

June 8, 1943.

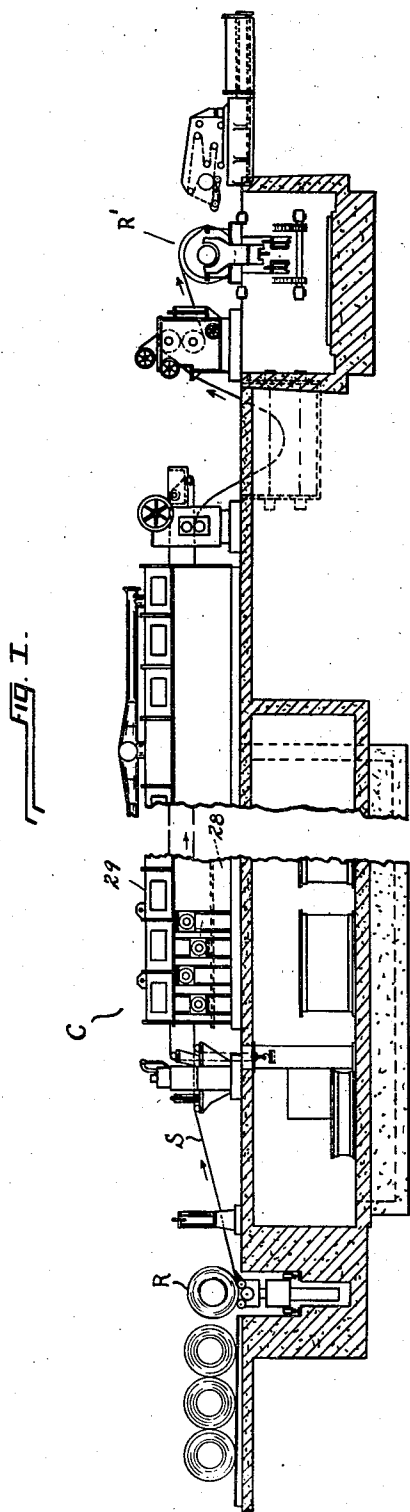
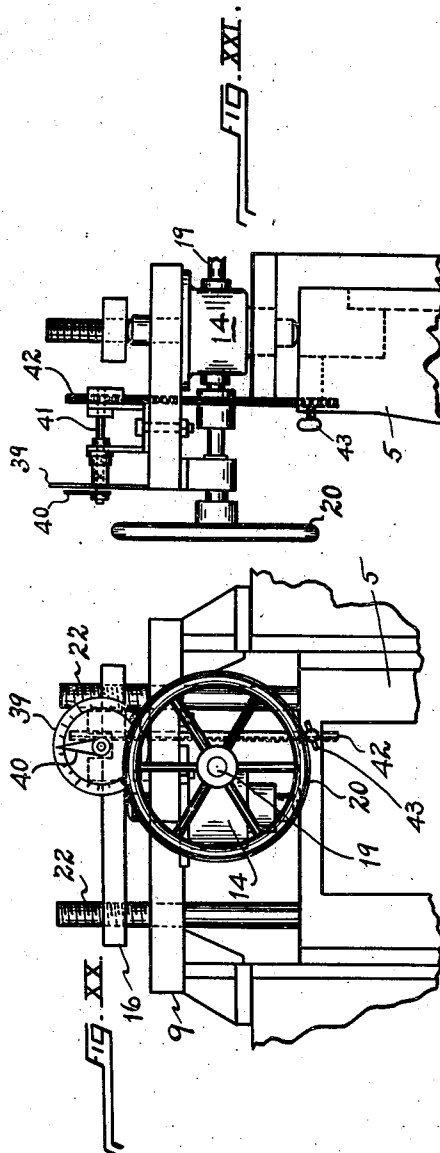
W. R. BOYER

2,321,179

SHEET-CLEANING APPARATUS

Filed Feb. 25, 1941

9 Sheets-Sheet 1



INVENTOR
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June 8, 1943.

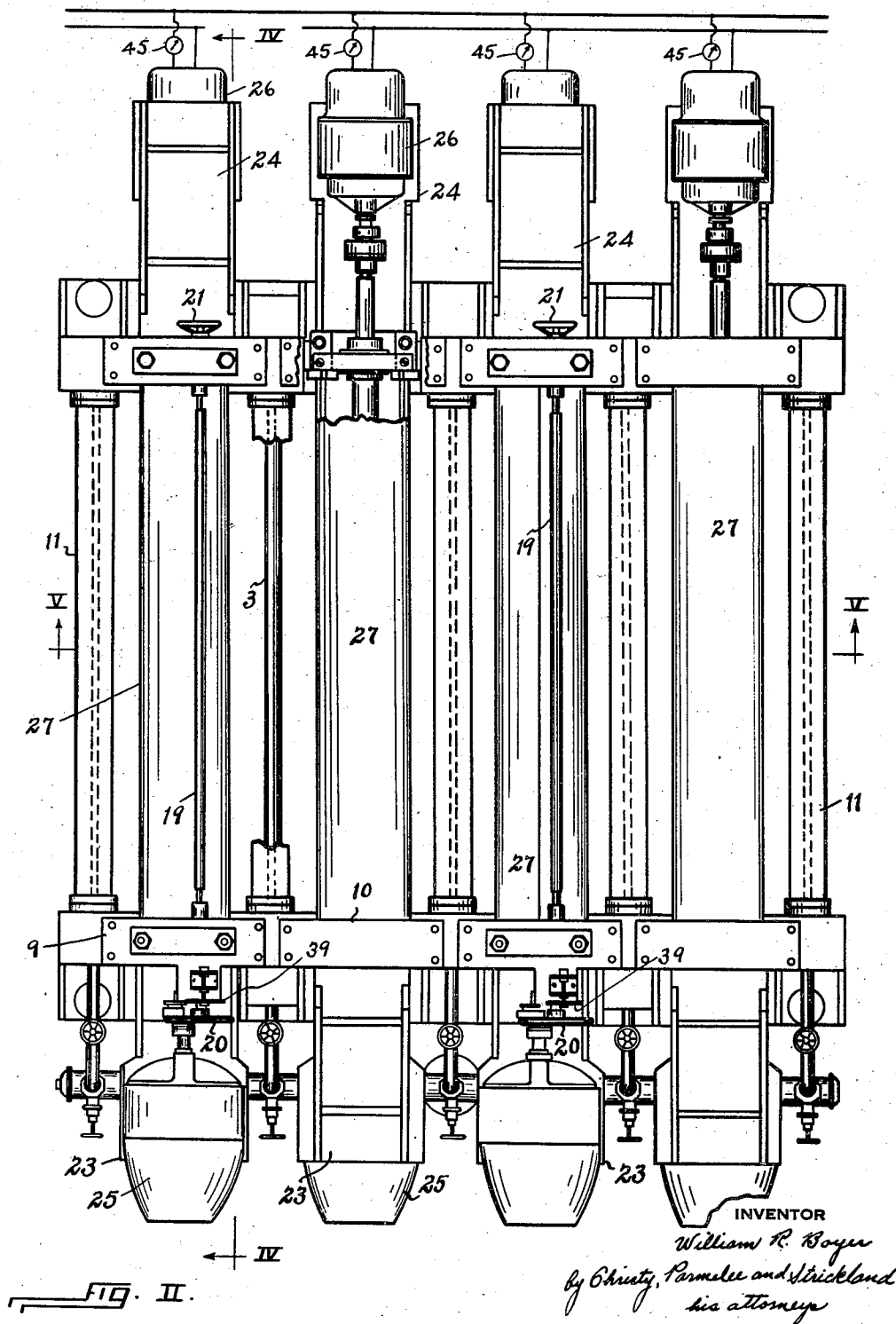
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SHEET-CLEANING APPARATUS

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9 Sheets-Sheet 2



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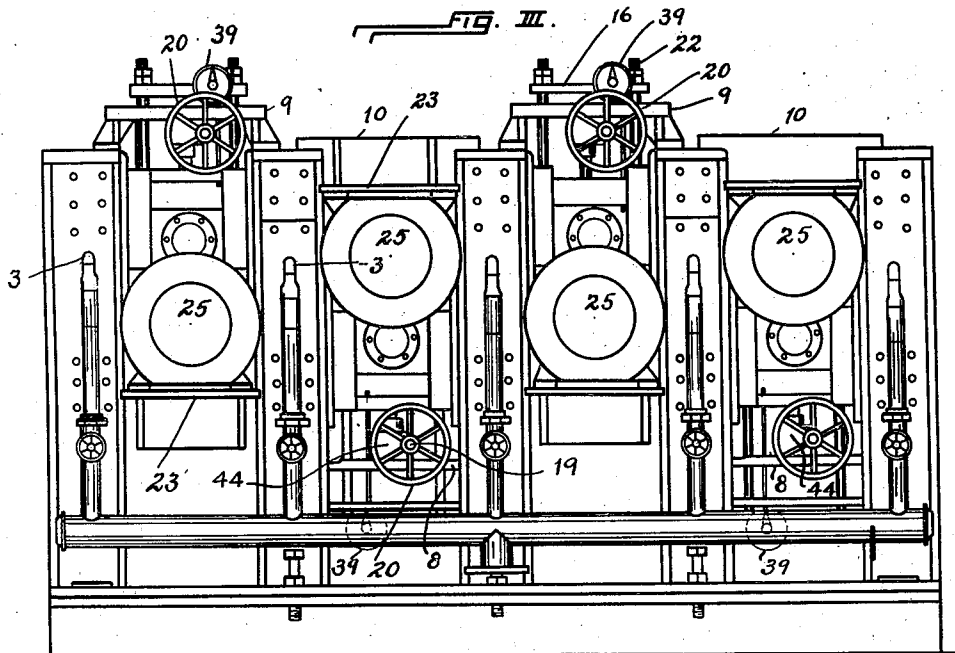
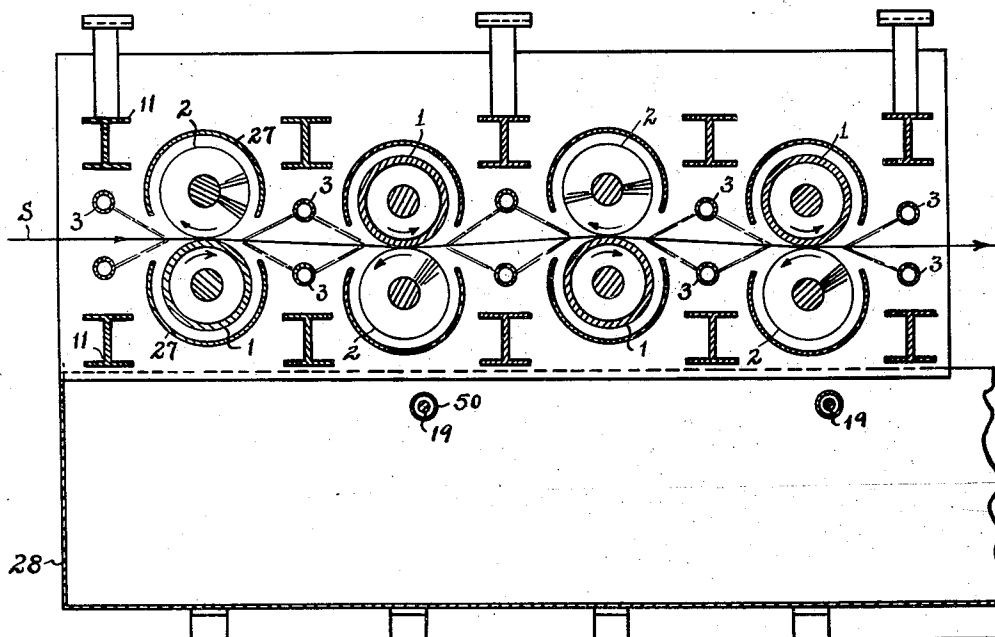
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9 Sheets-Sheet 3



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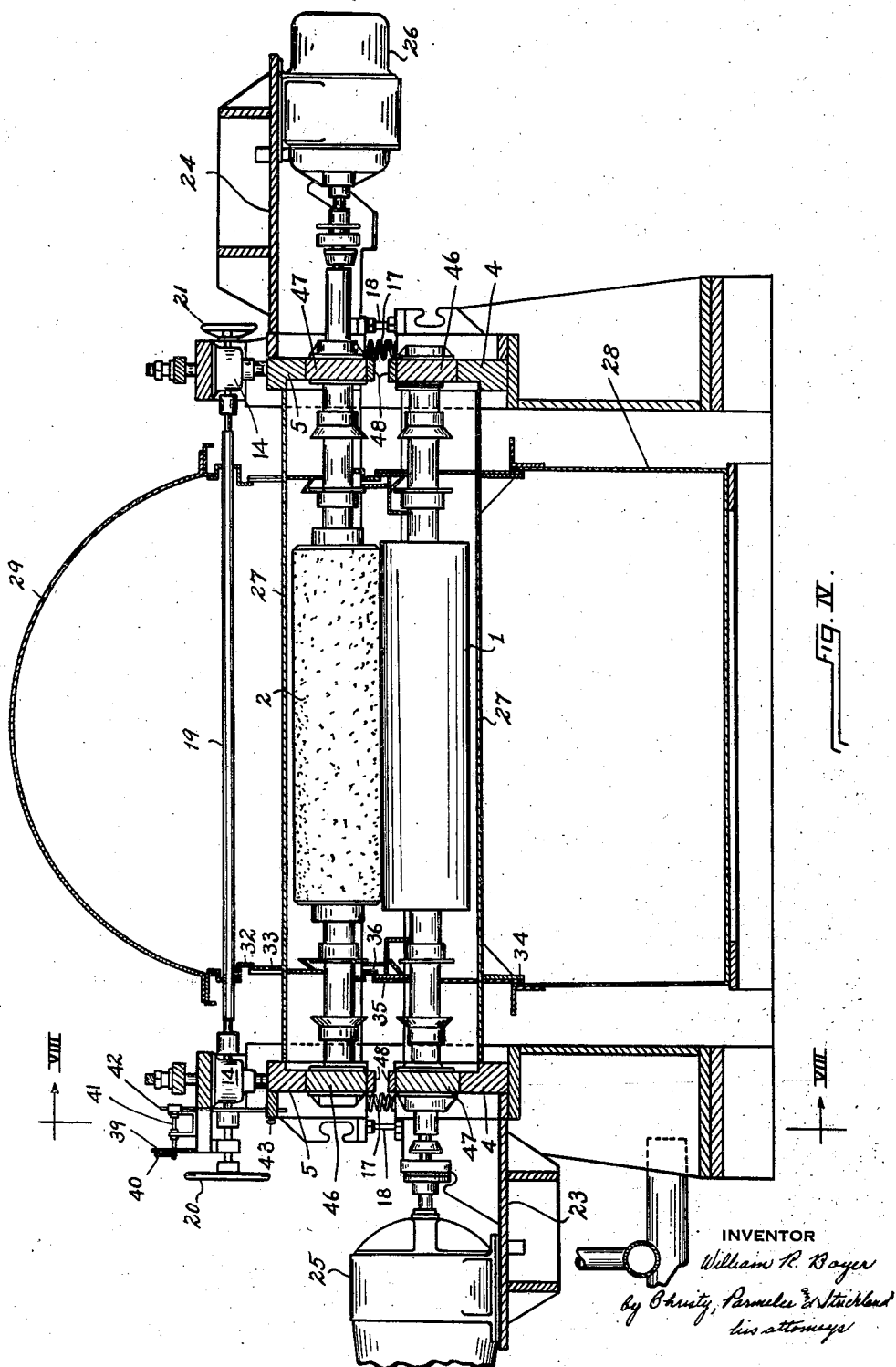
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SHEET-CLEANING APPARATUS.

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9 Sheets-Sheet 4



June 8, 1943.

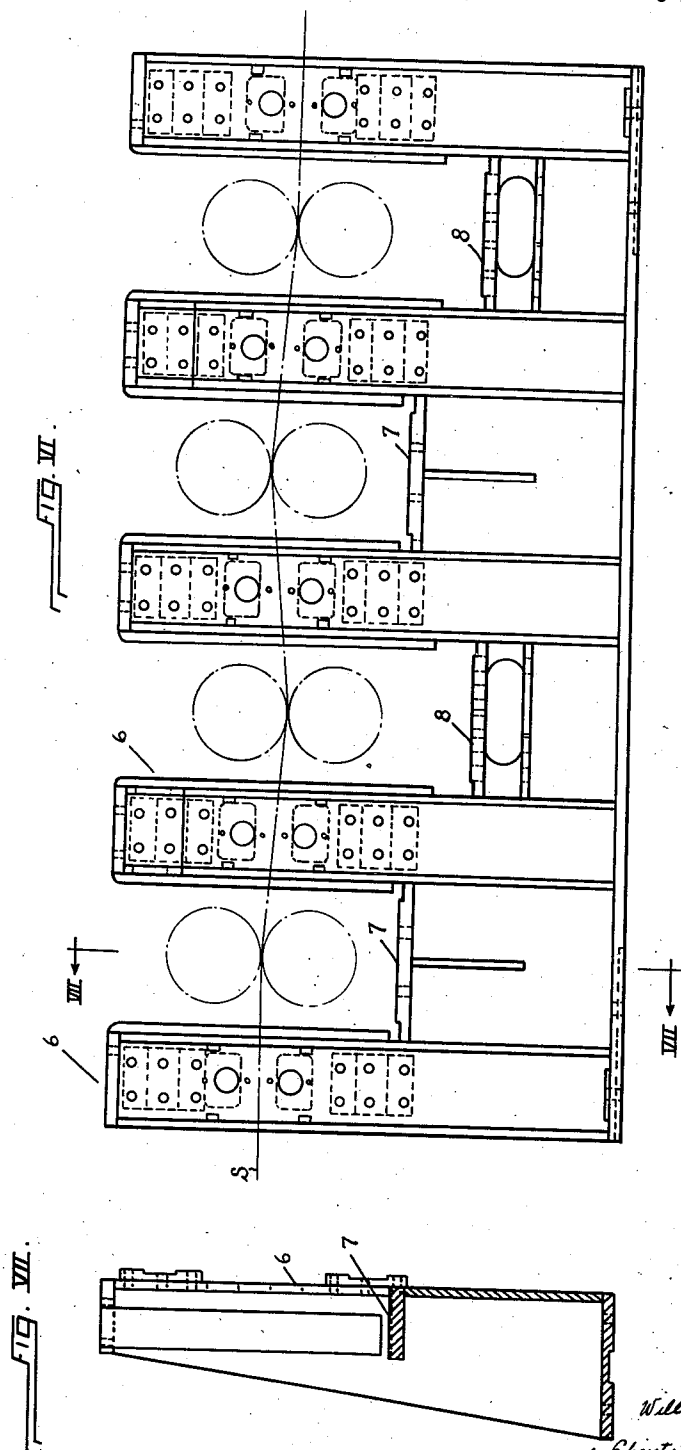
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SHEET-CLEANING APPARATUS

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9 Sheets-Sheet 5



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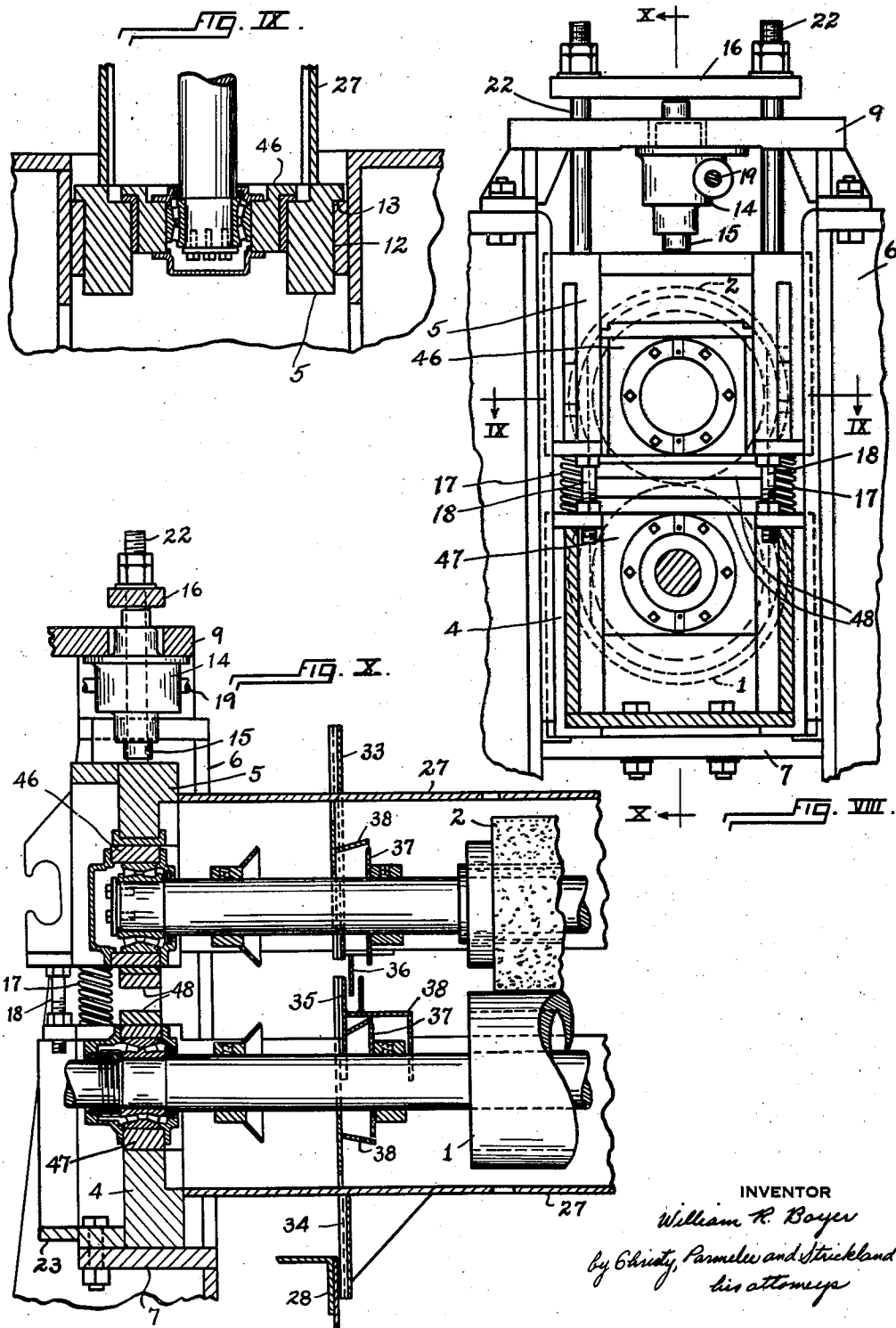
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SHEET-CLEANING APPARATUS

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June 8, 1943.

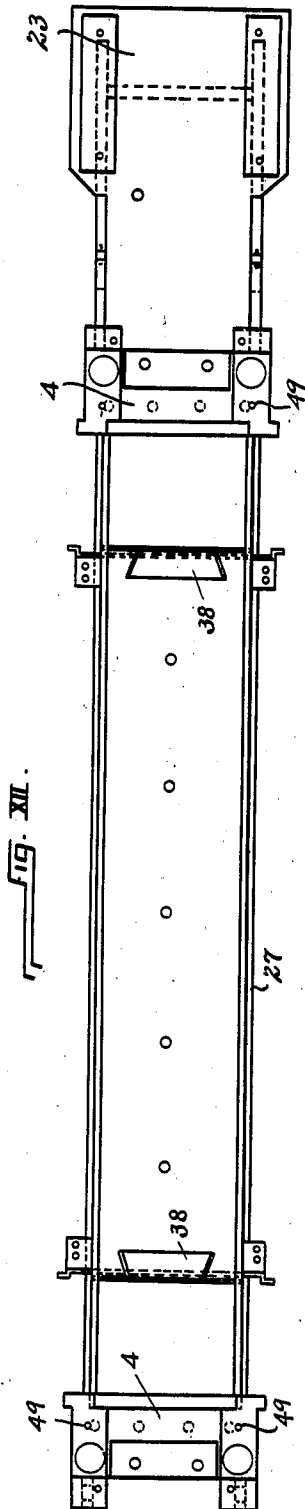
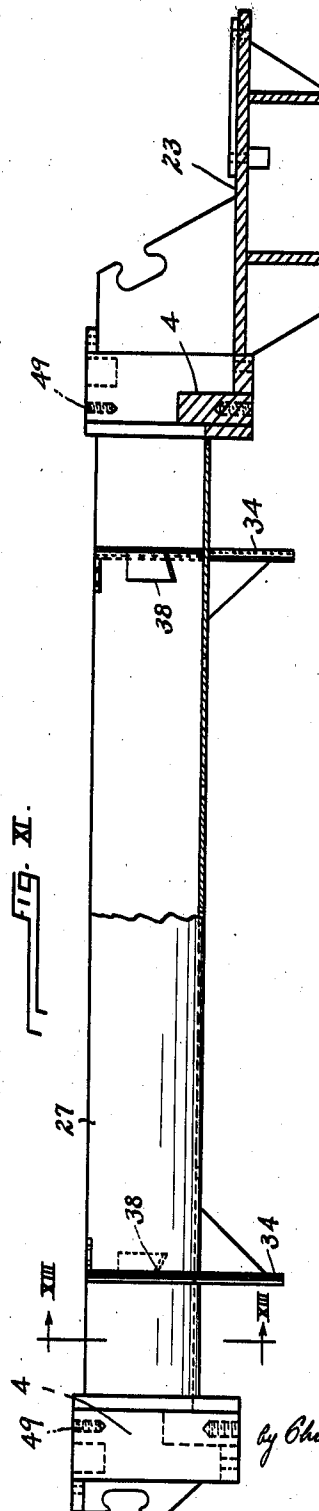
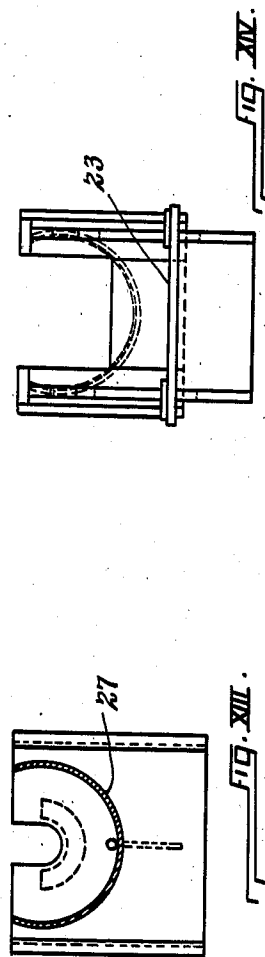
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SHEET-CLEANING APPARATUS

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9 Sheets-Sheet 7



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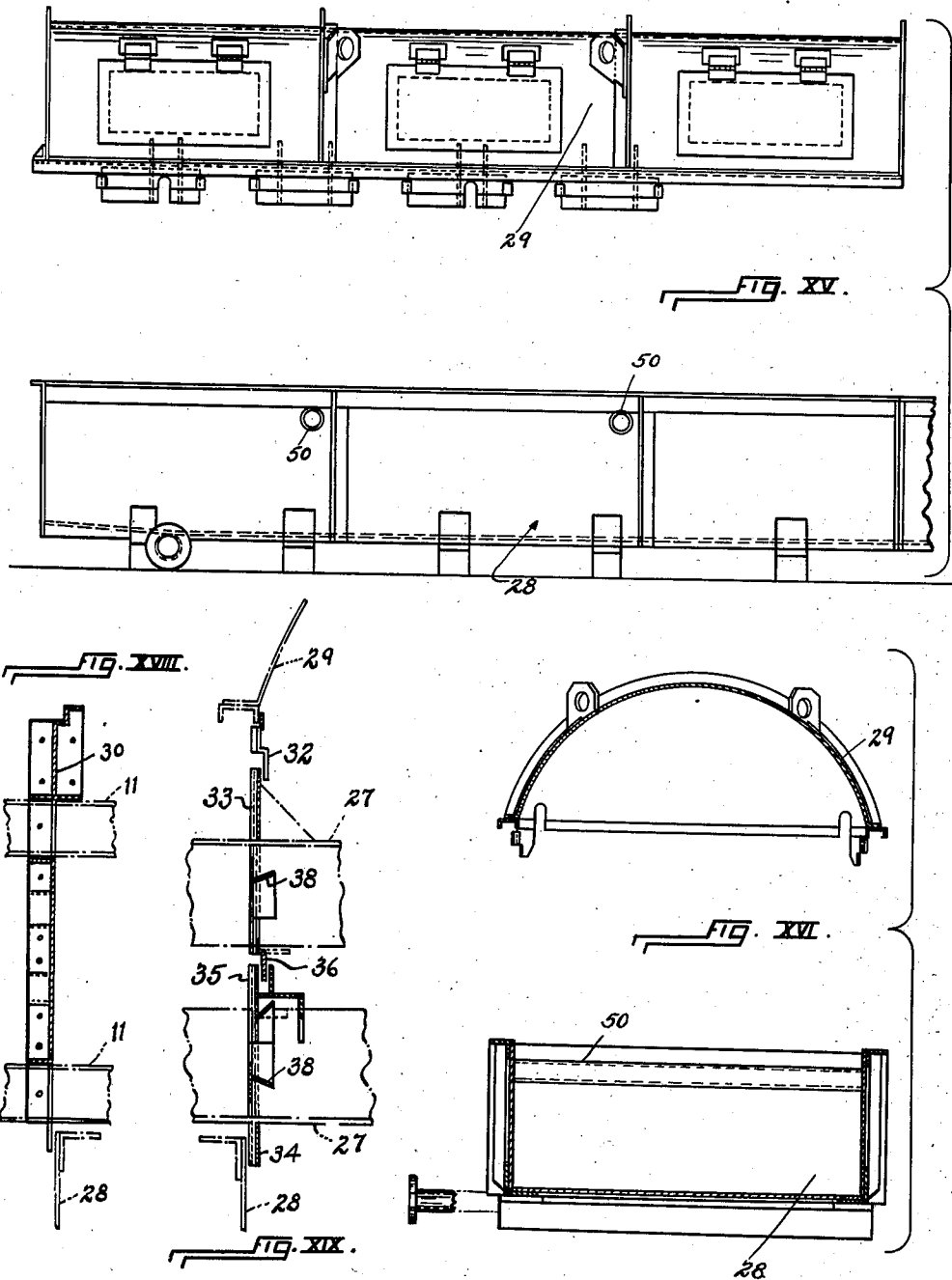
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SHEET-CLEANING APPARATUS

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9 Sheets-Sheet 8



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UNITED STATES PATENT OFFICE

2,321,179

SHEET-CLEANING APPARATUS

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Application February 25, 1941, Serial No. 380,419

4 Claims. (Cl. 15—77)

This invention relates to the cleaning of sheet material; and, while of obvious general applicability, it finds practical value in the cleaning of the surfaces of rolled steel strip as it advances through forming and treating apparatus. The invention resides in apparatus, and the objects of improvement are economy and efficiency, both in the cleaning step itself and in the aggregate of the successive steps of treatment to which in common practice the continuously advancing strip is subjected.

It is usual, as the strip advances in horizontal plane and straight-away course, to wash its upper and nether surfaces with an aqueous solution and to scrub the wet surfaces with brushes; it is usual to cause the wet sheet to advance over the surface of a backing roll and while so supported to scrub the opposite and exposed surface with a cylindrical brush mounted upon and rotating upon an axis parallel with that of the supporting roll and forming with the supporting roll a pass through which the strip advances; it is usual so to scrub in alternation the two surfaces of the strip, in successive passes, arranging the backing rolls and the brushes of the passes successively on alternate sides of the advancing strip; it is usual so to station the backing rolls that the strip shall be deflected or zig-zagged slightly from its straight-away course, both to prevent kinking and to insure a firm backing for the strip as the scrubbing brush engages and acts upon it. All of these features attend the practice of the invention in the specific embodiment of it that here is shown.

The material to be removed from the advancing strip may be assumed to be grease or oil, and the washing liquid may be assumed to be an aqueous alkaline solution heated near to the boiling-point. These assumptions are by way of affording example merely; the invention is applicable to washing with liquids generally. But, assuming these conditions, it is desirable, manifestly, both to conserve the solution, to conserve heat, to prevent splattering, and to protect adjacent parts of the apparatus from the fouling and corrosive contact of alkali.

The economies here chiefly contemplated are adequate scrubbing, efficiency long maintained, ready adjustability to change incident to continued operation, accessibility of parts for simple and speedy replacement, conservation of scrubbing liquid and of heat and protection of parts from fouling, adaptability to high strip speed, refinements of structure and provision of acces-

sory equipment, by aid of which the adjustability spoken of may be rendered the more effective.

In the accompanying drawings Fig. I is a fragmentary and diagrammatic view showing in elevation feed and take-up reels for steel strip and apparatus for the treatment of the strip as it advances from the feed reel to the take-up reel, and, specifically the apparatus of this invention arranged for operation upon the advancing strip. Fig. II is a view in plan and to larger scale of apparatus of the invention. From this showing, however, certain parts have, for clearness of illustration been omitted, and certain other parts have been broken away. Fig. III is a view in side elevation of the apparatus of Fig. II. Fig. IV is a view in vertical and transverse section, on the plane indicated at IV—IV, Fig. II; and in Fig. IV the parts omitted from Fig. II are restored. Fig. V is a vertical and longitudinal section, on the plane indicated at V—V, Fig. II. In Fig. V the position of the strip under treatment and the direction of its travel are indicated. Fig. VI is a view showing in elevation the line of housings that on one side form part of the apparatus. In this figure the positions of the scrubbers themselves and the course of the strip through the apparatus are indicated. Fig. VII is a view in transverse section, on the plane indicated at VII—VII, Fig. VI. Fig. VIII is a view to larger scale, showing the apparatus fragmentarily and in vertical section, on the plane indicated at VIII—VIII, Fig. IV. Figs. IX and X are views in section, on the planes indicated at IX—IX and X—X, Fig. VIII. Fig. XI is a view to the scale of Fig. VI, showing partly in side elevation, partly in vertical section a unit consisting of a pair of chocks adapted to be mounted in opposite housings, an incompletely cylindrical shield uniting the two chocks, and a platform for a motor, made integral with one of the chocks. Fig. XII is a view in plan, Fig. XIII a view in section (on the plane XIII—XIII, Fig. XI) and Fig. XIV a view in end elevation of the same unit. Figs. XV and XVI are views in side elevation and in transverse section of the lower tank-like portion and the upper vaulted portion of an enclosing tunnel. In these figures these component parts of the tunnel are shown spaced apart at the interval at which they stand separated in the assembly. The tunnel is completed by interposed side-walls. Fig. XVII is a view in vertical and longitudinal section of an assembly of parts, and in this figure one of the side walls of the tunnel appears in elevation. Figs. XVIII and XIX are views in vertical section of the side

wall, on the planes of section (one a broken plane) indicated at XVIII—XVIII and XIX—XIX, Fig. XVII. Figs. XX and XXI are views in front and side elevation of indicating mechanism organized with one of the chocks that carry the rotary scrubbing members.

Referring, first, to Fig. I, a strip S is seen, advancing in left to right course from a feed reel R to a take-up reel R'. As it advances the strip is made subject to apparatus, the nature and purpose of which are suggested merely, excepting only the cleaning apparatus C, shown in position immediately to the right of reel R. It is in this cleaning apparatus that the improvements of the present invention are embodied. The strip-treating apparatus with which this cleaning apparatus is associated may, for example, be such as that described in an application for United States Letters Patent filed by G. M. Croft, Serial No. 319,475.

Referring to Fig. V, a succession of pairs of scrubbing elements 1 and 2 will be seen in organized assembly and in cooperative action upon a strip S of material in course of cleaning. The elements 1 are steel rolls; the elements 2 are cylindrical brushes. Each brush, set opposite a roll, engages the work when backed by and held to position upon the face of the roll. In the successive pairs of scrubbing elements the backing rolls are alternately arranged beneath and above the strip, and correspondingly the brushes scrub the upper and nether surfaces of the strip. The pairs of elements are suitably spaced and in the intervals between, and beyond the ends of the assembly as well, pipes 3 are arranged, to spray suitable liquid (hot alkaline solution) upon the strip surfaces. The direction of strip advance is indicated to be from left to right. The lower rolls rise slightly above the direct line of strip travel and the upper rolls depend slightly below that line, and in consequence the strip, advancing under tension (as will be understood), is held taut upon and slightly bowed upon the roll surfaces. The direction of roll rotation is here indicated to be such that the roll surface advances with the strip; and it may be understood that the surface speed of the roll is the same as that of the strip. This is conventional; and thus, obviously, there will be no sliding of the strip upon the roll surface and scratching will be avoided. The direction of brush rotation is indicated to be, as preferably it is (though not necessarily), opposite to that of strip advance. In consequence of my refinements and improvements, it becomes possible to run the strip at high speed; and it is manifest that, for any given rate of brush rotation in the preferred direction, the scrubbing effect is by increase in speed of strip travel correspondingly enhanced. By the improvements here contemplated the deviation of the strip from straight-away course may be reduced to a minimum; and that is a condition favorable to high speed in strip advance.

The brush will be made of suitable material, and, so far as is now known, stainless steel wire is best. By adjustment of the brush relatively to the roll, the number of wires simultaneously in engagement with the strip may be increased or diminished. (It will be understood that when the apparatus is in operation and the brush in rotation the individual wires will bend to arc shape as their tips sweep the strip surface.) By adjustment, manifestly, the intensity of the scrubbing action may be varied.

The rolls and the brushes that, pair by pair,

constitute the scrubbing means are mounted for rotation in bearing boxes 46 and 47 secured in chocks 4 and 5 (cf. Figs. VIII—X), and the chocks in turn are mounted in housings; and, since in preferred organization there is a plurality of pairs of scrubbing rolls and brushes, the housings are correspondingly compound. Fig. VI shows in elevation the compound housing on one side, and it will be understood that this structure is matched by a symmetrically formed and oppositely placed housing structure on the other side. Each housing includes a succession of vertically standing pillars 6. The oppositely placed pillars of the two sets of housings are united by struts 11 (Figs. II, V, and XVII). Since the apparatus here illustrated comprises four pairs of scrubbing elements, Figs. V and VI show five pillars, with four spaces between. In these spaces alternately are fixed shelves 7 and 8, and upon the pillars and overspanning the spaces are removably secured in alternation the lintel plates 9 and 10 (cf. Figs. II, III, and VIII). The shelves 7 sustain rigidly the chocks 4 of the underlying rolls 1; and the lintel plates 10 afford rigid backing and support for the similar chocks of the overhanging rolls; while the lintel plates 9 afford backing and support for adjustable overhanging brushes 2 and the shelves 8 carry adjustably the chocks of the corresponding underlying brushes. The chocks fit snugly in the housings. Abutment of machined surfaces as indicated at 12, 13, Fig. IX, hold the chocks secure against horizontal movements. The lintel plate 9 carries a jack 14 of worm-and-screw type, and the plunger 15 of the jack bears downwardly upon the chock 5 and upwardly upon the cross-bar 16 of a yoke borne by the chock 5 (the position of this cross-bar is adjustable upon the chock by the means indicated). By the advance and retraction of the plunger of the jack the brush-carrying chock is adjusted vertically in its position in the housing. Springs 17 interposed between the chocks 4 and 5 may relieve the jack substantially of the weight of the brush. Adjustable stops 18 mounted upon chock 4 may be set to limit the descent of chock 5 to exact predetermined position.

The chock in the opposite housing, in which the brush at its opposite end is rotatably mounted, is by duplicate means severally adjustable. When by means of the jacks the two chocks have been adjusted so that the brush 2 throughout its length is properly positioned, in parallelism with roll 1, the worms by which the jacks are driven may be united by a shaft 19 (Fig. II). Hand-wheels 20 and 21 are shown in Figs. II, III, and IV, by which when connection is broken the two jacks may severally be operated; and, when the two jacks are connected, both may be operated by means of one hand-wheel.

The brushes, operating as they do at very high speed relatively to the advancing strip, are subject to wear, and must from time to time be removed for redressing and replacement. The back-up rolls also must from time to time be removed and replaced. When the assembly is completed and made ready for service both roll and brush must be accurately set, so that throughout the breadth of the strip the brush bears upon it with equal pressure of desired amount. The structure described permits removal and replacement and affords adjustment adequate to such ends.

The mounting of the brush of the next-succeeding pass, in which the chocks of the roll are rigidly secured to the lintel plate 10, is a substantial

inversion of that last described, with the qualification that in this case spring tension and gravity suffice to shift the brush chock downward, and the jack 44 (mounted on the shelf 8, Fig. III) acts upon the chock in one direction only, shifting it upward against the opposed forces of gravity and spring tension. As in the case already described, a shaft 19 is provided (cf. Fig. V) by which the two jacks upon opposite sides of the apparatus may at pleasure be connected for simultaneous operation. Since it is desirable that all the chocks for the brushes be identical and interchangeable, and since the body of chock 5 carries rigidly mounted stems 22 to form with the adjustable and separable cross-bar 16 the yoke already described (which yoke is serviceable only when the brush is arranged above the strip and the companion roll below), the shelves 8 are apertured, that the stems 22 (not serviceable in the alternate arrangement of roll and brush) may extend through and allow the chock to come firmly to position, resting upon the stem of the jack 44—the jack in turn resting upon the shelf 8.

One of each pair of roll-carrying chocks has united integrally to it an outward extending platform 23, and one of each pair of brush-carrying chocks has united integrally to it an outward extending platform 24 (cf. Figs. XI, XII, XIV with II, III, and IV). Upon each of these platforms is rigidly mounted an electric motor, and these motors by direct connection rotate the rolls and the brushes. The roll-driving motors 25 are arranged, all upon one side of the apparatus, and the brush-driving motors 26 are arranged, all upon the opposite side; and thus ample clearance and spacing are afforded for the inspection and servicing of the motors.

The pillars 6 on one side of the apparatus are ported for the extension through of connections for the spray pipes 3, and in such ports supporting lugs for the spray pipes may be set. This will be manifest on considering Figs. II, III, and VI.

Shields 27, Figs. II, IV, V, XI, XII, XIII, shroud the rolls and the brushes. Each is an incomplete cylindrical shell of diameter slightly larger than that of the part surrounded and cut away sufficiently, not to interfere with the advance of the strip and the operation of spraying and scrubbing, and to permit of the making of the assembly of the brush within the shield. These shields confine the splashing of liquid. They are properly ported for drainage. At its ends each of these shields is rigidly connected to the chocks that carry the shrouded member. When the brush (or roll) has been set in place and the bearing boxes 46 and 47 thereof have by means of keeper plates 48 (Fig. X) been secured in the chocks 5 and 4 respectively, the shield, thus uniting a pair of chocks, completes the integrity of a unit consisting of a roll (or brush), the chocks that carry it, and the motor that drives it. Each such unit is, as a unit, applicable to and removable from the housings. There is sufficient flexibility within the brush unit to admit of the individual adjustment already described of the chocks within the housings.

The manner of mounting the brush or roll in a unitary structure with the chocks, shield and motor, is thus such as to permit ready assembly or removal of the parts with the least disturbance to shop fitting and adjustment. Thus, after the bearing boxes 46 or 47 have been fitted accurately to the brush or roll shaft, this adjustment is in no way affected by the placing of the brush or roll in the chocks. As shown in Figures IX, XI, XII

and XIV, in each chock is an opening that forms a frame having a machined fit for three sides of a bearing box (46, 47). These bearing boxes are rectangular in form. After the bearing boxes have been placed in these openings, keeper plates 48, which span the open sides of the frame-forming openings in the chocks and which bear against the fourth side of a box 46 or 47, are secured to the chock at each end by means of machine screws drawn tight in threaded holes 49 (Figs. XI, XII). The motors 25 or 26 are then shimmed and bolted upon platforms 23, 24 to accurate alignment with the shaft extensions and are coupled to the shafts. It should also be noted that the mounting described provides for longitudinal expansion and contraction of the shaft, by permitting some sliding of the boxes 46, at the end of the shaft not driven, within the chocks. Fig. IX is drawn showing this end of the shaft in substantially extended position, the shoulder of box 46 touching the inner face of chock 5; but some further expansion is provided for in the bearing mounting. When the shaft is cold, there will be a slight gap between the shoulder on bearing box 46 shown in Fig. IX and the chock 5. The construction shown and described permits the removal of a lower brush or roll, by lifting it out from above, upon disconnecting the motor coupling and removing the keeper plates, without the necessity in this case of disturbing the chocks in their mounting in the housing, after the upper roll or brush assembly has been lifted out of the way.

Throughout the length of the apparatus, considered in the direction of strip travel and beyond, extends a tunnel whose function is more effectively to confine the liquid that is sprayed upon the sheet and necessarily splashed by the brushes, to confine the vapor also, and to conserve heat. The tunnel is formed conveniently of sheet metal and includes a tank-like rectangular base 28 that underlies and extends beyond the limiting pillars 6 of the compound housings, an overarching vault 29, and interposed side walls—to which side walls more minute attention will be given. The necks of the rolls and brushes are properly lengthened (cf. Fig. X), to allow structurally the ready interposition of the walls of this tunnel.

The tank 28, provided to catch the solution that drains from the strip and brushes, rests upon sills or other suitable support, and rises to a level just below the shields 27 (cf. Fig. IV). It is spanned transversely by pipes 50 (Fig. V) that make tight union with its walls and that afford passageway for the jack-uniting shafts 19 already described. The side walls are made up of sections, and the sections are severally carried upon the struts 11 and the shields 27; and the vault 29 (which also is sectional) rests upon the side walls (cf. Fig. XIX).

The side walls of the tunnel consists of panels that stand opposite the pillars 6, and panels that stand opposite the chocks in the housings formed by and between the pillars. These panels meet and overlap in vertical seams. The panels that stand opposite the pillars are made in two parts 30, 30 that extend vertically throughout the height of the side walls, and that, surrounding the struts 11 and the pipes 3, meet and are secured edge to edge. The struts 11 being advantageously formed as H-beams (Fig. XVII), the re-entrant spaces are filled with plates 31 cut and fitted to place and upon the so built-out struts the panel parts 30 make sealed union.

The space that in Fig. XVII appears between the spray pipe 3 and the panel parts 30, 30, will be filled by suitable packing.

The panels that stand opposite the chocks are made in three parts 32, 33, and 34, that extend transversely throughout the space between the pillar-facing panels, but are arranged in vertical succession, with overlapping, horizontally extending edges. The highest (32) of these three parts comes when applied to precise and immovable position, and its upper edge forms with the upper edges of panel parts 30, 30 a continuous edge for the support of the vault 29. The parts 33 and 34 are severally borne by the shields 27 of the brush unit and of the companion roll unit, and the part that is borne by the brush unit partakes of the movement of that unit in its adjustment. The overlaps with adjacent parts are sufficient in extent to admit of adjustment and yet to maintain the continuity of the tunnel wall. The lower ends of panel parts 30, 30, and 34 overlap the rim of the tank 28; and in the case of the panel part 34 the overlap is sufficient in extent to maintain continuity and yet allow for adjustment. The panel parts 33 and 34 are integrated with the brush and roll units and are removed and replaced with them. The panel parts 33 and 34 are continued in plates 35 and 36 that extend across the openings in the shields 27, and upon these and within the shields 27 baffles 38 and slingers 37 may be mounted (cf. Figs. X, XIX).

The indicating mechanism of Figs. XX and XXI includes a dial 39 and a hand 40. The hand is borne by a shaft 41 that rotates in response to the shifting of a rack 42 engaging a pinion borne by shaft 41. The rack is secured (adjustably) to one of the adjustable chocks that carry the brushes. By such means the position and the changes in position of the chocks may be minutely fixed and observed.

In service, after the brush has been adjusted to proper position relative to its companion back-up roll, the screw 43 that secures rack 42 to the chock is loosened, and the rack is shifted until the hand 40 comes to zero on the dial 39, whereupon the screw is tightened and the rack secured to the chock. The operator then has indication, to advise him of the direction and extent of subsequent adjustment. Fig. III shows indicators for the chocks of both the underlying and overhanging brushes. Those below are in the drawing partly concealed by the water connections. In fact, these water connections are spaced so widely from the face of the apparatus that the dials of the lower indicators are freely exposed to view.

In making assembly and preparing the apparatus for use, the pairs of roll units and brush units are introduced in proper order, the chocks in the housings, and the panel parts 33 and 34 in overlapping assembly with one another and with the adjacent, permanently mounted panel parts 30. The panel parts 32 also are brought to position. The brushes then are adjusted by means of the jacks, until the contact of the brush with the back-up roll is uniform throughout the length of the brush. When this has been done by the independent operation of the jacks, connection is made by shaft 19 between the jacks at the two ends of the brush, so that thereafter the chocks that together carry the brush may be shifted in unison by the turning of a single-hand wheel. When this has been done the cover of the tunnel is applied and rests upon the assembled

side walls. The jacks then are operated to afford clearance between the brushes and the back-up rolls, the strip is threaded through, and the jacks are operated again to press the brushes upon the roll-backed strip. The pressure of the brush upon the strip is very light, and it must be accurately adjusted in degree, for while the office of the brush is to loosen foreign matter it should not scratch the surface of the strip. Obviously, the greater the pressure of the brush upon the strip, the larger the number of the wires of the brushes that simultaneously make contact with the strip, the sharper the curve to which in operation the wires will be bent, and the greater the power required to rotate the brush.

Operation then is effected by turning on the sprays of solution from pipes 3, drawing the strip through the apparatus in the direction indicated, and rotating rolls and brushes by motors 25 and 26.

Under these conditions the amount of power required to drive the brush will be indicative of the pressure of the brush upon the strip; and, since each brush is severally driven by its own motor, an electrical instrument 45 (Fig. II) placed in the line that supplies current to the motor will serve to indicate whether the pressure is proper in degree. And if, after having been set in optimum position, a brush by prolonged service becomes worn, the electrical instrument placed as just specified will afford indication of such condition. And if for any reason the brush should suffer displacement and the pressure increased or decreased from the norm, this instrument will give indication of the fact.

It is manifest that, with a separate motor for each brush and for each back-up roll, it is possible to rotate any brush or any back-up roll in either direction, with corresponding assistance or retardation in the advance of the strip. If the strip is moving at high speed and the brush is turning in such direction that the bristles advance with the strip, the velocity of brush rotation would have to be very high, in order that brush rotation should be effective in removing foreign matter; but if the brush is turning in opposite direction, the rotation of the brush, whatever the speed, will be effective. And it is manifest that if the back-up roll be driven at the same surface speed with the strip, and in direction to advance in unison with the strip in the area of tangency, the roll, since it is power-driven, will aid in the propulsion of the strip, and there will be no sliding of the strip upon the roll surface, and no scratching.

The invention is not limited in this matter of direction of brush rotation. If means otherwise provided for the progress of the strip suffice, the brushes may be rotated in direction opposed to strip advance; or, if the brushes be rotated in direction favorable to strip advance, less power will be required for the means otherwise provided for strip progress.

While the foregoing specification has had to do with the scrubbing of steel strip, it is manifest that the apparatus is serviceable for scrubbing sheet material generally, whether in strip form or other form, and whether of steel or of other particular material.

I claim as my invention:

1. In apparatus for scrubbing sheet material a scrubbing element consisting of paired back-up roll and brush, each comprising part of a unit severally applicable to and removable from housings, each unit including first, a rotatable mem-

ber, second, a pair of chocks in which the rotatable member is borne, third, a shield open throughout an interval but incompletely shrouding the rotatable member and uniting the chocks, and fourth, a panel part borne by the shield, the shields of the two said units arranged in the assembly with their openings in opposed positions facing one another and the panel parts borne by the shields meeting with overlapped edges and forming part of a brush-surrounding tunnel.

2. In apparatus for scrubbing sheet material that includes a housing and a succession of pairs of scrubbing elements, each pair consisting of a back-up roll and a brush together with shields incompletely surrounding each of the two said members of said pair, the rolls and brushes being rotatably mounted pair by pair in the housing and relatively adjustable in such mounting, the invention herein described of a tunnel adapted to surround the work advancing through the succession, said tunnel having side walls composed of separable panels, certain of said panels being mounted on the housing structure, and other of said panels being mounted on the shields of said pairs of scrubbing elements.

3. In apparatus for scrubbing sheet material that includes a succession of pairs of housings, a succession of pairs of relatively adjustable

chocks mounted in such housings, a succession of pairs of scrubbing members rotatably mounted in such chocks, each pair of scrubbing members including a back-up roll and a brush, and a tunnel surrounding the path of advance of material through the apparatus, such tunnel including side-walls formed in sections, the chocks carrying sections of the side walls, and a vault removably borne by the side walls.

4. In apparatus for scrubbing sheet material that includes a pair of oppositely placed housing structures each including a succession of pillars with spaces between, pairs of relatively adjustable chocks mounted in such spaces, pairs of cleaning members rotatably borne by oppositely placed chocks and adapted to engage material advancing between the housing structures, and a tunnel enclosing the path of advance of material, such tunnel consisting of an underlying tank, an overarching vault, and intermediate side walls, the side walls formed in overlapping sections carried in part by the pillars of the housings and in part by the chocks, the side walls overlapping the walls of the tank below, and the vault of the tunnel removably borne by the side walls.

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