J directs the compressed air from the line 133 through the port J^4, line 139 and port 113*b* into the cylinder 113 at the underside of the piston 116*a*, whilst the air on the upper side of the piston 116*a* is exhausted through line 137, port J^3 and port J^7. The piston 116*a* is thus forced upwardly and the crank discs 125 are rotated through 180° and in the opposite direction to that in which they were rotated when the valve J was actuated by the pilot valve K. The pitching arms 104, which are now out of engagement with the notches 102 and are clear of the surface of the pallet 9, are thus swung rearwardly.

At or near the rear dead centre position of the crank discs 125, the cam lever 140 actuates the pilot valve N, if necessary or desired, through a spring-pressed cam, a switch plus a solenoid, or any other suitable means; in Figure 21 the cam lever 140 is shown as actuating the pilot valve N directly through the spring-pressed roller of the valve. This reverses the valve H air being exhausted through port H^6, line 149, port N^1 and port N^2. At the same time, compressed air from the branch line 133 is directed by the valve H through port H^4, line 146 and port 110*b* into the cylinder 110, whilst the air in the cylinder 110 on the trunnion side of the piston 109*a* is exhausted through port 110*a*, line 145, port H^3, and port H^7. The piston 109*a* is forced towards the trunnion end of the cylinder 110 and the pitching arms 104 are thereby lowered to engage in the next succeeding pair of notches 102. One cycle of the pitching motion is thereby completed and the pitching arms 104 are in position to move the pallet forward after the next double row of briquettes has been laid across the pallet and the pilot valve K has been actuated.

The motion of the pallet 9 during the pitching movement is approximately simple harmonic; this avoids appreciable displacement of the briquettes on the pallet which would otherwise occur with the shock at the start and finish of each pitching movement of the pallet. In order that this motion of the pallet may more closely approximate to simple harmonic motion, the speed of rotation of the crank discs 125 should be constant. This necessitates controlling the rate of travel of the piston 116*a* throughout its stroke without regard to the varying resistances which occur during each stroke. For this purpose, it is advantageous to provide damping means on one or more of the members which transmit the movement of the piston 116*a* to the pitching arms 104. It is preferred to provide the damping means as an oil dash-pot 150 on the shaft 119, the dash-pot 150 being pivotally suspended from the bracket 115 and having its piston rod 151 pivotally connected to a lever 152 keyed on the shaft 119. One or more restrictor valves may be provided in the piston of the dash-pot 150, or the dash-pot may be connected at each end through lines 153 and 154 to an oil reservoir 155, a restrictor valve 156 being provided in each of the lines 153 and 154 (Figure 21).

At the end of a forward or rearward swing of the pitching arms 104, the pressure of the air in cylinder 113 is held by the limit stops 338 of the crank discs 125, thus leaving the pitching arms located but quite free to be raised from or lowered into the notches 102.

The pilot valves and the main air valves may also be provided with throttles valves in or on their exhaust ports: the speed of operation of each pilot or main valve may then be controlled. Throttle valves may also be provided in the ports of the two air cylinders 110 and 113.

One form of spring-loaded cam suitable for use with the pilot valve K, and, if desired, with any of the pilot valves L, M, and N or with the similar pilot valves R and S hereinafter referred to, is illustrated in Figures 22 and 23. A cam 340 is fixedly mounted on a sleeve 341 carried on a pin 342 held in a bracket 343, the cam surface 344 of the cam being in contact with the spring-pressed roller or port controller 345 of pilot valve T. Two arms of a cam actuator 346 are also fixedly mounted on the sleeve 341, and a pin 347 mounted between the outer ends of the two arms carries a roller 348. The cam 340 is held in its inoperative position by a tension spring 349 secured at one end to a pin 350 depending from the bracket 343 and secured at the other end to pin 351 on the cam actuator 346, the cam actuator 346 being held against a stop pin 352. When the cam is actuated, for example by a double row of briquettes being loaded onto a pallet and bearing at their forward end on roller 348, the cam surface 344 rides over the port controller 345 and presses it inwardly to open the inlet port

T^1 (connected to one or more main air valves) and the outlet or exhaust port T^2 of the pilot valve T. A throttle valve **353** is illustrated in the outlet port T^2, the provision of which reduces the speed of operation of the main air valve or valves controlled by the pilot valve T. The pilot valve may, however, be actuated through a microswitch and solenoid. The cam **340** would then trip the microswitch, as diagramamtically illustrated in Figure 21 with reference to the microswitch O and pilot valve K.

As the loading of the pallet resting on the upper fixed track **12** proceeds, the rear movable track **15** carrying an empty pallet is raised by the track operating gear and brought into alignment with and to abut against the upper fixed track **12**. The hooked latches **91** projecting forwardly from the empty pallet ride over and engage the laterally projecting pins **103** provided at the rear end of the pallet being loaded. At the next forward movement given to the front pallet by the pitching arms **104**, the empty, trailing pallet is also drawn forward. As the loading of the front pallet proceeds, the pitching arms **104** are eventually disengaged from the last pair of notches **102** of the front pallet and at the end of that particular pitching motion they are engaged in the first pair of notches **102** of the empty, trailing pallet. During the remainder of its loading period, the front pallet receives its pitching motion as a thrust from the empty, trailing pallet. During the course of the pallet loading operation, the front pallet passes on to the front movable track **14** which is in position to receive it.

When the front pallet is fully loaded and the two interconnected pallets are moved forward by the pitching arms **104**, thereby bringing the trailing pallet into position to receive its first double row of briquettes, the latches **91** of the trailing pallet are disengaged from the pins **103** of the loaded pallet as the roller **95** on each of the two latches **91** rides up on the cam **157** (Figure 1), one of the cams **157** being provided on each of the two members forming the upper fixed track **12**. At the same time, the hooked latches **91** of the fully loaded pallet engage with catches **158** provided at the forward ends of the two members forming the front movable track **14**. This forward movement of the loaded pallet on the movable track **14** is limited by a stop **200** (Figures 24 and 25) on each of the two rails of the track **14**. Each stop **200** advantageously comprises a bracket **201** secured to the rail, and the end of a bolt **202** in threaded engagement with the bracket **201** comes into contact with a bracket **97** on the loaded pallet to limit its forward movement. The front movable track **14** is then automatically lowered to bring it into alignment and contact with the lower fixed track **13**.

Track operating mechanism

The front and rear movable tracks **14** and **15** are supported, raised and lowered by similar sets of levers and links operated pneumatically in a similar manner, the front movable track **14** being operated through an air cylinder **159** and the rear movable track **15** through an air cylinder **160** (Figures 24 to 29).

The air cylinders **159** and **160** are each pivotally suspended from transverse members **4** of the main framework **1** and each of the piston rods **161** and **162** of the two cylinders is pivotally connected to a forked lever **163** keyed on its own shaft **164**. Each of the two shafts **164** is mounted in bearings **165** and a lever **166** is keyed on each end of each of the shafts **164**.

The upper fork end of a connecting rod **167** is linked to the lever **166**, the lower fork end of the rod **167** being connected to one arm of a bell crank lever **168** which is keyed on a short transverse shaft **169** mounted in a bearing **170**. A connecting rod **171** is pivotally connected at one of its forked ends to the other arm of the bell crank lever **168** whilst the other forked end of the rod **171** is linked to a lever **172** keyed on a short transverse shaft **173** mounted in a bearing **174**.

A forked track lever **175** is keyed on each of the shafts **169** and **173** and between the forks of two interconnected and adjacent track levers **175**, one of the two rails forming each movable track **14** and **15** is mounted on pins **176**.

The movable tracks **14** and **15** which are raised simultaneously and lowered simultaneously, are operated in the following manner. The tappet **177** on the pallet being loaded contacts the roller of a spring-loaded pilot valve S, or trips the switch of a solenoid operated pilot valve, mounted on a bracket on a longitudinal member **3** of the main framework **1**, to actuate the pilot valve S (Figures 28 and 29).

Actuation of the pilot valve S simultaneously reverses two main valves P and Q of the piston type which control the air cylinders **159** and **160** respectively. Air is released to exhaust through ports P^1 and Q^1, line **186**, port S^1 and port S^2. Simultaneously, the valve P directs the compressed air from supply line **180** through port P^2, port P^3, line **182** and port **159***a* into the upper, trunnion end of the cyinder **159**, the valve Q directs the compressed air from supply line **181** through port Q^2, port Q^3, line **183** and port **160***a* into the upper trunnion end of the cylinder **160**, whilst air on the lower sides of the pistons **161***a* and **162***a* in the clinders **159** and **160** is exhausted, through port **159***b*, line **184**, port P^4 and port P^5 from the cylinder **159** and through port **160***b*, port Q^4 and port Q^5 from the cylinder **160**.

The pistons **161***a* and **162***a* are thus forced downwardly and through the sets of levers and links hereinbefore described, the front and rear movable tracks **14** and **15** are raised into their upper positions in line with and in contact with the upper fixed track **12**. The front movable track **14** is then in position to receive the loaded pallet whilst the rear movable track supports an empty pallet. The position of the pilot valve S is so provided that the pallet being loaded on the upper fixed track **12** is in such a position that the latches **91** on the empty pallet raised by the rear movable track **15** engage the pins **103** on the pallet being loaded. Any impact that the pallet being loaded may receive from the empty pallet, will not move the front pallet as it is restrained by the pitching arms **104** engaged in the notches **102** and/or by the engagement of the rollers **131** of the spring-loaded levers **129** with the notches **102**.

When the front pallet is fully loaded and the empty trailing pallet is brought by the pitching arms **104** into position to receive its first double row of briquettes, the trailing pallet it released from the loaded pallet by the cams **157**, the latches **91** of the loaded pallet engage the catches **158** at the forward end of the front movable track **14**, and the tappet **177** on the loaded pallet contacts the roller of a spring-loaded pilot valve R or trips the switch where the pilot valve R is operated by a solenoid, thereby actuating the pilot valve R which is mounted on a bracket secured to a longitudinal member **3** of the main framework **1**. Actuation of the pilot valve R reverses the valves P and Q simultaneously. Air is released to exhaust from valve P through port P^6, line **178**, port R^1 and port R^2 and from valve Q through port Q^6, line **179**, port R^1 and port R^2. Simultaneously, the valves P and Q direct compressed air from the supply lines **180** and **181** into lower ends of the cylinders **159** and **160** respectively, whilst the air above the pistons **161***a* and **162***a* is exhausted from the cylinders **159** and **160**. The compressed air passed into the lower end of the cylinder **159** through port P^2, port P^4, line **184** and port **159***b* and the air on the upper side of the piston **161***a* is exhausted through port **159***a*, line **182**, port P^3 and port P^7. Similarly, the compressed air passes into the lower end of the cylinder **160** through port Q^2, port Q^4, line **185** and port **160***b* and the air is exhausted from the upper part of the cylinder through port **160***a*, line **183**, port Q^3 and port Q^7.

The pistons **161***a* and **162***a* are thus forced upwardly

and the movable tracks 14 and 15 are lowered into line with and in contact with the lower fixed track 13. The loaded pallet on the front movable track 14 is then immediately traversed over the lower fixed track 13, its layer of briquettes is scraped off on to the wagon 17 located on the hoist 19 and the pallet, now empty, continues its travel on to the rear movable track 15, as hereinafter described.

Each of the compressed air supply lines 180 and 181 is advantageously provided with a filter unit 187 and an air lubrication unit 188. Where the pressure of the air from the main air supply line 132 is such that a reducing valve is necessary, such a reducing valve 189 may advantageously be provided in each of the lines 180 and 181.

Separate main control valves P and Q have been described for cylinders 159 and 160. It will be understood, however, that the two valves P and Q could be replaced by a single valve.

It has been found advantageous to provide means in the track operating mechanism to steady the speed at which the tracks 14 and 15, particularly the front track 14, are lowered. Such means preferably consist of an oil dash-pot 190 the piston rod 191 of which is pivotally connected to a lever 192 keyed on the shaft 164, one dash-pot 190 being provided on each of the two shafts 164 and being pivotally suspended from transverse members 4 of the main framework 1. One or more restrictor valves may be provided in the piston of each dash-pot 190, or preferably, a separate oil reservoir 192 is provided for each dash-pot 190, the reservoir 192 being connected to the upper and lower ends of the dash-pot through lines 193 each of which is provided with a restrictor valve 194. Furthermore, a throttle valve is advantageously provided in the port 159*a* and/or in the line 182. Throttle valves may also be provided when desired in one or more of the exhaust ports of the pilot valves R and S, of the main control valves P and Q, and of the cylinders 159 and 160.

The turning moment of each of the rails of each of the movable tracks 14 and 15 on the shafts 164, may be substantially counterbalanced by means of four tension springs 195. One end of each spring 195 is secured to one arm of the corresponding bell-crank lever 168, the other end of each spring being engaged by a corresponding hook bolt 196 secured by nuts to a corresponding bracket 197 mounted on a longitudinal member 3 of the main framework 1. When the movable tracks 14 and 15 are in their lower positions, each of the springs 195 is stressed to provide a maximum turning moment, the stress being relieved as the tracks 14 and 15 return to their upper positions and being a minimum when the tracks are in the upper position.

The pneumatic circuit of the pallet pitching mechanism (Figure 21) and the pneumatic circuit of the track operating mechanism (Figure 29) have been described with reference to the use of main air control valves H, J, P and Q of the type embodying a piston, each of the main air control valves being reversed by exhausting the air from one side of the piston through a pilot valve, the piston being thereby caused to move towards that end of the main air valve from which the air is exhausted. It will be understood, however, that the main air control valves and the pilot valves described may be replaced by other suitable valves or means.

By the use of modified pilot valves of known construction, compressed air may be passed in to each main air control valve on the appropriate side of its piston to assist in or to effect the movement of the piston. A pneumatic circuit embodying such means for reversing the main air control valves is diagrammatically illustrated in Figure 30, the pneumatic circuit of the pallet pitching mechanism and that of the track operating gear being shown in combination. This pneumatic circuit is substantially a combination of the circuits shown in Figures 21 and 29, with the following exceptions:

(1) The air cylinders 110, 113, 159 and 160 have, for the sake of clarity, been omitted;

(2) The pilot valves K, L, M, N, R and S have been replaced by the modified pilot valves K*a*, L*a*, M*a*, N*a*, R*a* and S*a* respectively;

(3) Pipe lines 360, 361, 362 and 363 (shown in broken lines) have been added to provide for positive reversal of the main air valves H, J, P and Q; and,

(4) A stop valve 359 has been provided in the line 180 of the main air valve P and in the line 181 of the main air valve Q.

When the pilot valve K*a* is actuated upon the completion of the laying of a row of briquettes across the pallet 9, the main air valve J of the pallet pitching mechanism is reversed in the manner hereinbefore described, air being released to exhaust through port J^1, line 138, port K^1a and port K^2a. Simultaneously, however, movement of the piston in the main air valve J is assisted or effected by compressed air on the opposite end of the piston, which compressed air passes in through line 360, ports M^3a and M^1a of pilot valve M*a*, line 148 and port J^6. When the main air valve J is next reversed by actuation of the pilot valve M*a*, air is exhausted from one side of the piston in the valve J through port J^6, line 148, port M^1a and port M^2a, and compressed air passes into the valve J, at the opposite end of its piston, through line 361, line 362, ports K^3a and K^1a of the pilot valve K*a*, line 138 and port J^1.

Reversal of the other main air valves H, P and Q may also be assisted or effected in similar manner. Thus upon actuation of the pilot valve R*a*, air on one side of the pistons of valves P and Q is exhausted through ports P^6 and Q^6 respectively in the manner hereinbefore described, and compressed air passes into the valves P and Q through ports P^1 and Q^1 respectively from line 363, ports S^3a and S^1a of pilot valve S*a* and line 186. Upon the next reversal of the valves P and Q, by actuation of the pilot valve S*a*, air is exhausted from the corresponding ends of their pistons through ports P^1 and Q^1 respectively, whilst compressed air is passed in to the opposite ends of their pistons through the ports P^6 and Q^6 respectively from line 363, ports R^3a and R^1a of pilot valve R^a, and line 179.

Similarly, actuation of pilot valve N*a* exhausts the air from one side of the piston of main air valve H through port H^6 in the manner hereinbefore described, whilst compressed air passes into the valve H through port H^1, at the other side of the piston, from line 361, ports L^3a, and L^1a of pilot valve L*a*, and line 141. Upon actuation of the pilot valve L*a*, air is exhausted through port H^1 from one side of the piston in the main air valve H whilst compressed air passes into the valve H at the opposite side of the piston through line 361, ports N^3a and N^1a of pilot valve N*a*, line 149 and port H^6.

It will be understood that air is also passed into and also exhausted from the cylinders 110, 113, 159 and 160 in the manner hereinbefore described with reference to Figures 21 and 29.

Pallet traversing mechanism, plough and plough locating mechanism

The adjacent ends of the movable tracks 14 and 15 rest, when the tracks are in their lower position, on track brackets 198 on which the rails of the lower fixed track 13 also rest. The other ends of the rails of the tracks 14 and 15 rest, in their lower positions, on brackets 199.

When the front movable track 14 with its loaded pallet is lowered, the roller 95 on each of the two latches 91 comes to rest on a cam plate 203 provided on each of the brackets 199 at the forward end of the main framework 1, so disengaging the latches 91 from the two catches 158.

Upon the front movable track 14 reaching its lower

position, the traverse pawls **99** provided on each side of the loaded pallet are engaged by two conveyor chains **204** and the loaded pallet is traversed horizontally and rearwardly over the lower fixed track **13** and on to the rear movable track **15** where the traverse pawls **99** are automatically disengaged (Figure 31).

Each of the two conveyor chains **204** travels over a chain wheel **205** keyed on a stub shaft **206** mounted in a bearing **207**, and is driven through a chain wheel **208** keyed on a transverse shaft **209**. The conveyor chains **204** are driven by an electric motor **210** through a worm reduction gear **211** and a flexible coupling **212** keyed on the transverse shaft **209**, the drive from the motor **210** to the worm gear **211** being advantageously effected by a V-rope or belt **213** and that from the worm gear **211** to the shaft **209** through the flexible coupling **212** being advantageously effected through a chain **214**. Chain guards **215** may be provided for the conveyor chains **204**; a guard **216** may also be provided for the chain **214** as well as a guard **217** for the V-rope or belt **213**.

The plough **16** scrapes the briquettees off the loaded pallet as it is traversed rearwardly by the conveyor chains **204** and the pallet, now empty, continues its rearward travel until it is fully on the rear movable track **15** when the traverse pawls **99** are automatically disengaged from the conveyor chains **204** as the latter travel over the chain wheels **208**. The conveyor chains **204** are advantageously kept continually moving.

Each of the laterally projecting pins **103** at the rearward end of the now empty pallet are engaged by a hooked latch **218** pivoted at a position to the rear of the centre of gravity of the latch **218** on a bracket **219** mounted at the rear end of the rear movable track **15**. When the rear movable track **15** is raised to its upper position, each latch **218** is disengaged from the pins **103** by means of catch plates **220**, mounted on vertical members **2**, which bear on a roller **221** provided on the rear end of each of the latches **218**.

A resilient stop **222** is advantageously provided on each of the two rails forming the rear movable track **15**, to absorb the momentum of the pallet and to bring it to rest when the traverse pawls **99** are disengaged from the conveyor chains **204**. The resilient stop **222** may comprise a pin **223** slidable in a bracket **224**, a compression spring **225** being provided on the pin **223** between a collar **226** fixed on the pin **223** and a washer **227** which bears against one arm of the bracket **224**. The bracket **224** is mounted on the movable track **15** so that the front end of the pin **223** comes into contact with one of brackets **97** on the pallet. The resilient stops **222** also ensure that the latches **218** remain in engagement with the projecting pins **103** until they are disengaged by the catch plates **220**.

The plough **16** is provided as a rectangular bar extending transversely of the main framework **1**. The plough is advantageously faced with a strip **228** of steel or of hard rubber, for example, and its ends rest in guide brackets **229** in which it is adapted to slide, the brackets **229** being mounted on the inner sides of the two rails forming the upper fixed track **12** (Figures 32 and 33). The plough **16** is secured to the straps **230** of two eccentric sheaves **230***a* which are keyed on a shaft **231**. Bearings **232** are provided for the shaft **231**, the bearings **232** being mounted on brackets **233** extending forwardly from a transverse member **234** which is secured at its ends to the two rails of the upper fixed track **12**.

One end of the shaft **231** projects through one of the rails of the upper fixed track **12** and on this projecting end of the shaft a chain pinion **235** is keyed, the pinion **235** being engaged through a chain **399** with a chain pinion **397** keyed on a short shaft **396** mounted in bearings in a bracket **395** secured to a longitudinal member **3**. A star wheel **398** is fixedly mounted on the shaft **396** in such position as to be engaged by the roller **98** of a pallet as the pallet is pitched forwardly over the upper fixed track **12** in the loading operation.

A short shaft **238** is mounted in a bearing **239** secured to a bracket or stand **240** provided on a longitudinal member **3** of the main framework **1**, the inner end of the shaft **238** being carried in a bearing provided in a rail of the lower fixed track **13**. A star wheel **241** and a chain wheel **242** are keyed on the short shaft **238**, the chain wheel **242** being engaged by means of a chain **243** with a chain pinion **244** provided on a rotary valve **245** of the hydraulic control means of the hoist **19**.

The plough locating mechanism functions in the following manner. As the loaded pallet is traversed rearwardly by the conveyor chains **204**, rearward movement of the briquettes on the pallet is limited by the plough **16**. The briquettes are thus stripped off the pallet as it proceeds rearwardly and are deposited as a compact layer on the wagon **17** which is in position on the hoist **19** to receive them. In the rearward traverse of the pallet and after the briquettes have been stripped from the pallet, the roller **98** mounted on the bracket **97** (Figure 17) engages the star wheel **241** and rotates it through an angle of 90°. The chain wheel **242** is thereby rotated and through the chain **243** and the pinion **244**, the rotary valve **245** is rotated to actuate the hydraulic control means of the hoist **19** to lower the hoist through a distance equal to the thickness of one briquette. After the hoist **19** has been so lowered through the thickness of one briquette, the star wheel **398** is engaged by the roller **98** of a pallet being pitched forwardly on the upper fixed track **12** and the star wheel **398**, together with its shaft **396**, is rotated through an angle of 90°. The chain pinion **397** is thereby rotated and through the chain **399** and the pinion **235**, the shaft **231** is rotated, the ratio of the pinions **397** and **235** being advantageously provided as 2:1 so that the shaft **231** is rotated through 180°. Rotation of the shaft **231** is transmitted through the eccentric sheaves **230***a* and straps **230** to the plough **16** which is thus moved forwardly or rearwardly in the guide brackets **229**. The next layer of briquettes deposited on the wagon **17** will thus be staggered in relation to the previous layer and the plough **16** will be returned to its original position as the roller **98** of the next pallet pitched forwardly on the upper fixed track **12** engages the star wheel **398**. The following layer of briquettes laid on the wagon **17** will be staggered with respect to its preceding layer and will be vertically above the layer first referred to. The forward travel of the pallets in the loading operation on the upper fixed track **12** thus serves to reciprocate the plough **16** after the hoist **19** has been lowered upon receiving a layer of briquettes. The layers of briquettes deposited on the wagon **17** are thereby staggered in a longitudinal direction so as to form a stable and internally bound stack.

As the briquettes **6** are swept off a pallet by the plough **16**, each transverse row of briquettes falls through a small distance, for example ⅞ inch, on to the wagon **17**. As the briquettes drop, the side faces of the briquettes in each row thus rub against the side faces of the briquettes of the immediately adjacent transverse row and with certain types of briquettes or bricks this has resulted in a tendency to damage the top edges of some of the briquettes or bricks. This tendency to damage was found to be greatest when the member **228** was a thick rubber strip. When the member **228** was made of steel, for example, or when the member was removed altogether, the tendency to damage the edges of some of the briquettes or bricks was distinctly less.

Where the articles being stacked are such that this tendency to suffer damage exists, it is preferred to use a plough provided with a retractable member or pusher bar **370** (Figures 40 to 44). The retractable member or pusher bar **370** may be provided as two angle irons **370***a* and **370***b* which are welded together and are secured at the forward ends of two members **369**, the retractable member **370** presenting a smooth flat face for contacting the briquettes **6**. Each of the members **369** is adapted to slide in its own slot **16***a* provided in the plough **16** and

at its rearward end each member 369 is pivoted on a pin 371 between a pair of swivel plates 372. Each pair of swivel plates 372 is mounted to swivel about pins 373 provided in fulcrum blocks 374, the two fulcrum blocks 374 being secured to the plough 16 to extend rearwardly of the plough.

The two pairs of swivel plates 372 are interconnected by a connecting member 375 the length of which is advantageously adjustable, each end of the connecting member 375 being mounted on a pin 376 about which it is adapted to swivel. Each pin 376 is mounted between a pair of the plates 372 at a position between the swivel pin 373 and a pin 377 mounted between the rearward ends of the plates 372.

Through pin 377, connecting rod 378 of adjustable lengh and a coupler 379, one pair of swivel plates 372 is directly connected to the piston rod 380 of a double-acting air cylinder 381. The other pair of swivel plates 372 is connected in similar manner through its pin 377, a similar connecting rod 378 and a similar coupler 379 to the piston rod 382 of an oil dash-pot 383. The air cylinder 381 and the oil dash-pot 383 are each pivotally mounted at their trunnion ends on corresponding brackets 384 secured to the rear surface of the plough 16.

It will thus be understood that operation of the air cylinder 381 serves to move the retractable member 370 of the plough 16 away from or towards the plough 16, the retractable member 370 remaining substantially parallel to the plough 16 throughout its movement. The air cylinder 381 is operated through a 4-way main air value U similar to the valves H, J, P, and Q hereinbefore described, the valve U being controlled by pilot valves V and W which are similar to the automatic return pilot valves previously referred to.

As a loaded pallet is traversed over the lower fixed track 13, the underside of the leading edge of the loaded pallet contacts the spring-loaded roller of the pilot valve V as the first transverse row of briquettes are swept off the pallet by the plough 16 and its retractable member 370, the position at this instant being illustrated in Figure 43. The pilot valve V may however be actuated, as may pilot valve W, through a spring-loaded cam, a switch plus a solenoid, or through any other suitable means. Actuation of the pliot valve V serves to reverse the main air valve U, compressed air passing into one end of the valve U from the main supply line 132 through lines 385 and 385*a*, ports V^3 and V^1 of pilot valve V, line 386 and port U^1 whilst air is released to exhaust from valve U through port U^6, line 387, and ports W^1 and W^2 of pilot valve W. Upon reversal, the valve U directs compressed air from the line 385 through ports U^2 and U^3, line 388 into the trunnion end of the cylinder 381 through port 381*a*. The piston 380*a* in the cylinder is forced away from the trunnion end and the air in front of the piston passes to exhaust through port 381*b*, line 389, and ports U^4 and U^5. Through the piston rod 380, connecting rod 378 and connecting member 375, this movement of the piston 380*a* causes the two pairs of swivel plates to rotate about their swivel pins 373 to retract the member 370 towards the plough 16.

Thus as the briquettes are being swept off the pallet by the retractable member 370 of the plough 16, the member 370 is automatically retracted towards the plough 16 and in the same direction as the loaded pallet is travelling. This retraction has been found to decrease or eliminate the tendency to damage that some types of briquettes or bricks suffer as they are transferred from the pallet on to the wagon 7. In the particular apparatus described, the member 370 was retracted through a distance of about one inch during the time the layer of briquettes is dropping from the pallet on to the wagon 17. This distance may be increased or decreased as desired.

It is generally essential for the motion of the retractable member 370 to be damped; such damping is effected by the oil dash-pot 383. The dash-pot is provided with a port 383*a* at one end and a port 383*b* at the opposite end, the two ports being interconnected through a line 390 in which an oil reservoir 391 and one or more restrictor valves 392 are provided. The external circuit for the oil may, however, be eliminated by providing one or more restrictor valves in the piston 382*a* of the dash-pot 383, or the damping system may be replaced by one of another type or form.

The retractable member 370 is returned to its outer position in readiness for the next loaded pallet, by actuation of the pilot valve W. The pilot valve W is secured to a member of the framework 1 in such position as to be actuated by the tappet 177 provided on each pallet, whilst the pallet is being loaded on the upper fixed track 12. Upon actuation of the pilot valve W, compressed air passes from line 132 through line 394, ports W^3 and W^1 of pilot valve W, line 387 and port U^6 to reverse the valve U. From valve U, air is released to exhaust through port U^1, line 386, and ports V^1 and V^2 of the pilot valve V. The valve U, upon reversal, directs compressed air from line 385 through ports U^2 and U^4, line 389 into the cylinder 381 through the port 381*b*. The piston 380*a* is thereby forced towards the trunnion end of the cylinder 381, the air from the trunnion side of the piston being exhausted through port 381*a*, line 388, and ports U^3 and U^7. This movement of the piston 380*a* towards the trunnion end of its cylinder is transmitted through the linkage hereinbefore described to move the retractable member 370 of the plough 16 into its outer position in readiness for the next loaded pallet. This completes one cycle in the movement of the member 370 and a further cycle is started when the next loaded pallet, in its traverse over the lower fixed track 13, contacts the pilot valve V.

It will be understood that the plough 16, and with it the member 370, will also be given a forward or rearward movement in the guide brackets 229 as hereinbefore described.

It is preferred that a filter unit and a lubrication unit should be provided in the line or lines leading to the valves U, V and W. If necessary, throttle valves will also be provided in the lines and/or in the exhaust ports of one or more of the three valves.

Hoist controls

The wagon 17 on the hoist 19 is lowered through a distance equal to the thickness of a briquette in the interval between the deposition of one layer of briquettes on the wagon and the descent of the front movable track 14 carrying the next loaded pallet, into its lower position. Such lowering of the hoist 19 is actuated by the star wheel 241 when it is engaged and rotated by the roller 98 of a newly unloaded pallet in the rearward traverse of the pallet over the lower fixed track 13.

The hoist 19 is raised to its upper position by starting a motor 246 and bringing the control lever 247 of a manual control valve 248 from its central, neutral position to the position Y (Figure 34). The motor 246 is connected through a shaft 249 to a pump 250, and the pump 250 driven by the motor 246 passes pressure fluid, for example oil, from a storage tank 251 through line 252, the manual control valve 248, line 253 and line 254 into the ram cylinder 19*a* of the hoist 19. The oil is also passed by the pump 250 from line 253 through line 256, the rotary valve 245 and one of the lines 257 and 258 into a volumetric control cylinder 259 on one side of the piston therein.

The hoist 19 carrying an empty wagon 17 is raised into its upper limit position by the oil pumped into the ram cylinder 19*a*, for the first layer of briquettes to be deposited on the wagon. The limit of the upward travel of the hoist 19 is advantageously determined by a shunt limit switch 255 which is operated by the hoist 19 thereby cutting out the motor 246.

The lever 247 of the control valve 248 is then released

to return to its central, neutral position, in which position all ports of the valve **248** are closed; this isolates the ram cylinder **19***a* from the pump **250**.

As a loaded pallet is traversed rearwardly over the lower fixed track **13**, its load of briquettes is scraped off by the plough **19** and deposited as the first layer on the floor of the wagon **17** on the raised hoist **19**. The roller **98** of the pallet engages the star wheel **241** and rotates it, together with the chain wheel **242**, through 90°. Through the chain **243** and the chain pinion **244** on the rotary valve **245**, this 90° rotation of the chain wheel **242** is multiplied to rotate the rotary valve **245** through an angle of 180°. Assuming that the ports of the rotary valve **245** were so placed when the hoist **19** was being raised that the oil was pumped into the volumetric control cylinder **259** through the line **258**, the rotation of the rotary valve **245** through 180° brings the line **258** into communication with the oil storage tank **251** through lines **260**, **260***a* and **261**, and the lower side of the piston in the volumetric control cylinder **259** into communication with the ram cylinder **19***a* through line **257**, the rotary valve **245**, line **256** and line **254**. The oil above the piston in the control cylinder **259** is thus discharged to the storage tank **251** and an equal quantity is forced into the control cylinder **259** on the lower side of its piston from the ram cylinder **19***a*. The hoist **19** is thereby lowered to be in position to receive the next layer of briquettes. The position at which the line **260** is connected to the line **260***a* is at a higher level than any part of the control cylinder **259**, so that oil is maintained in the piping from this position through to the control cylinder **259**.

At the next actuation of the rotary valve **245**, the oil below the piston in the volumetric control cylinder **259** is discharged to the storage tank **251**, the piston in the volumetric control cylinder being forced downwardly and the space above the piston being filled by oil from the ram cylinder **19***a*. Thus after each layer of briquettes is laid on the wagon **17**, the rotary valve **245** is actuated and an equal volume of oil is withdrawn from the ram cylinder **19***a* at each actuation of the rotary valve **245** to drop the hoist **19** in a series of steps each of equal depth.

The volume of oil withdrawn from the ram cylinder **19***a*, and consequently the distance through which the hoist **19** is lowered, at each actuation of the rotary valve **245**, is determined by the volume of the control cylinder **259**. In order that the distance through which the hoist **19** is lowered may be varied to equal the thickness of the bricks, briquettes or other articles being loaded on to the wagon **17**, known means **262** are provided to adjust the effective volume of the control cylinder **259**.

The hoist **19** is thus automatically lowered in a series of steps of equal depth. When the hoist **19** reaches ground level, it trips a shunt limit switch **263** to close a circuit to bring the hereinafter described wagon pushing gear into operation.

It is preferred that the final step of lowering the hoist **19** to ground level be effected manually by operation of the control valve **248**, the lever **247** of the control valve being swung over into the position Z. This places the ram cylinder **19***a* into direct communication with the storage tank **251** through line **254**, line **253**, control valve **248** and line **261** to exhaust the remaining oil from the ram cylinder **19***a*.

The step-up gear ratio from the star wheel **241** to the rotary valve **245** and the chain pinion **235** of the plough locating mechanism, may be avoided by providing a further star wheel **354** (Figures 45, 46 and 47). The star wheel **354** is of similar form to the star wheel **241** and is keyed on a shaft **355** mounted in bearings **356** carried in a bracket **400**. A chain pinion **357** is keyed on the shaft **355** and is engaged through a chain **358** with a pinion **359** keyed on the shaft **238**. In the rearward travel of a pallet over the lower fixed track **13**, the roller **98** on the pallet engages the star wheels **241** and **354** in turn and rotates each through an angle of 90°. By providing the pinions **242**, **244**, **357** and **359** each of the same size, the rotary valve **245** is rotated twice through 90° for each rearward traverse of a pallet over the lower fixed track **13**, thus giving the rotary valve **245** a total rotation of 180°.

Wagon stop and release mechanism

An empty wagon **17** is in readiness on rails **18***a* to the rear of the hoist **19** to replace the loaded wagon on the hoist, stop and release mechanism (Figures 35 and 36) being provided to prevent forward movement of the empty wagon until the hoist **19** is in its "down" position. The mechanism comprises a hook **264** the slot **265** of which is adapted to engage an axle **17***a* of the wagon. The hook **264** is provided with two similar arms **266** which are pivoted on a fulcrum pin **267** mounted in a bracket **268**. To a pin **269** mounted between the ends of the arms **266** remote from the hook **264**, one end of a connecting rod **270** is pivotally connected, the other end of the rod **270** being connected to a pin **271** mounted between two corresponding arms of two similar bell crank levers **272**, which are disposed in parallel relation to each other and are interconnected by transverse members **273**. The two bell crank levers **272** which pivot about a fulcrum pin **274** mounted in a bracket **275**, carry a pin between their other two arms on which is mounted a roller **276**. One end of a tension spring **277** is connected through a tie rod **278** to a pin **279** mounted between the arms **266** at a position adjacent to the pin **269**, the other end of the spring **277** being connected to an eyebolt **280** secured by nuts **281** in a bracket **282**. The tension spring **277** thus tends to rotate the arms **266** about the fulcrum pin **267** to move the hook **264** upwardly but the rotation of the arms **266** in this direction is limited by one of the transverse members **273** of the bell crank levers **272** coming to bear against the end of a set screw **283** threaded through a cross member **284** of the bracket **275**.

The hook **264** is lowered and disengaged from an axle **17***a* of an empty wagon by the hoist **19** bearing upon the roller **276** and rotating the twin bell crank levers **272** about their fulcrum pin **274**, as the hoist is lowered to ground level. The empty wagon may then be pushed forwardly on to the hoist **19**. When the hoist **19** is raised, the tension spring **277** causes the arms **266** to rotate to bring the hook **264** into its upper position. Upon pushing a wagon on the rails **18***a* towards the hoist **19**, the front axle **17***a* of the wagon rides over the arms **266** and depresses them against the action of the spring **277** until the axle is engaged and held in the slot **265** of the hook **264**.

A stop and release mechanism (Figures 37 and 38) is also provided to locate and hold a wagon **17** on the hoist **19** during the loading operation. This mechanism comprises a pair of arms **285** on a fulcrum pin **286** mounted in a bracket **288**, the arms **285** being integral at their forward ends with a slotted hook **287**. A pin **289** is mounted between the ends of the arms **285** remote from the hook **287** and is engaged by the eye of an eyebolt **290**. The other end of the eyebolt **290** passes through a swivel block **291** mounted in a bracket **292** and a compression spring **293** is mounted on the eyebolt in a stressed condition between the swivel block **291** and a nut **294** secured by a locknut **295**. The compression spring **293** thus thrusts the pin **287** forwardly in a direction to rotate the arms **285** about their fulcrum pin to raise the hook **287**.

The twin arms of a forked connecting rod **296** are also mounted at their rear ends on the pin **389**, the forward ends of the two arms being mounted on a pin **297** which is held in two arms of a pair of bell crank levers **298** which are interconnected by an angle tie **299** and which pivot on a fulcrum pin **300** mounted in a bracket **301** projecting over the forward end of the hoist **19**. A roller **302** is mounted on a pin between the ends of the other two arms of the bell crank levers **298**. Rotation of

the arms 285 by the compression spring 293 to raise the hook 287 upwardly is limited by a set screw 303, threaded through a member 304 integral with the bracket 301, coming to bear on the angle tie 299 of the bell crank levers 298.

A pair of upstanding bell crank levers 305 are mounted forwardly of the hoist 19 on a fulcrum pin 306 carried in a bracket 307, the bell crank levers 305 being provided with a rearwardly projecting platform 308 which engages the roller 302 when the hoist 19 is brought into its "down" position. Engagement of the roller 302 with the platform 308 rotates the levers 298 about their fulcrum pin 300 and this movement of the levers 298, transmitted through the connecting rod 296 rotates the arms 285 and disengages the hook 287 from the axle of a loaded wagon on the hoist, the spring 293 being simultaneously compressed.

A roller 309 is mounted between the two upper arms of the two bell crank levers 305 to project both rearwardly and upwardly of the edges of the levers. One end of a tension spring 310 is, through a link 312, engaged by a pin 311 mounted between the two lower arms of the bell crank levers 305, the other end of the spring 310 being engaged in the eye of an eyebolt 313 which is secured to a bracket 314. The tension spring 310 thus tends to turn the upstanding bell crank levers 305 about their pivot 306 to bring the roller 309 nearer to the hoist 19, but the extent of this movement is limited by a stop 315 mounted on the lower arms of the levers 305 coming to bear against a set screw 316 threaded through a member 317 integral with the bracket 314.

When the hoist 19 is in its "down" position, the hook 287 is disengaged from the front axle 17*a* of the loaded wagon as hereinbefore described, and the loaded wagon may be pushed forwardly off the hoist on to the rails 18*b*. As the loaded wagon is pushed forwardly on to the rails 18*b*, the front axle 17*a* of the wagon bears against the upper arms of the upstanding bell crank levers 305 and rotates them about their fulcrum pin 306 against the action of the tension spring 310. As the front axle 17*a* rides over the roller 309 at the upper end of the upstanding bell crank levers 305, the roller 302 at forward end of the bell crank levers 298 rides over the rear edge of the platform 308 and under the action of the compression spring 293, the hook 287 swings into its uppermost position and the forward arms of the bell crank levers 298 are rotated downwardly with the roller 302 bearing against a depending skirt 308*a* of the platform 308. The springs 293 and 310 both contribute to maintain the upstanding bell crank levers 305 in the position into which they have been rotated by the front axle 17*a* of the loaded wagon removed from the hoist 19, by retaining the roller 302 in contact with the skirt 308*a*. The distance between the front and rear axles of the wagons 17 is such that the rear axle is forward of the hook 287 when the hook 287 swings upwardly as the roller 302 rides downwardly over the edge of the platform 308.

The hook 287 is thus in position to engage the front axle 17*a* of the empty wagon when it is pushed on to the hoist 19, so preventing the wagon from over-running the hoist and also holding the wagon securely on the hoist during the loading operation. When the hoist 19 with its empty wagon is raised to receive the first layer of briquettes, the bell crank levers 298 rise with the hoist and the bell crank levers 305 are rotated into their normal, upstanding position by the spring 310. The platform 308 is then in position to engage the roller 302 when the hoist 19 is again lowered into the "down" position.

Wagon pushing mechanism

The mechanism for removing a loaded wagon from the hoist 19 and replacing it with an empty wagon, comprises a wheeled trolley 318 driven by two endless conveyor chains 319 (Figures 1, 34 and 39). The drive is provided by an electric motor 320 through a V rope or belt 321, a reduction gear 322, a chain 323, a sprocket 324 fixedly mounted on a shaft 325, and two sprockets 326 keyed on the shaft 325 and over each of which one of the two conveyor chains 319 runs. At the rearward end of their travel, the conveyor chains 319 run over sprockets 327 keyed on a shaft 328, the position of the shaft 328 being advantageously adjustable to take up any slackness in the conveyor chains 319. Guards 319*a*, 321*a* and 323*a* are advantageously provided for the conveyor chains 319, V rope or belt 321 and the chain 323 respectively.

The trolley 318 comprises two side members 329 and a transverse member 330, each side member 329 being provided with two runners 331 adapted to travel in the channels of two longitudinal members 3*a* of the main framework 1. Upstanding attachments 332 are provided on the side members 329 for engaging the lower strands of the two endless conveyor chains 319. By reversing the motor 320, the trolley 318 may thus be reciprocated longitudinally of the main framework 1 over a distance approximately equal to the distance between the shafts 325 and 328.

Two pivoted pawls 333 depend forwardly from the transverse member 330 of the trolley 318, and in the normal position of the trolley 318, the pawls 333 lie to the rear of the empty wagon which is engaged by the hook 264 and is in position ready to be pushed on to the hoist 19.

As hereinbefore described, lowering of the hoist 19 to ground level serves to disengage the stop-and-release mechanisms of the loaded and empty wagons to permit the wagons to be moved. The hoist 19 also trips the limit switch 263 to close the circuit of the electric motor 320 whereby the trolley 318 is driven forwardly towards the hoist 19. The pawls 333 of the forwardly moving trolley 318 bear against the rear end of the empty wagon and propel it forwardly. The empty wagon contacts the rear end of the loaded wagon on the hoist 19 and pushes it off the hoist on to the rails 18*b* whilst the empty wagon passes on to the hoist where its front axle 17*a* is automatically engaged by the hook 287 in the manner hereinbefore described, so locating the wagon securely in the correct position on the hoist.

Just before the empty wagon is engaged by the hook 287, the trolley 318 trips a shunt limit switch 334 which reverses the electric motor 320, thus reversing the direction of travel of the trolley 318 (Figure 34). On its rearward run, the trolley 318 trips a shunt limit switch 335 to close the circuit of the electric motor 240, thus driving the pump 250 of the hydraulic circuit of the ram cylinder 19*a*. Pressure fluid does not however pass into the ram cylinder 19*a* and the volumetric control cylinder 265 until the operator brings the lever 247 of the control valve 248 into the position Y, whereupon the pressure fluid passes through the valve 248 into the ram cylinder 19*a* to raise the hoist 19 with its empty wagon into position for the loading of the wagon.

The end of the rearward run of the trolley 318 is determined by a shunt limit switch 336 which is tripped by the trolley to open the circuit of the motor 320. The motor 320, and consequently the trolley 318, remains out of action until the hoist 19 again trips the switch 263.

Electrical interlocking is provided in known manner, in the circuits of the motors 246 and 320 to prevent movement of the trolley 318 unless the hoist 19 is in its "down" position and to prevent the ram motor 246 from being started until the switch 335 is tripped by the trolley 318 on its rearward run. An ultimate limit switch 237 is advantageously provided on the outside of each of the limit switches 334 and 336 as a safety switch.

A further empty wagon is then brought forward, manually or otherwise, on the rails 18*a*. The pawls 333 rotate about their pivots and ride over the upper surface of this further empty wagon which is then engaged by

the hook 264 by which it is held until the hoist 19 returns to its "down" position.

Operation of the apparatus

The articles to be located on to the wagon or truck are first laid in rows on a pallet by the reciprocating pushing mechanism. In this motion towards the pallet, the articles pass over the drawbridge which may be opened to by-pass faulty or damaged articles and prevent them from being laid on the pallet.

As a row of the articles is completed on the pallet, the pallet pitching mechanism is automatically brought into operation and the pallet is moved or pitched, in a direction at right angles to the row of articles, through a distance sufficient to permit a second row of articles to be laid by the side of the first row. During one of such pitching movements, the movable track operating mechanism is actuated and the front and rear movable tracks are raised and brought into line with the upper fixed track on which the pallet being loaded rests. The front movable track is empty but the rear movable track carries an empty pallet which automatically attaches itself to the rear end of the pallet being loaded; the empty pallet thus partakes in the further pitching movements given to the front pallet.

When the front pallet is fully loaded with a layer of the articles, its final pitching movement, which brings the trailing pallet into position to receive its first row of articles, serves to disengage the trailing pallet from the loaded pallet and to actuate the movable track operating gear to lower the tracks to the level of the lower fixed track. The fully loaded pallet which is carried down on the front movable track, is engaged by the pallet traversing mechanism and is traversed rearwardly over the lower fixed track and on to the rear movable track.

During the rearward traverse, rearward movement of the layer of articles on the pallet is prevented by the plough, the layer of articles being thus stripped off the pallet and deposited as a compact layer on the wagon located on the hoist. A member on the rearwardly travelling pallet engages a star wheel, a switch or other actuator of the mechanism for lowering the hoist through the thickness of one of the articles being loaded. After the hoist has been so lowered, a member on the pallet being pitched forwardly on the upper fixed track engages a star wheel, a switch or other actuator of the mechanism for moving the plough either forwardly or rearwardly in order that the layer of articles stripped from the next pallet may be deposited on the wagon in staggered relation to the preceding layer.

The now empty pallet is held on the rear movable track until it is raised to the level of the upper fixed track when the empty pallet attaches itself to the rear end of the pallet being loaded to be brought forward by that pallet into the loading position.

The wagon on the hoist receives layer after layer of the articles until it is fully loaded at which stage the hoist has reached ground level. As the hoist reaches ground level, the mechanisms which hold the loaded wagon and the empty wagon in position are automatically released and the hoist trips a switch which brings the wagon pushing trolley into movement in a forward direction to push the empty wagon on to the hoist, the empty wagon in turn pushing the loaded wagon off the hoist. Movement of the loaded wagon off the hoist actuates the locating mechanism on the hoist to engage the front axle of the empty wagon to hold the wagon securely in position on the hoist.

The forward movement of the wagon pushing trolley is limited by a switch which the trolley itself trips; the tripping of this switch serves to reverse the driving motor of the trolley. The trolley then travels rearwardly to its original position where it trips a further switch to cut out its driving motor. In its rearward travel, the trolley trips a switch which brings the driving motor of the hydraulic pump into operation. The operator then operates the control valve to allow the pressure fluid to pass into the cylinder of the hoist to raise it to its upper limit position. The upper limit position of the hoist is determined by a switch which is tripped by the hoist to open the circuit of the motor driving the pump. The hoist and its empty wagon are then in position to receive the first layer of articles from the pallet which was being loaded whilst a loaded wagon on the hoist was being replaced by an empty wagon and the hoist and empty wagon were being raised.

The pallet pitching mechanism enables the following results to be achieved:

(1) A straight line pitching motion with a pitching movement of a determined, constant length;

(2) A gentle acceleration of the pallet at the beginning of a pitching movement;

(3) A gentle retardation of the pallet at the end of a pitching movement; and,

(4) A reasonably constant velocity of the pitching movement in the interval between the initial acceleration and the final retardation.

These results, furthermore, may be achieved whilst handling relatively heavy loads. For example, the apparatus particularly described with reference to the drawings, is capable of handling iron ore briquettes, each of a weight of 13 lbs., at a rate of 2,400 briquettes per hour, the particular iron ore briquettes used in testing being those prepared in the manner described in British patent specification No. 670,678.

The pallet particularly described weighs approximately 750 lbs. when unloaded, and carries a full load of eighty briquettes in eight double rows with each single row containing five briquettes. When one pallet alone is given its first pitching movement it carries a double row of briquettes, a total of ten briquettes, and the load thus moved by the pitching mechanism amounts to 880 lbs. When a fully loaded pallet is given its final pitching movement, it carries eighty briquettes and, moreover, pulls an empty pallet; the load moved by the pitching mechanism at this stage then amounts to 2,540 lbs.

The distance through which a pallet is moved at each pitching movement with the particular iron ore briquettes referred to is ten inches, each pitching movement being completed within two seconds and a pallet being filled every two minutes. Thus the loaded wagon has to be removed from the lowered hoist, and replaced by an empty wagon and the hoist raised to its upper limit position within two minutes; this is readily accomplished.

From the particular form of the apparatus according to the invention, which has been described with reference to the accompanying drawings, it will be seen that, excluding the exceptions given below, the synchronisation of the valves and switch gear for the various motions has been provided in such manner that the end of one motion causes the beginning of the next, thus reducing all time lags between the operations to a minimum. The exceptions to such automatic follow-on control are:

(*a*) The rearward traverse of the pallet over the lower fixed track; the mechanism for this operation has been described as in continuous operation.

(*b*) The final step in the lowering of the hoist to ground level; this has been described as being effected manually.

(*c*) The raising of the hoist to its upper limit position; this has been described as manually controlled.

(*d*) The operation of the by-pass drawbridge; this is effected manually.

(*e*) The by-pass conveyor under the drawbridge; this has been described as continuously running.

It will be appreciated, however, that the motions referred to under (*b*) and (*c*) may be readily provided to follow-on automatically, that the motion referred to under (*a*) may be readily made intermittent to be started and stopped in synchronism with other motions, and that the by-pass conveyor may be readily started and stopped

automatically by the presence or absence of a load on its band.

The apparatus, together with the mixer and feed to the briquetting press, may be controlled by a single operator, a control panel being advantageously provided for this purpose. The only further requirement is the feeding of empty wagons to the apparatus; this may be done either automatically or manually.

We claim:

1. Apparatus for the stacking of articles, comprising means for loading the articles in a layer of spaced rows on a carrier, means for moving a carrier from the loading position to an unloading position, means for moving a plurality of carriers in succession from a loading position to an unloading position, to an idle position and returning them in succession to the loading position, and timing means for controlling the movement of an unloaded carrier to move it into loading position immediately upon movement of a loaded carrier from loading position, a scraper at the unloading position for removing the layer of articles from a loaded carrier, a member to receive a layer of articles removed from a carrier by a scaper, and means varying the position of the member in a vertical direction in synchronism with the travel of a carrier.

2. Apparatus for stacking block-like articles, including means for laying the articles in a row on a carrier, pitching means for moving the carrier when a complete row of the articles has been laid on the carrier to bring the carrier into position to permit a further and adjacent row to be laid on the carrier, means for moving a plurality of carriers in succession from a loading position to an unloading position, to an idle position and returning them in succession to the loading position, and timing means for controlling the movement of an unloaded carrier to move it into loading position immediately upon movement of a loaded carrier from loading position whereby the action of the means for laying the articles in a row on a carrier may continue without interruption, a plough for removing the articles from a loaded carrier, a wagon on a hoist to receive the articles removed from a carrier by the plough and means for dropping the hoist in synchronism with the travel of a carrier to cause the articles to be deposited in superposed layers on the wagon.

3. Apparatus according to claim 2, in which the pitching means comprises at least one pivoted pitching arm adapted to engage the carrier, a crank connected through a link to the pitching arm, means to move the pivot of the pitching arm to bring the arm into and out of engagement with the carrier, and means for rotating the crank.

4. Apparatus according to claim 2, in which the hoist is hydraulically operated, a valve and a volumetric cylinder being provided in the hydraulic circuit of the hoist, and a member provided on the carrier to actuate the valve as the carrier travels from the unloading position the the loading position, actuation of the valve serving to empty hydraulic fluid from the volumetric cylinder and to withdraw a substantially equal volume of the hydraulic fluid from the hoist ram.

5. Apparatus according to claim 2, in which means are provided to move the plough during the unloading operation in the direction of travel of the carrier being unloaded.

6. Apparatus for stacking articles, comprising laying means for laying a row of articles on a carrier, means for moving the carrier in synchronism with the laying means to permit a further row of articles to be laid on the carrier in substantially parallel relation to the preceding row, means for moving a plurality of carriers in succession from a loading position to an unloading position, to an idle position and returning them in succession to the loading position, and timing means for controlling the movement of an unloaded carrier to move it into loading position immediately upon movement of a loaded carrier from loading position whereby the action of the means for laying the articles in a row on a carrier may continue without interruption, means for unloading the layer of articles from a carrier, a hoist to receive the layer of articles removed from a carrier, and means for moving the hoist downwardly through the thickness of one layer of the articles in synchronism with the travel of a carrier to cause the articles to be stacked in superposed layers on the hoist.

7. Apparatus according to claim 6, in which the laying means comprises a pusher for sliding a row of articles on the carrier, and the means for moving the carrier in synchronism with the laying means comprises at least one pitching arm adapted to engage the carrier, a crank connected to the pitching arm, means for intermittently rotating the crank when a complete row of the articles has been laid on the carrier, and means for engaging the pitching arm with and disengaging the pitching arm from the carrier.

8. Apparatus according to claim 6, in which the means for moving a carrier from the loading position to the unloading position comprises a track supported by a rotatable shaft, means for rotating the shaft, and driving means for engaging a carrier on the track when the track is in its lowered position to drive the carrier to and through the unloading position.

9. Apparatus according to claim 6, in which the means for moving a carrier from the unloading position to the loading position comprises a track supported by a shaft and lowered and raised by rotation of the shaft, and means for rotating the shaft intermittently to and fro through a determined angle.

10. Apparatus according to claim 6, in which the means for unloading a layer of articles from a carrier comprises a plough mounted for reciprocation in guide brackets and means for reciprocating the plough whereby the layers are laid on the hoist in staggered relation.

11. Apparatus according to claim 6, in which the means for unloading a layer of articles from a carrier comprises a plough provided as two interconnected and substantially parallel members and means to vary the distance between the two members.

12. Apparatus according to claim 6, in which the means for unloading a layer of articles from a carrier comprises a plough, a rotatable shaft, an eccentric sheave integral with the shaft, a strap mounted about the eccentric sheave and secured to the plough, and a pinion integral with the shaft and adapted to be rotated by movement of a carrier.

13. Apparatus according to claim 6, in which the hoist is operated by a liquid under pressure passed to and withdrawn from the hoist ram through a pressure liquid circuit comprising pipes, the means for lowering the hoist comprising a valve and a volumetric cylinder provided with two ports in the pressure liquid circuit, a pressure liquid reservoir, and a member on a carrier to actuate the valve, actuation of the valve placing one port of the volumetric cylinder into communication with the hoist ram and placing the other port of the volumetric cylinder into communication with the pressure liquid reservoir.

14. Apparatus for stacking articles in superposed layers on a wagon, comprising a pusher for sliding a row of the articles on to a carrier, pitching means for moving the carrier in a direction at right angles to the row of articles upon the completion of the row of articles to form a layer of the articles on the carrier, means for moving a carrier from the loading position to an unloading position, means for moving a carrier from the unloading position to the loading position, a transverse plough for unloading a carrier, means to permit the plough to move during the unloading operation in the direction of travel of the carrier being unloaded, means to reciprocate the plough from one position to another position in the interval between two successive unloading operations, a

hoist to carry the wagon in position to receive a layer of articles removed by the plough from a carrier, and means operating in synchronism with the travel of a carrier for dropping the hoist through a determined distance to cause the articles to be deposited in superposed layers on the wagon.

15. Apparatus for the stacking of articles, comprising means for laying a layer of the articles in a series of spaced rows on a carrier, means for moving a carrier from its loading position to an unloading position, means for moving a carrier from the unloading position to a loading position, a member for unloading a carrier, a hoist to receive the layer of articles removed from a carrier, means to lower the hoist in timed relationship with the travel of a carrier to cause the layers to be laid in superposed formation on the hoist and means to reciprocate the member for unloading a carrier to cause adjacent, superposed layers on the hoist to be laid in staggered relationship.

16. Apparatus for stacking of block-like articles on a wagon, comprising laying means for laying a row of articles on a carrier resting on a first fixed track, pitching means for moving the carrier in synchronism with the laying means to form a layer of the articles in a series of substantially parallel rows on the carrier, a first movable track to receive a carrier from the first fixed track during the loading operation, a second movable track, a second fixed track, means to move the first and second movable tracks from the level of the first fixed track to the level of the second fixed track and vice versa, means to traverse a carrier from the first movable track to the second movable track over the second fixed track, means to unload the carrier in its traverse from the first movable track to the second movable track, a hoist on which the wagon rests in position to receive the layer of articles unloaded from a carrier, and means to lower the hoist in timed relationship with the traverse of a carrier on to the second movable track to cause the layers of articles to be deposited in superposed formation on the wagon.

17. Apparatus according to claim 16, in which the means to unload the carrier comprises a transverse member located in guide brackets, a shaft, an eccentric sheave integral with the shaft, a strap mounted on the sheave and integral with the transverse member, and means actuated by the carrier for rotating the shaft.

18. Apparatus according to claim 16, in which the means to unload the carrier comprises a transverse member for contacting the layer of articles, at least one lever to move the transverse member in a direction at right angles to the length of the transverse member, and means to operate the lever to cause the transverse member in the unloading operation to travel in the same direction as the carrier being unloaded.

19. Apparatus according to claim 16, including locating mechanism on the hoist to hold a wagon in stacking position on the hoist, the mechanism comprising a pivoted hook member and a spring for urging the hook member into engagement with a wagon.

20. Apparatus according to claim 16, in which the hoist is operated by a liquid under pressure, including a pressure liquid circuit comprising a valve and a volumetric cylinder, and a member on the carrier to actuate the valve as the carrier travels on to the second movable track, actuation of the valve serving to empty pressure liquid from the volumetric cylinder and to withdraw a substantially equal volume of pressure liquid from the hoist ram.

21. Apparatus according to claim 16, in which the hoist is operated by a liquid under pressure, including a pressure liquid circuit comprising pipes, a valve, a volumetric cylinder provided with a piston and a port at each end, and a pump, a motor for driving the pump, a wagon pusher for pushing a wagon on to the hoist, a motor starting switch adapted to be actuated by the wagon pusher, and a motor cut-out switch adapted to be actuated by the hoist.

22. Apparatus for loading articles in a series of rows on a carrier, comprising means for placing a number of the articles in a row on the carrier, at least one pitching arm adapted positively to engage the carrier, means for intermittently moving the pitching arm to cause the carrier to travel with a substantially simple harmonic motion in a direction substantially at right angles to the row of articles, and means for bringing the pitching arm into and out of engagement with the carrier.

23. Apparatus for loading articles in a series of rows on a carrier, comprising a pusher to slide the articles in a row on to the carrier, at least one pivoted pitching arm adapted to engage the carrier positively and to swing in a plane substantially at right angles to the row of articles, a crank connected to the pitching arm, means to move the pivot of the pitching arm to bring the arm into and out of engagement with the carrier, and means for intermittently and reversibly rotating the crank whereby movement imparted to the carrier is approximately simple harmonic.

24. Apparatus for loading a layer of articles in a series of parallel rows on a carrier, comprising a pusher to slide a number of the articles in a row on to the carrier, a pair of pivoted pitching arms adapted to engage the carrier and to swing in planes substantially at right angles to the row of articles, two cranks each of which is connected by a link to one of the pitching arms, means to raise and lower the pivots of the pitching arms, an air cylinder for rotating the cranks, and means for actuating the air cylinder when a complete row of articles has been laid on the carrier.

25. Apparatus according to claim 24, in which the means to raise and lower the pitching arms comprises an air cylinder the piston rod of which is pivotally connected to a lever rigidly mounted on a shaft, and two pivot levers rigidly mounted on the shaft, one pitching arm being pivoted on each pivot lever.

26. Apparatus for the stacking of bricks, comprising pushing means for intermittently feeding the bricks into a row on a carrier, pneumatically-operated means for intermittently moving and stopping a carrier in timed relationship with the pushing means so that the bricks are laid in a series of spaced, parallel rows on the carrier, means for moving a carrier from the loading position to an unloading position, a plough for removing the bricks as a layer from a loaded carrier, a member to receive the layer of bricks removed from a loaded carrier, means to lower the member in timed relationship with the travel of a carrier, and means to move the plough from one position to another position whereby two layers may be laid in staggered relationship on the member.

27. Apparatus according to claim 26, including a member over the surface of which the bricks are fed on to the carrier by the pushing means, said member being disposed adjacent to the carrier, and means automatically to retract the said member from the carrier when the carrier is moved by the pneumatically-operated means.

28. Apparatus for the stacking of articles, comprising at least two carriers, laying means for loading the articles in a row on one of the carriers, means for intermittently moving and stopping the carrier being loaded in timed relationship with the laying means so that the articles are loaded in a series of rows, means for bringing the carrier to an unloading position, a plough for moving the articles in a layer from a loaded carrier, a member to receive the layer of articles removed from the loaded carrier, means for moving the plough from one position to another position whereby two layers of the articles are loaded in staggered relationship on said member, means to lower the said member in timed relationship with the travel of a loaded carrier, and means to move an unloaded carrier to the loading position whereby the operation of the laying means for loading the articles may continue without interruption.

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