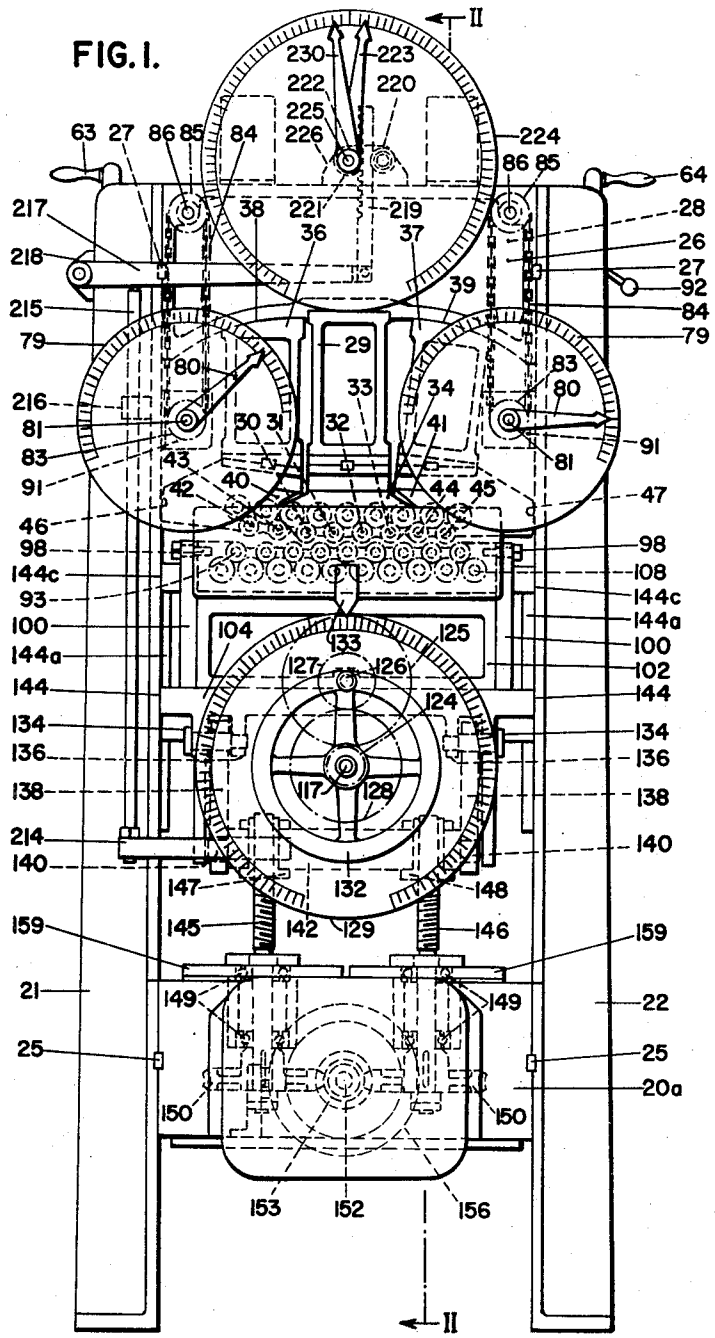
Aug. 16, 1960 F. K. MAUST 2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Filed Dec. 30, 1955 5 Sheets-Sheet 1

FIG. I.



INVENTOR
FREDERICK K. MAUST
BY Lester N. Clark
HIS ATTORNEY

Aug. 16, 1960 F. K. MAUST 2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Filed Dec. 30, 1955 5 Sheets-Sheet 2

FIG. 2.

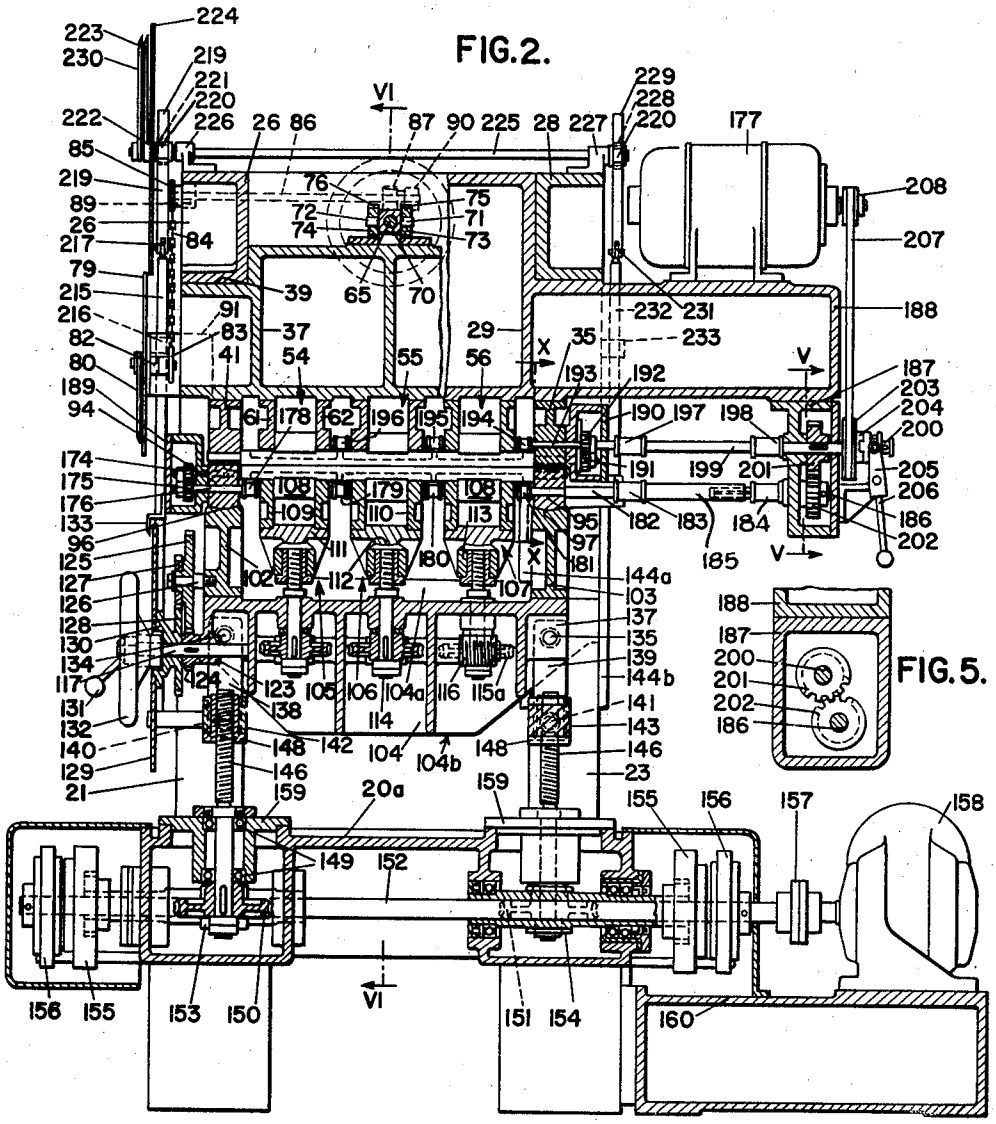


FIG. 5.

FIG. 4.

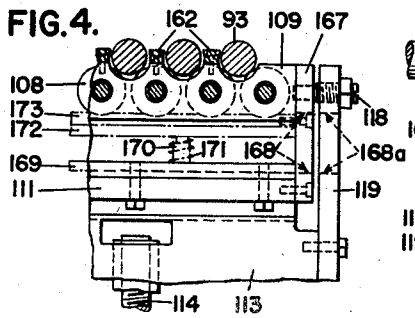
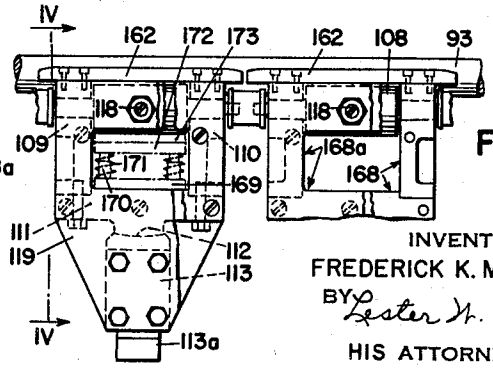


FIG. 3.



INVENTOR
FREDERICK K. MAUST
BY Lester H. Clark
HIS ATTORNEY

Aug. 16, 1960 F. K. MAUST 2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Filed Dec. 30, 1955 5 Sheets-Sheet 3

FIG. 7.

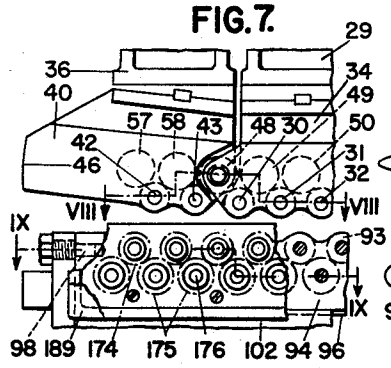


FIG. 8.

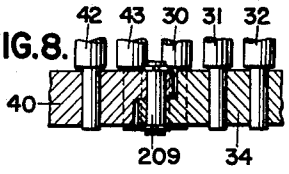


FIG. 9.

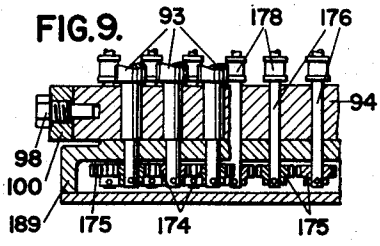


FIG. 11.

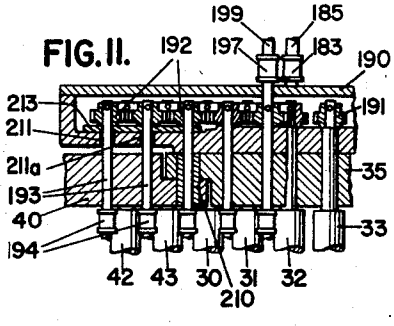


FIG. 10.

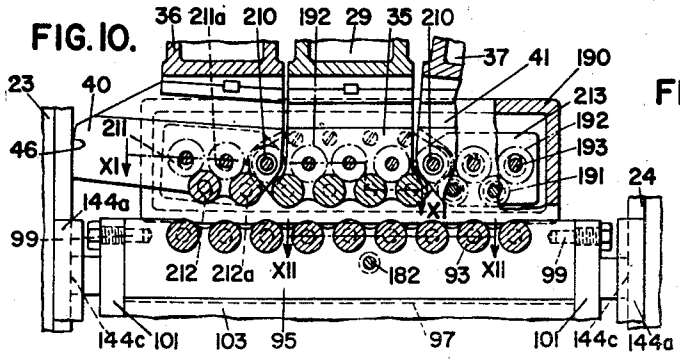


FIG. 6.

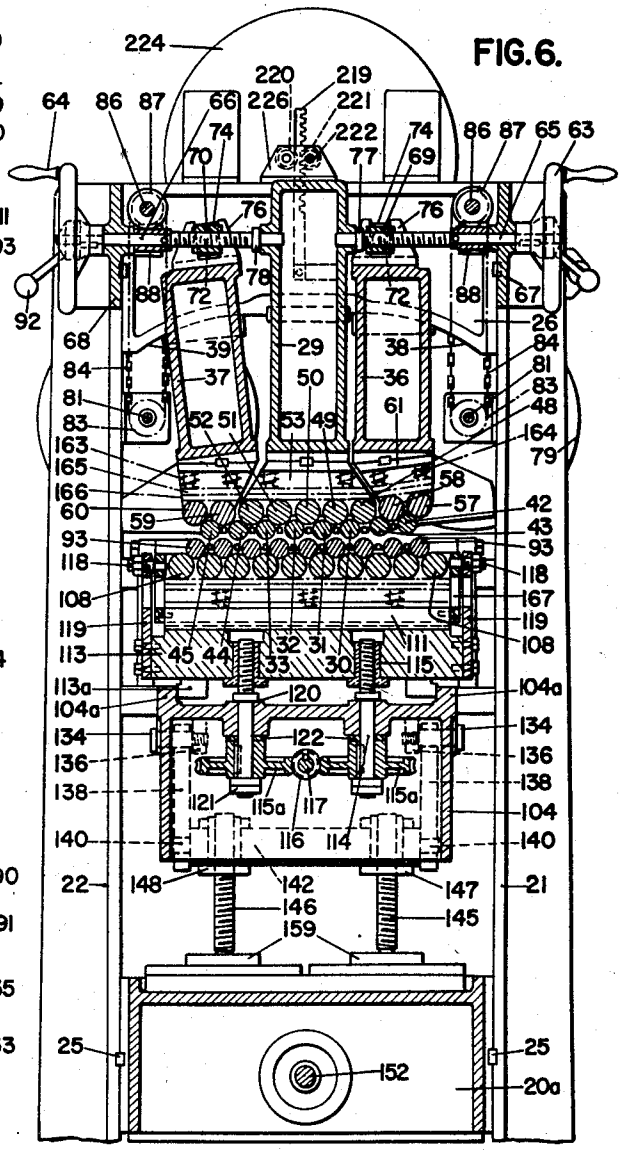
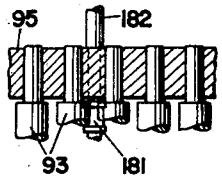


FIG. 12.



INVENTOR
FREDERICK K. MAUST
BY Foster H. Clark
HIS ATTORNEY

Aug. 16, 1960 F. K. MAUST 2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Filed Dec. 30, 1955 5 Sheets-Sheet 4

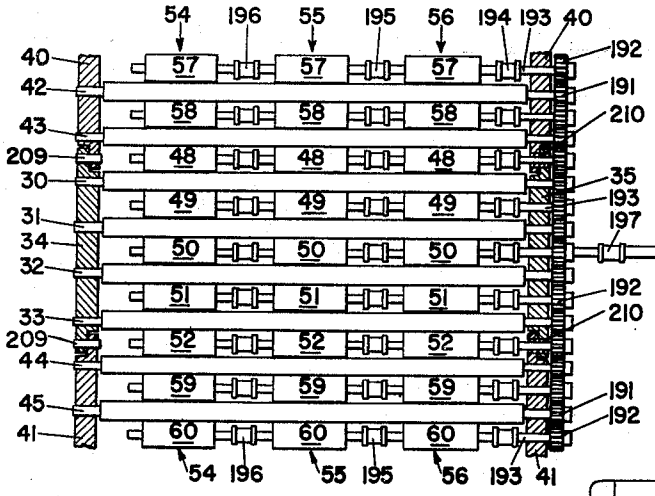


FIG. 13.

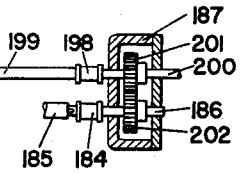
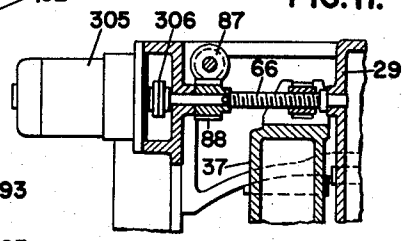
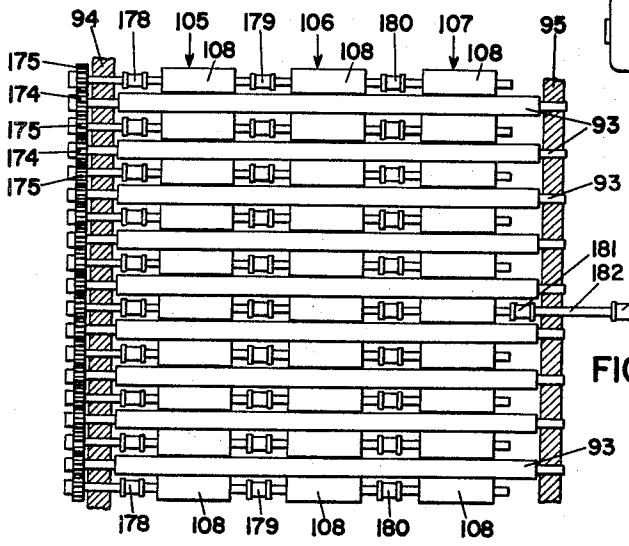


FIG. 17.





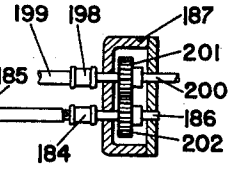


FIG. 14.

FIG. 16.

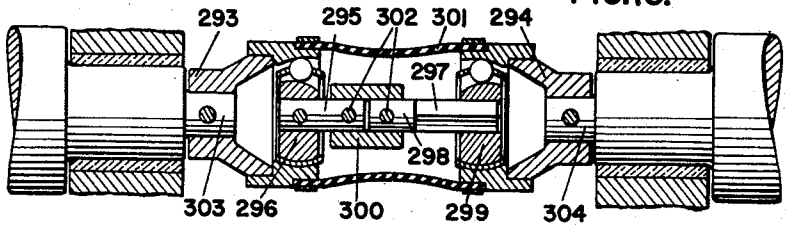
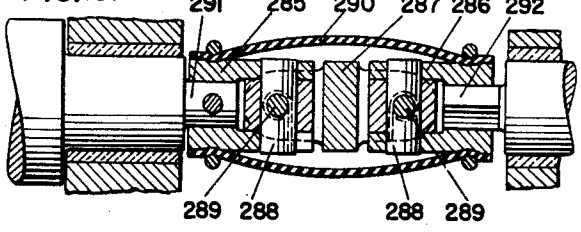


FIG. 15.



INVENTOR
FREDERICK K. MAUST
BY Lester H. Clark
HIS ATTORNEY

Aug. 16, 1960 F. K. MAUST 2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Filed Dec. 30, 1955 5 Sheets-Sheet 5

FIG. 18.

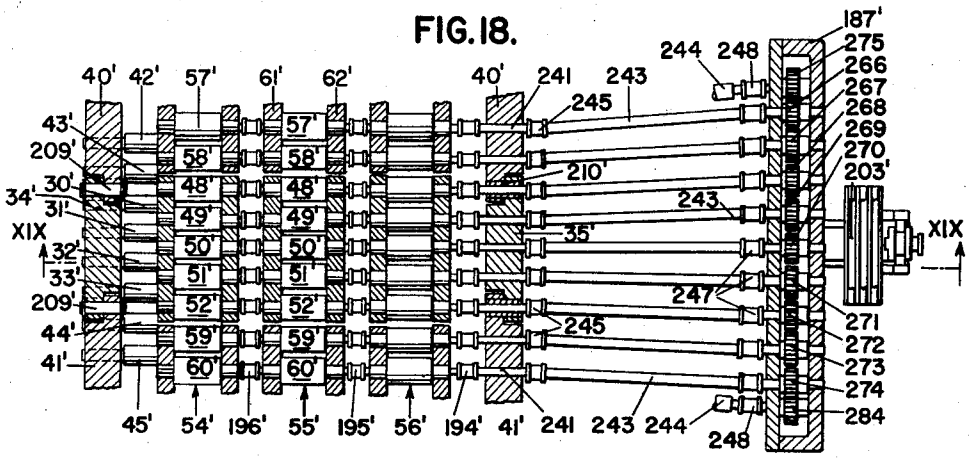


FIG. 19.

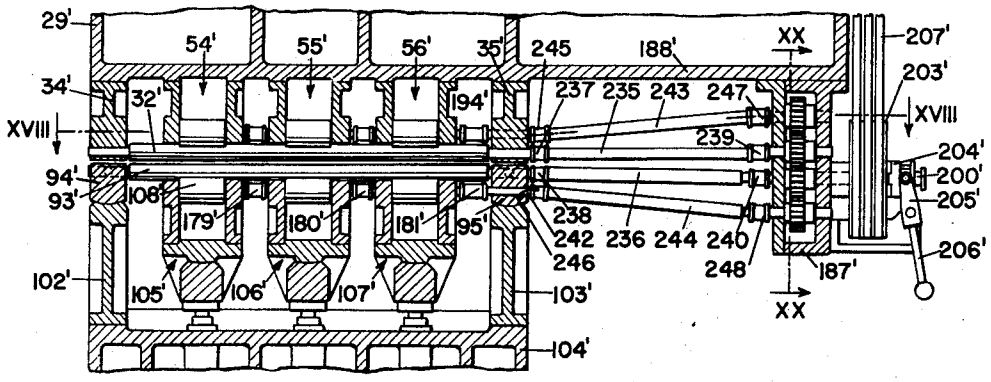
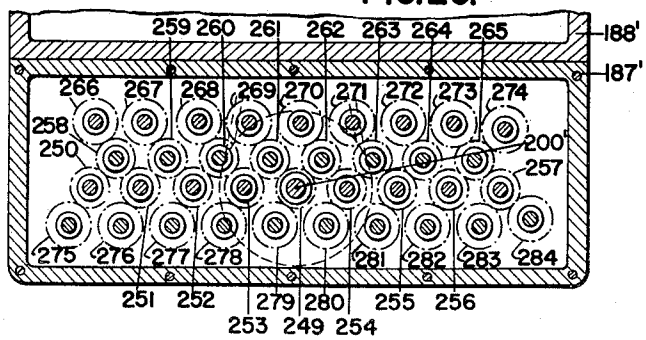


FIG. 20.



INVENTOR
FREDERICK K. MAUST
BY Lester H. Clark
HIS ATTORNEY

United States Patent Office 2,949,147
Patented Aug. 16, 1960

2,949,147

ROLLER LEVELER WITH DRIVEN BACK-UP ROLLS

Frederick K. Maust, 85—36 212th St., Queens Village 27, N.Y.

Filed Dec. 30, 1955, Ser. No. 556,677

18 Claims. (Cl. 153—106)

This invention relates in general to backed-up roller levelers for leveling and flattening ferrous and non-ferrous sheet and strip material, such as steel, stainless steel, copper, brass, aluminum etc. Backed-up roller levelers or so-called four-high levelers have two banks of straightening or work rolls between which the work material is repeatedly flexed beyond its elastic limit by subjecting it to a series of waves transverse to the pass direction. Because the elastic limit of the material must be exceeded, the bending radii of the waves must be as small as possible. Therefore, the work rolls should be of comparatively small diameter and must therefore be supported intermediate their ends by series or banks of short back-up or supporting rolls from which the name "backed-up" roller leveler derives. During the passage of the material through the staggered straightening roll banks, one or both banks may be deflected to correct the mill shape, i.e., to stretch the short areas of the material.

Backed-up roller levelers have been of great benefit to many industries, especially rolling mills. They have, however, one considerable drawback, particularly noticeable and objectionable when leveling highly finished stock such as bright aluminum, brass, copper, polished and painted material. While very expensive and slow, such stock had to be leveled heretofore by stretching between the jaws of hydraulic stretchers to avoid so-called "streaks" on top and bottom from the rolls of backed-up roller levelers. The jaw marks from the stretcher on each end of the sheet must be sheared off subsequently which makes this method of leveling still more expensive on account of the waste of stock and extra handling. For this reason, two-high levelers, i.e. levelers without back-up rolls have been tried for this class of work. On such levelers, the streaking effect above described is avoided but they can not correct the mill shape of sheets and strips and therefore are not able to produce leveled stock.

The prior art shows many attempts to solve this problem of streaking in backed-up roller levelers. No satisfactory solution had been found previously, however. Backed-up rolls driven at the same circumferential speed as the work rolls have been suggested, but the solution offered, namely, to build a gear box with intermeshing gears as part of each support roll section and then to drive the several gear boxes of the support roll sections located along the work rolls from the work rolls is extremely expensive, and leads to noisy operation and excessive maintenance problems. In addition, and not least important, the provision of individual gear boxes seriously detracts from the space available along the work rolls and prevents the use of the greatest possible number of support sections along the work region for a given length of work roll. This inherently limits the maximum load capacity and also reduces the flexibility and versatility of the work roll deflection for correcting the mill shape of the material.

As pointed out before, the correcting and leveling effect in a roller leveler depends on the bending radii to which the stock can be subjected during its passage through the

work rolls. Shortest possible center distances between adjacent straightening rolls have previously been accepted as unquestioned solution to obtain best results. But when leveling aluminum, for instance, which has a modulus of elasticity of roughly one-third that of steel, the actual wave depths or amplitudes of the corrugations to which the stock has to be subjected to get comparable results is also about three times that of steel. For maximum correction results I have found it highly beneficial to increase the center distance between the work rolls. For example, while a clearance between one inch diameter straightening rolls of about one-sixteenth to one-eighth of an inch was previously believed best, I have found that increasing this clearance to three-eighths, or one-half inch and even more, permits deeper nesting of the upper work rolls into the lower work rolls, thus subjecting the aluminum or other material to physically deeper waves during its passage between the rolls with consequent highly increased correction efficiency when handling stock with comparatively low modulus of elasticity.

The leveler shown in this application is basically a "double tilt" leveler as shown and claimed in my U.S. Patents No. 2,132,426, issued October 11, 1938, and No. 2,638,143, issued May 12, 1953. In the double tilt design, one bank of straightening rolls is divided transversely into three groups, which may be termed an "entry group" or "entry wing," a "middle group" or "center group," and an "exit group" or "exit wing."

One of the main objects of the present invention is to provide a method of, and apparatus for, leveling sheet and strip material in backed-up roller levelers without transferring "streaks" to the material passing therethrough including improved means for driving the supporting or back-up rolls positively at the same circumferential speed as their associated straightening or work rolls.

A further object is to provide such improved back-up roll driving means which is located outside the work roll region and which employs only flexible coupling means between flights of coaxial back-up rolls, thus minimizing the space longitudinally of the rolls required by the back-up roll driving means and thereby allowing the use of a maximum proportion of the roll length for active back-up roll sections.

Another object is to provide simple but effective wiper means for the driven back-up rolls so that any foreign particles, such as aluminum oxide, dust or dirt, deposited on the work rolls and transferred from these to the back-up rolls, is automatically and continuously wiped off to keep the rolls clean.

A further object is to provide novel support roll cradles and saddles with the swivel center of the cradles in the center of the supporting rolls to eliminate marking of the straightening rolls due to uneven support of the straightening rolls and to provide at the same time sufficient space to install wipers as described above. Another object is to provide novel deflector bars between adjacent straightening rolls mounted directly on the bearing blocks of the supporting rolls and movable therewith to positively prevent wrappnig of the leading edge of a sheet to be leveled around the work rolls.

Another object is to provide a new method of double tilting by tilting each wing around the rotational center of a supporting roll for the purpose of eliminating a previously existing restriction as to maximum possible tilt angle which is of importance in levelers with wider roll centers in order to transform the deeper waves or corrugations into a flat product at the exit side.

Still another object is to provide novel means for tilting the end wings for increasing or decreasing the angle of tilt as a direct function of the tilt actuating means which is important for flattening tapered material as now required by the aircraf industry.

Still another object is to provide novel means for longitudially tilting one or both straightening roll banks to a much greater degree than heretofore possible for either gradually increasing or decreasing the roll opening from one end to the other or for concentrating preferential pressure on a short area of one edge of the material only.

These and other objects and advantages of my invention will become apparent from a consideration of the following description and claims, taken together with the accompanying drawings.

In the drawings:

Fig. 1 is a front view of the leveler;

Fig. 2 is a longitudinal section of the leveler taken along line II—II of Fig. 1;

Fig. 3 is a detailed side view of the lower support roll arrangement;

Fig. 4 is a partial cross-sectional view of the lower support roll arrangement as indicated by line IV—IV, Fig. 3;

Fig. 5 is a cross-sectional view of the auxiliary gear-box along line V—V of Fig. 2;

Fig. 6 is a cross-section through the leveler along line VI—VI, Fig. 2;

Fig. 7 is a partial front view of the upper and lower straightening roll bearing blocks, the upper and lower bearing blocks being shown spaced apart;

Fig. 8 is a partial sectional plan view through the upper front straightening roll bearing blocks along line VIII—VIII, Fig. 7;

Fig. 9 is a partial sectional plan view through the lower front straightening roll bearing block and attached gear-box as indicated by line IX—IX, Fig. 7;

Fig. 10 is a cross-sectional view through upper and lower rear straightening roll bearing blocks along line X—X, Fig. 2;

Fig. 11 is a partial sectional plan view through the upper rear straightening roll bearing blocks and attached gear-box as indicated by line XI—XI, Fig. 10;

Fig. 12 is a partial sectional plan view through the lower rear straightening roll bearing block along line XII—XII, Fig. 10;

Fig. 13 is a diagrammatic exploded view of the upper straightening and supporting rolls;

Fig. 14 is a diagrammatic exploded view of the lower straightening and supporting rolls;

Fig. 15 is an enlarged cross-section through a double universal joint which may be used for the driving connection between adjacent support rolls;

Fig. 16 is an enlarged cross-sectional view of a constant velocity driving connection which may be used instead;

Fig. 17 shows a modification of the wing tilt drive in that an electric motor replaces the manual mechanism of Fig. 6;

Fig. 18 is a partial sectional plan view showing mainly a modification of the drive for the upper supporting rolls, taken along line XVIII—XVIII, Fig. 19;

Fig. 19 is a sectional side view of the modified roll drive shown in Fig. 18, taken along line XIX—XIX, Fig. 18;

Fig. 20 is a cross-section through the common gear-box along line XX—XX, Fig. 19.

Referring specially to Figs. 1, 2, and 6, the main construction members of the leveler are base **20***a* connected to the four uprights **21**, **22**, **23**, **24** (Fig. 10) by bolts and keys such as **25**. A cross-piece or crown **26** between left and right hand uprights **21**, **22** is bolted and keyed to the latter by keys **27**. A similar crown **28** is secured to the left and right hand rear uprights or housings **23**, **24**. A center beam **29** is fastened at its ends to crowns **26** and **28** and rotatably carries the center group of upper work or straightening rolls **30**, **31**, **32**, **33** journaled at their respective ends in front and rear straightening roll bearing blocks **34** and **35**, respectively. The region along the length of the work rolls and the supporting rolls between left and right-hand uprights or housings **21**, **22**, and **23**, **24** in which region flexing stresses are applied to the sheet material and opposing stresses are transferred through the straightening and supporting rolls to bearing structures, is defined herein as the "work region."

Double tilt mechanism

As viewed in Fig. 1, the left and right-hand end groups of the upper work roll bank consisting in left-hand group of work rolls **42**, **43** and right-hand group of work rolls **44**, **45** are journaled at their ends in respective bearing blocks **40** and **41**. Bearing blocks **40**, **41** have curvilinear sliding surfaces **46**, **47**, respectively, which are guided on machined surfaces of left and right-hand uprights or housings **21**, **23** and **22**, **24**, respectively, as best seen in Figs. 1, 7 and 10.

Bearing blocks **40** are secured to each end of left-hand wing or wing beam **36**; bearing blocks **41** are similarly secured to each end of right-hand wing or wing beam **37** (Figs. 1, 2 and 13). Left-hand wing **36** and right-hand wing **37** are of identical design because the upper work rolls are symmetrically arranged around the vertical center line of the leveler as viewed in Figs. 1 and 6. Left-hand wing **36** is, therefore, a mirror image of right-hand wing **37**.

The weights of wing beams **36**, **37** are supported in front of the leveler by pivot pins **209** (Figs. 8 and 13) and in the rear of the leveler by bushings **210** (Figs. 10, 11 and 13). Pins **209** and bushings **210** extend through respective bearing blocks **34**, **35** fast to center beam **29** and respective bearing blocks **40** and **41** fast to the left and right-hand wings **36** and **37**, respectively. Center beam **29** is fastened to crowns **26**, **28** as already described.

Left and right-hand wing beams **36**, **37** have similar shoulder portions at their front and rear ends, as shown in Fig. 2 for the front end of right-hand wing beam **37** and in Figs. 1 and 6 for the front end of left-hand wing beam **36**. The upper surfaces **38**, **39** of the shoulder portions at the front and rear ends of these wing beams are of curvilinear shape (Figs. 1, 2 and 6) and rest against similar matching curvilinear surfaces on front and rear crowns **26**, **28**. Thus front and rear crowns **26**, **28** take the upward thrust imposed on wing beams **36**, **37** by the leveling process.

A plurality of supporting roll sections prevent the upper work rolls from undesirable deflection under load. As a matter of example, three such support roll sections are shown. Each of the three support roll sections on center beam **29** for backing up the center group of straightening rolls consists of five short support rolls **48**, **49**, **50**, **51**, **52** (Fig. 13) journaled at their ends in bearing blocks such as **53** (Fig. 6). The center-to-center distance between adjacent straightening rolls is considerable and the support rolls are shown larger in diameter than their work rolls which permits the application of large diameter bearings for maximum load carrying capacity and life. The support rolls are located in staggered relation to the work rolls to give them not only vertical but also lateral support against deflection.

Between their work roll bearing blocks **40**, **41**, the wing beams **36**, **37** each carry also three similar support roll sections such as **54**, **55**, **56** shown for the right hand wing **37** in Fig. 2. See also Fig. 13. Each of the three support roll sections of the left wing **36** consists of two back-up or supporting rolls **57**, **58**; similarly, each of the three support roll sections of the right wing **37** carries two support rolls **59**, **60**. Bearing blocks such as **61**, **62** rotatably support the ends of each pair of wing support rolls **57**, **58** and **59**, **60**.

The wings **36** and **37** are slidably guided by curvilinear surfaces **46** and **47** on respective housings **21**, **23** and **22**, **24** and against cross members **26** and **28** on matching curvilinear surfaces **38** and **39**, respectively, as previously described. It is emphasized that the longitudinal axes of support rolls **48** and **52** are the pivot points for the

left and right hand wings **36** and **37**, respectively. They are therefore the pivot centers or fulcrums of curvilinear surfaces **38**, **46** of the left hand wing and curvilinear surfaces **39**, **47** of the right hand wing, respectively.

The wings are tilted by rotating handwheels **63**, **64** fast to respective adjusting lead screws **65**, **66**. The hubs of handwheels **63**, **64** bear against side plates **67**, **68** which extend between housings **21**, **23** and rear housings **22**, **24**, respectively. Lead screws **65**, **66** are threaded in pivoted nuts **69**, **70**. Each of these nuts has trunnions **71**, **72**, Fig. 2, journaled in respective pillow blocks **73**, **74** which are slidably guided for substantially vertical movement in shoes **75**, **76** secured to the top of wing elements **36**, **37**, respectively. The ends of screws **65**, **66** carry thrust collars **77**, **78** and are journaled in bosses of center beam **29**. The combination of trunnion pins **71**, **72** and vertically guided pillow blocks **73**, **74** make these nuts floating and prevents binding when the wings are being tilted.

Left hand wing **36** is shown nearly at maximum upward tilt. The plane through the center lines of work rolls **42**, **43** therefore forms a comparatively large angle of inclination with respect to the center group of rolls. The right hand wing **37** on the other hand is shown tilted so that work rolls **44**, **45** are in the same horizontal plane as the center group of work rolls. Wings **36**, **37** may be inclined with respect to the middle section **29** so that the apices of their angles of inclination are directed toward the middle section. By comparison it will be seen that pivoted nuts **69**, **70** move very little in shoes **75**, **76** for the extreme difference in tilt adjustment because screws **65**, **66** are located tangent to the tilting arc. Hence, the amount of tilt of the wings is substantially in direct proportion to the number of turns given to screws **65**, **66**. This direct relation is important when flattening sheets with tapered longitudinal cross-sections as presently required in the aircraft industry. The fulcrums or pivots for each wing coincide with the longitudinal axes of the back-up rolls **48**, **52** located between the inside work rolls **43**, **44** of the respective wings **36**, **37** and corresponding adjacent work rolls **30**, **33** of the middle section **29**.

To show the operator the exact tilted positions of the wings and to facilitate resetting to positions previously found most effective, a large mill type dial **79** is provided for each of the wings **36**, **37**. Dials **79** are secured to the housings by suitable brackets **91**. Clamping levers **92** may be employed to lock the handwheels in place after adjustment. Hands **80** on dials **79** are fast to one end of indicator stub shafts **81** which are rotatably mounted in bearing brackets **82** fastened to housings **21**, **22**, respectively. The other ends of shafts **81** carry chain sprockets **83** connected by chains **84** to sprockets **85** secured to shafts **86**. These carry helical gears **87** in mesh with helical gears **88** on shafts **65**, **66** (Fig. 6). The helical gears **88** rotate these shafts **81** concurrently with the hubs of handwheels **63**, **64**. Shafts **86** are suitably journaled in bearings **89** and **90**.

Deflection of lower straightening rolls

The lower straightening or work rolls, generally designated as **93** are shown to form a single roll bank. The ends of these rolls are journaled in end bearing elements or front and rear bearing blocks **94**, **95** which are supported throughout their length on straightening roll saddles **102**, **103**. Plates **100**, **101** are bolted to or made integral with the ends of saddles **102**, **103** and extend vertically upward therefrom. To avoid excessive stresses on the journals of the work rolls **93** when the latter are being deflected, bearing blocks **94**, **95** and saddles **102**, **103** are constructed so that the blocks may swivel on the saddles. For this purpose, bearing blocks **94**, **95** and saddles **102**, **103** are provided with matching arcuate sliding surfaces **96**, **97** which are concentric with pins **98**, **99** threaded in the upper ends of the plates **100**, **101** and having non-threaded ends extending into aligned bores in the ends of the bearing blocks **94**, **95** as best seen in Fig. 9. Saddles **102**, **103** are fast to yoke **104** which carries as an example three support roll sections **105**, **106**, **107**. Each of these support or back-up roll sections consists of a plurality of flights of support or back-up rolls **108**. Each flight of three coaxial rolls is placed in staggered relation to its associated work rolls **93** in a similar manner as previously described in connection with the upper support rolls. The ends of these short and therefore stiff back-up rolls are journaled in bearing blocks **109**, **110** (Fig. 2) which in turn are secured on rocking cradles **111**. The latter possess arcuate supporting surfaces **112** and rest on matching arcuate surfaces of supporting roll saddles **113**. Pivot pins **118** (Fig. 6) are threaded for side adjustment in front plates **119** which are shown bolted to the left and right-hand ends of the saddles **113**, as viewed in Fig. 6. These saddles and plates could be made integral but it is obvious that the demountable construction shown facilitates removal of cradles **111** with their support rolls. Cradles **111** may therefore rock around pivot pins **118** to maintain equal pressure on all bearings of each support roll bank when the lower straightening rolls are deflected.

Each of the saddles **113** is vertically adjustable by means of two screws **114** whose upper ends are threaded in nuts **115** which are secured to saddles **113**. The lower ends of screws **114** carry worm wheels **115***a* which are in mesh with worms **116** on deflection adjusting shaft **117** (Fig. 6). Each support saddle **113** is provided at its lower end with at least one thrust block **113***a* on each side, bearing against one or two flanges **104***a* of yoke **104**. These thrust surfaces will help absorb the bending load on deflection screws **114** in the direction of pull in tension leveling.

Tension leveling, by the way, is the method of roller leveling coiled stock taken from a pay-off reel on the entry side of the leveler and rewound on a reel at the exit side under tension while the stock is being flexed and corrected between the bank of work rolls. During this operation, the power drive of the leveler may drive the rolls, or the power drive of the leveler may be disengaged and the strip pulled through the leveler by the tension reel alone. In this case, the straightening and supporting rolls will be rotated by the friction of the stock passing through.

Suitable thrust shoulders **120**, which form part of screws **114**, rest on bosses on top of yoke **104** and lock nuts **121** keep worm wheels **115***a* located against thrust washers **122**. Deflection adjustment shaft **117** is mounted in suitable bearings such as **123** (Fig. 2) which are part of or are attached to yoke **104**. Shaft **117** carries a keyed-on pinion **124** in mesh with idler gear **125** on stud **126**. Another pinion **127** on stud **126** is in mesh with gear **128** freely rotatable on shaft **117**. A deflection dial **129** is secured to collar **130** which may be integral with gear **128**. A locking lever **131** permits locking of deflection adjustment handwheel **132**, fast to shaft **117**, after the desired adjustments have been made. Hence, dial **129** is rotated by gear train **124**, **125**, **127**, **128** and stationary pointer **133** traveling with yoke **104** will indicate the degree of deflection of lower work rolls **93** at all times.

I have chosen, as a matter of example, to show the leads of screws **114** as so selected that, depending on the direction of rotation of handwheel **132**, all of the support roll sections **105**, **106**, **107** will be displaced simultaneously suitable distances to deflect work rolls **93** into convex or concave contours. Instead of this, individually adjustable support roll sections or a combination such as shown in my pending application, Serial No. 545,045, or any other method of work roll deflection may be employed.

Screw-down adjustment

The roller leveler shown is of so-called "upside-down" design in as much as the mechanism for adjusting the roll

opening between upper and lower work rolls is located at the bottom of the machine. The support roll sections **105, 106, 107** and the deflection mechanism for displacing these sections are all supported on yoke **104**, which is pivotally supported on the upper ends of four generally vertically extending links **138, 139**, one near each corner of the yoke **104**. Pivot pins **134, 135** rockingly connect forks **136**, which are located near each end of yoke **104** and may form part of it, to the upper ends of the links **138, 139**. Pivot pins **140, 141** in turn connect the lower ends of links **138, 139** on cross-support members **142, 143**. To prevent movement of yoke assembly **104***b* laterally, i.e. from side to side as it appears in Fig. 1, both the front and rear ends of the yoke **104** are provided with projections having surfaces **144** which slidably engage the housings or uprights **21, 22, 23** and **24**. Plates **100** and **101**, which are bolted to straightening roll saddles **102, 103**, as previously described, are provided with projections having surfaces **144***c*, which also are adapted to slide on uprights **21, 22, 23** and **24**, respectively, to still further assist in preventing lateral movement of yoke assembly **104***b*. In order to permit tilting movement of the assembly **104***b*, while preventing unrestricted lateral movement from side to side as it appears in Fig. 2, the sliding surfaces **144** and **144***c* at the rear of the assembly are vertically guided between gibs **144***a* and **144***b*. Alternatively, an equivalent vertical guide could be provided at the front housings, or on any other convenient stationary part. With this longitudinal roll tilt design, yoke **104** may be longitudinally tilted to any desired degree without danger of binding or other interference. Furthermore, this novel design will give freedom to tilt the lower roll bank into extreme angular positions for increasing or decreasing the roll opening between upper and lower work rolls at either left or right hand end of the work rolls. This wide adjustment possibility is of special advantage for concentrating the roll pressure on narrow edge portions of the stock.

Each of the cross-support members **142, 143** (Figs. 1, 2) is adjustable in height by two lift screws **145, 146** which are threaded in respective nuts **147, 148** secured to these cross-members. Screws **145** and **146** may be rotatably guided in base **20***a* by ball bearings **149**. These are mounted in members **159** bolted to base **20***a* for convenience in assembly. The screws **145, 146** carry at their lower ends worm-wheels numbered **150, 151** keyed thereto. Sleeve-type worms **153, 154** in mesh with worm-wheels **150, 151** are carried freely rotatable on screw-down shaft **152** for front and rear end adjustments, respectively. One end of these two sleeves **153, 154** each carries the free half **155** of a clutch, such as a magnetic clutch of the Stearns type. The other halves **156** of the clutches are keyed to screw-down shaft **152**. A coupling **157** connects screw-down shaft **152** to a power source, such as an electric gearhead motor **158**, Fig. 2. This motor may be of the direct current adjustable speed type for automatic adjustment of the roll opening when tapered sheets are to be leveled and may be mounted on an extension **160** on rear housings **23, 24**. By engaging both clutches **155, 156**, the yoke assembly **104***b* may be raised or lowered uniformly. By engaging only one of these clutches, the yoke may be longitudinally tilted to any desired angle.

To indicate the exact position of the lower work rolls **93** in the front and rear housings, an indicator is provided (see Figs. 1 and 2), comprising pointers **223, 230**, cooperating with a scale **224**. A bracket **214** is fastened to the front cross-member **142**. A rod **215**, fast to bracket **214** and guided in bearing **216**, transmits vertical movement of bracket **214** to lever **217** pivoted on one end in bearing **218**, mounted on left hand housing **21**. The other end of lever **217** pivotally carries rack **219** vertically guided by roller **220** and engaging a pinion **221** mounted on a sleeve **222** which also carries pointer **223** on dial **224**. Sleeve **222** is freely rotatable on the front end of indicator shaft **225** mounted in bearings **226, 227**, Fig. 2. The pointer **230**, which gives the position of the straightening rolls **93** in the rear housings **23, 24** is fast to shaft **225** and is actuated analogous to the other pointer by pinion **228** fast to the rear end of indicator shaft **225**, rack **229**, guide roll **220**, pivoted lever **231**, and rod **232** guided in bearing **233**. The lower end of rod **232** is connected to a bracket similar to bracket **214** previously described. The respective positions of pointers **223** and **230** shown in Fig. 1 indicate the extent to which the lower straightening roll bank is longitudinally tilted relative to the upper work roll bank.

Deflector bars for work rolls

To prevent the leading edge of a sheet or strip to wrap around the work rolls, sheet deflector bars **162** are provided as best seen in Figs. 3 and 4. While sheet deflectors per se are known in the art, they were never satisfactory because they interfered with the work rolls and their deflection. My novel deflector arrangement overcomes these previous shortcomings and permits deep waves or corrugations in the stock as well as any practical deflection of the work rolls for mill shape corrections. The new deflector design shows sufficient side clearance between them and the adjacent flanks of the work rolls so that the deflectors need never contact the work rolls. As shown in Figs. 3 and 4, the deflector bars **162** are bolted or otherwise fastened to the support roll bearing blocks, such as lower bearing blocks **109, 110** (Figs. 3, 4) or upper bearing blocks **61, 62** (Fig. 2).

It will be noted that the deflector bars **162** are secured to the lower bearing blocks such as **109, 110** in the approximate vertical center line of the respective back-up rolls (Fig. 4). Bearing blocks **109, 110** (Fig. 2) may rock with cradles **111** when the support roll sections **105, 106**, and **107** are vertically displaced for deflecting the work rolls **93** to correct the mill shape of the work material. Thus the deflector bars **162** will automatically assume the correct vertical as well as angular positions with respect to the deflected work rolls. Each top and bottom support roll section has a plurality of such deflectors **162**, one between each pair of adjacent work rolls. The deflector bars **162** may be of approximately the same length as the overall distance between the two bearing blocks of each support roll section, or they may extend beyond the bearing blocks and overlap the couplings **195, 196** between the bearing blocks as shown in Figs. 2 and 3 with sufficient clearance between adjacent deflector bars as not to interfere with each other when the work rolls are being deflected.

Wiper arrangement for support rolls

The work rolls of levelers have the tendency to pick up metal and dirt particles from the stock being leveled and to deposit some of these on the back-up rolls which is one reason for the streaks on the surface of the stock. Additional streaking occurs on account of the slip between work rolls and back-up rolls when the back-up rolls are driven by friction from the work rolls only. These surface blemishes are specially objectionable and noticeable on brightly finished or painted stock. The prior art offers no effective and practical cure for this evil. With the positively driven back-up rolls to be described in detail later, efficient wipers for the back-up rolls may be employed which in combination with the elimination of slip between work rolls and back-up rolls prevent the heretofore unavoidable streaking effects.

To install and service wipers conveniently, space must be provided above the upper and below the lower back-up rolls. Such space is provided for the upper support rolls by making previously described bearing blocks **61, 62** sufficiently high as shown in Figs. 2, 6. The latter figure depicts separate wipers for the wing and center groups of each supporting roll section. Each wiper may consist of two or more springs **163** guided on pins **164**

with a base plate **165** which is lined with felt **166** or other suitable material. Springs **163** exert pressure on felt-lined base plates **165**. The felt will pick up continuously and automatically from the rotating support rolls any particles which may be transferred to them by the work rolls, thus keeping both support rolls and work rolls clean.

The difficulty is to provide the required space below the lower support rolls without sacrificing their rocking motion around the center. Figs. 3 and 4 show the new cradle design with high supporting roll bearing blocks **109, 110**. The pivot plates **167** in front and rear carry pivot pins **118** and are provided with windows **168**. Windows **168***a* in cover plates **119** of the support roll saddles **113** permit easy access for mounting similar wipers as described in connection with the upper support rolls. The wipers may consist of a plate **169**, guide pins **170**, springs **171** and base plate **172** lined with felt **173** or other suitable material. In as much as all lower support rolls are shown to form one single, uninterrupted roll bank, one such wiper extending across all support rolls of each section will suffice.

Drive of lower and upper support rolls

A wiper arrangement as previously described would be helpful for keeping the support rolls clean of conventional roller levelers with idler support rolls but has there the detrimental effect of acting like a brake on the support rolls so that their relative slip with respect to the driven work rolls becomes still more pronounced with the result that the marking effect on the work rolls is increased.

These disadvantages are overcome by the proposed novel method of positively driving all straightening as well as support rolls as shown. Figs. 1 to 14 inclusive depict a gear arrangement for driving all lower work rolls **93** and their associated back-up rolls **108** from the front or left side of the leveler as viewed in Fig. 2. Each work roll **93** carries at its left hand end a gear **174** with a pitch diameter equal to the diameter of the work roll. Spaced in staggered relation to gears **174** and in mesh therewith are gears **175** fast to shafts **176** which are preferably in axial alignment with the longitudinal axes of the lower support rolls **108** when the latter are in their non-deflected position as shown in Fig. 2. Gears **174** and **175** are inclosed in an oiltight auxiliary gear-box **189** for continuous lubrication of these gears either by dipping in oil or by spraying oil continuously on these gears by means of a suitable oil pump and piping to recirculate the oil, depending on the contemplated operating speed of the leveler. To impart identical circumferential speeds to the support rolls as their work rolls, gears **175** have the same pitch diameter as the outside diameter of the support rolls.

It is again emphasized that gear box **189** is located outside the work region and hence does not occupy important and valuable space within that region. Thus the maximum possible proportion of space along the work rolls may be devoted to support roll sections and hence the number of such support roll sections may be maximized for increasing the load carrying capacity and for exerting preferential pressure on short areas of the stock to be corrected at a maximum number of points along its width. As far as economy of design, maintenance, and gear noise are concerned, these advantages are obtained by employing only one gear train for driving the flights of all the lower supporting roll sections. While three sections have been shown by way of example, the same single gear box is, of course, capable of driving any number of such support roll sections.

It is, of course, not essential to provide pitch diameters for the gears which are equal to their respective straightening and support roll diameters. It is only essential that the ratio of the roll diameters is the same as the ratio of the pitch diameters of the gears which drive them.

Gears **174** do not mesh with each other, neither do gears **175**. It will be clear that when any of the support rolls or straightening rolls are rotated, all others will be forced to rotate in unison. This holds whether the rolls are rotated by pulling a strip through the leveler or whether they are driven by a motor such as **177** to be described later. Any possible slip between work rolls and their associated support rolls is consequently positively eliminated. Shafts **176** are journaled in lower rockable straightening roll bearing block **94** so that perfect gear mesh is assured regardless of the contour into which the lower work rolls **93** may be deflected. The bearing necks at the ends of these lower straightening rolls or work rolls **93** are journaled in bearing blocks or end bearing elements **94** and **95**, respectively. Thus the work region of the leveler is confined to the length of the straightening rolls between said end bearing elements **94, 95** located between housings **21, 22** and **23, 24**, respectively. The support roll sections **105, 106, 107** are located along the work region of said straightening rolls intermediate said end bearing elements.

Suitable couplings **178** such as double universal joints or constant velocity joints may be used to transmit the rotation of gears **175** on shafts **176** to the supporting rolls of support section **105** adjacent to the front housings. Other similar drive joints **179** connect the ends of supporting rolls of section **105** to those of section **106**; similar drive joints **180** interconnect corresponding support rolls of sections **106** and **107**. Figs. 15 and 16, to be described in detail later, show preferred arrangements of double universal joints and constant velocity joints, respectively.

Preferably one of the centrally located supporting rolls of section **107** is connected by similar drive joints **181** (see Figs. 2 and 14) to drive shaft **182** journaled in rear straightening roll bearing block **95**. Shaft **182** is drivingly connected by universal joints **183** and **184** and drive spindle **185** to stub shaft **186** carrying gear **202** in common driving gear box **187**. The latter is fast to center beam extension **188** on center beam **29**. In as much as the lower yoke **104** with its work and support rolls may be raised or lowered by means of the screw-down mechanism previously described, the drive spindle **185** is slidably keyed to one end of universal joint **184** as shown in Fig. 2, in order to permit vertical movement of the bearing **95** supporting shaft **182** while the box **187** remains stationary.

The upper straightening rolls and their associated support rolls are driven in a similar manner. Because auxiliary gear-box **189** for the lower rolls may require considerable space, another auxiliary gear-box **190** for the upper straightening and support rolls is placed on the rear end or right hand side of the upper straightening rolls as viewed in Fig. 2. Each upper straightening roll carries at its right hand end a gear **191** meshing with a gear **192** each for driving the upper support rolls. The respective mesh arrangement, pitch diameters and location of these gears **191** and **192** is similar as described in connection with gears **174, 175**. Gears **192** are fastened to shafts **193** journaled in upper rear straightening roll bearing blocks **40, 41, 35** (see Figs. 10, 11, 13) and connected to corresponding rolls of the upper support roll section **56** by suitable coupling means **194** which may be similar to those described before. The driving action and connection between support rolls of adjacent sections is again effected by suitable couplings **195** and **196**. Again a preferably centrally located support roll drive shaft **193** is extended and connected to shaft **200** in gear-box **187** by means of universal joints **197, 198** and drive spindle **199**. A gear **201** is keyed to shaft **200** and is in mesh with gear **202** of the lower roll drive, thus completing the driving circuit.

Shaft **200** is shown to extend through the rear cover of gear-box **187** and carries freely rotatable thereon belt pulley **203** and the left hand half of jaw clutch **204**. The right hand half of jaw clutch **204** is slidingly keyed to shaft **200** and may be engaged or disengaged by pivoted clutch fork **205** and hand lever **206**. A belt **207** con-

nects pulley 203 and pulley 208 on output shaft of motor 177.

By employing motor 177 as power source for rotating all straightening rolls and supporting rolls in unison, this motor may be used for threading a strip through the leveler in tension leveling or for conventional leveling of sheets. When the machine is used for tension pull-through operation, jaw clutch 204 is usually disengaged and then the friction between strip and upper and lower straightening rolls will rotate all straightening rolls and supporting rolls at identical linear speeds. The exploded, diagrammatic views shown in Figs. 13 and 14 show the straightening roll and support roll drives for the upper and lower roll banks, respectively, in clear simplified and easily understandable form.

Double tilt pivot arrangement

The end groups of straightening and supporting rolls in the left and right hand wings 36 and 37 (appearing at right and left hand sides, respectively in Fig. 6), which may also be called entry or exit wings depending on the direction of operation of the leveler, are tiltable relative to the center group of upper straightening rolls identified as 30, 31, 32, 33 on center beam 29 around the rotational axes of support rolls 48 and 52, respectively. At the front end of the leveler, a pivot pin 209, Fig. 8, whose pivot axis is in line with rotational axis of support roll 48, passes through abutting shoulders on bearing block 40 of left hand wing 36 and of central bearing block 34. In as much as the upper support rolls 48, 52 are driven at the rear of the leveler by shafts such as 193 carrying gears 192, the pivot pin construction required there is different from the pivot pin 209 at the front. As shown in Fig. 11, the shaft 193 of support roll 48 is journaled in, and extends through a bushing 210 whose outside surface serves as the pivot in a similar way as pin 209 previously described, thus solving the problem of having a drive shaft and pivot in the same axial alignment as support roll 48. The front and rear ends of right hand wing 37 are similarly pivoted, thus permitting wings 36, 37 to tilt around the axes of support rolls 48 and 52, respectively, when handwheels 63, 64 are rotated.

Gear-box 190 encloses all gears 191 and 192 for the straightening and supporting rolls of wings 36, 37 as well as of center beam 29. Because the arrangements are identical for both wings 36, 37, only the left wing 36 will be described to cover both.

Curved slots such as 211 and 211*a* with pivot bushing 210 as center are provided in the wall of gear-box 190 to allow drive shafts 193 of support rolls 57, 58 to tilt (Fig. 11). Similar curvilinear slots 212, 212*a* are provided for necks of straightening rolls 42, 43 for the same purpose. A sealer plate 213 closely fits around the tiltable drive ends and against the wall of gear-box 190 to seal it against oil seepage.

The most important advantage of this new double tilt design is that the wings may be tilted to any desired maximum angular inclination with the horizontal center group of rolls. Selecting the rotational axes of the respective supporting rolls (48, 52) adjoining the left and right hand wings as the pivot axes of those wings does away with any interference such as encountered at the support rolls when swinging the wings around the axes of the straightening rolls as taught in my previously mentioned U.S. Patent No. 2,132,426, for instance. The degree of tilt angle obtainable with this last mentioned design would be insufficient to flatten out the deep waves produced between the center group of rolls of the present leveler with wider spacing of the roll centers and consequent deeper nestable straightening rolls. Other advantages of this new arrangement are that the wings are now positively located by the pivot pins at all times; the latter are easily held to close tolerances, thus avoiding detrimental play between wing groups and center groups. Furthermore, they are cheaper to manufacture and maintain.

Fig. 15 shows in greater detail a standard, commercially available double universal joint such as previously identified by numerals 178, 179, 180, 181 and 194, 195, 196 for the bottom and top support roll drives, respectively. These joints consist of left and right hand forks 285, 286 which are drivingly connected by the center member 287 with pins 288 and 289 placed at right angles to each other in each end of center block 287. A rubber or fabric cover 290 keeps the lubricant inside. The left hand joint half 285 is pinned to the drive neck 291 of one support roll, while the right hand half drivingly slides axially on square drive neck 292 of the adjacent support roll. A key fitted for sliding service or a spline would serve the same purpose. The universal joint has removable pins for lifting out the center block 287 for convenient maintenance.

Fig. 16 shows basically a Rzeppa constant velocity joint as also commercially available. The left and right hand joints 293, 294 are secured to their respective support roll drive necks 303 and 304. A drive spindle 295 is pinned to the left hand ring member 296. The square end 297 of another drive spindle 298 slidingly fits in a matching square aperture of right hand ring member 299. The two spindles 295, 298 are pinned to a sleeve 300 by pins 302. A cover 301 is again provided for retaining lubricant. To disassemble this drive connection without disturbing the leveler, the pin is removed from right hand half 294 and the coupling as a whole pushed to the left on square end 297 until its hub clears the drive neck 304.

A special point has been made to emphasize that the couplings do not rigidly connect two adjacent support rolls. The reason for the importance of this arrangement is the fact that the vertical adjustment of the lower support roll sections should in no way be interfered with by the drive; also the freedom of the support saddles 111 to freely swivel around the pivot pins 118 must be carefully guarded.

The decision as to whether employ double universal joints or constant velocity joints depends among other factors on the magnitude of the contemplated adjustments of each support roll section, on the arrangement and number of support sections employed, on the operating speed, surface finish of the stock to be handled and so forth.

Fig. 17 depicts a motorized double tilt adjustment instead of the manual adjustment with handwheels such as shown in Figs. 1, 2 and 6 for instance. When leveling sheets with continuously tapering cross-section along their lengths, the wings must be made to automatically follow the taper for which reason the tilt screws 66 are preferably power driven by means of a variable speed motor, such as a direct current motor 305. A suitable coupling 306 connects motor shaft and screw 66. The roll deflection adjustment may also be motorized whenever required.

Figs. 18, 19, and 20 illustrate a modification for the drive of all work rolls and their support rolls from a single common gear-box located altogether away from the leveler. Corresponding parts have received the same numerals as used before with a prime mark attached so that the description does not have to be completely repeated. The common gear-box 187′ is shown in a simple form for illustrative purposes but may be of any design known in the art to distribute the loads on the gears more uniformly.

In this modification no gears are employed directly on the upper and lower work rolls. They are all driven from the common gear-box 187′ by drive spindles such as 235 and 236, respectively, which are connected to the ends of the work rolls by single universal joints 237, 238 and to the gear shafts in the gear-box by similar single universal joints 239, 240, respectively.

The intermediate shafts 241, 242 of all upper and lower support rolls are similarly driven by drive spindles 243, 244 and universal joints 245, 246 adjacent to the leveler proper and connected to the gear shafts by universal joints 247, 248. Fig. 18 shows a plan view of the upper support roll bank sections 54', 55', 56'. All flights of support rolls in adjacent sections, being in line, facilitate driving the rows of support rolls in adjacent sections, for instance, by joints 196', 195', 194', each flight of support rolls being driven from the common gear-box by one drive spindle 243.

The gear-box 187' shows one possible gear arrangement. The drive spindles 236 of all lower work rolls are driven by gear shafts and gears 249, 250, 251, 252, 253, 254, 255, 256, and 257. The drive spindles 235 of all upper straightening rolls are driven by similar gear shafts and gears 258, 259, 260, 261, 262, 263,264, 265. Main drive shaft 200' drives directly into the center roll of lower work roll bank and carries gear 249. The gears for the upper work rolls are staggered with respect to those for the lower work rolls in a similar way as the upper work rolls are staggered in relation to the lower work rolls. The gears of the upper work rolls do not mesh with each other, neither do those for the lower work rolls. However, lower gear 249 meshes with upper gears 261 and 262 and these respectively with lower gears 253 and 254, and so on. Each gear for the upper work rolls meshes with a gear for driving the upper support roll banks. These have been numbered 266, 267, 268, 269, 270, 271, 272, 273, and 274. Similarly, the gears for the drive of the lower straightening rolls mesh with the gears for rotating the lower support roll banks, and they have received the numbers 275, 276, 277, 278, 279, 280, 281, 282, 283, and 284.

The modification shown in Figs. 18, 19, 20 has the advantage that the size of the gears which may be used in the gear-box 187' for driving straightening rolls as well as support rolls can be made larger in pitch diameter than in the design depicted in Figs. 1 to 14 inclusive, because the drive spindles between roll necks and gear-box can be fanned out. Thus the load carrying capacity of the gears may be increased as required.

General

I have elected to show the application of a support roll drive to a double tilt leveler because it presents more problems. It should be understood that the new method of driving the back-up rolls and work rolls at substantially the same circumferential speeds is not limited to double tilt levelers, but may also be utilized to the same advantage in connection with single tilt levelers or levelers having individually adjustable backed-up work rolls as frequently found in large plate levelers.

As far as the particular design shown in Figs. 1 to 14 is concerned, it is clearly not essential to use a gear-box such as 187 for connecting the drives of upper and lower rolls to force them to rotate in unison. Gears or other means may be used directly on or adjacent to the ends of the upper and lower roll banks to interconnect both. The arrangement shown was selected for the primary reason that the lower roll bank may be vertically adjusted in wide limits without sacrificing perfect gear mesh under any operating conditions. When space permits, belts or any other suitable means may drive the support rolls individually, in groups or as a whole. The designs shown employ the work rolls or their gear-box drive to obtain identical linear speeds for work rolls and support rolls. This is not essential per se and separate drives for work rolls and support rolls may be provided, if necessary with suitable control means to synchronize the separate drives.

The flights of the support rolls were described to be drivingly interconnected from support roll section to support roll section by double universal or constant velocity joints as an example. The upper suport rolls are non-

adjustably mounted on wings 36, 37 and center piece 29 so that any other suitable, commercially available couplings, preferably of the flexible type for convenient assembly, may be used instead. Oldham type couplings of standard or modified design may be provided for either or both upper and lower support roll drives, or a combination of these several types of couplings and joints. The term "coupling" will be used in the claims to follow as including any of the types shown or described.

In connection with the novel double tilt construction, it is immaterial how many straightening rolls and their associated support roll sections are placed in each wing 36, 37. If desirable, one or any number of work rolls may be used; also, one wing may be provided with a different number of work rolls than the other wing.

I claim:

1. A roller leveler comprising rows of straightening rolls and supporting rolls, one of said rows including a center group and two end groups of straightening and supporting rolls, means to tilt each of said end groups about the longitudinal axes of the respective supporting rolls at the ends of the center group, adjustable power means for changing the tilt positions of each of said end groups, and other adjustable power means for varying the opening between said rows of straightening rolls for changing the crosswise taper of that opening for leveling sheets having tapered longitudinal cross-sections.

2. In a roller leveler, a base, a pair of front and a pair of rear uprights, two banks of cooperating work rolls mounted in said uprights for repeatedly flexing material passed between them, a screw-down adjustment for raising, lowering and longitudinally tilting one of said work roll banks comprising a yoke, bearing blocks secured to said yoke for rotatably mounting one of said work roll banks, screw-adjusting means located on said base between the front and rear uprights, support members operatively connected to said screw-adjusting means, pivot connections between said yoke and said support members to cause said yoke to participate freely in any vertical displacement of said support members, guiding means for said yoke on front and rear uprights to prevent undesirable movement of said yoke normal to the axes of said work rolls, and other guiding means in one pair of said uprights to maintain said yoke against substantial movement in the direction of the longitudinal axes of the straightening rolls.

3. In a roller leveler, a middle section comprising a plurality of spaced parallel work rolls for engaging a sheet of work material passing along one side thereof, a plurality of spaced parallel supporting rolls rotating in contact with the other sides of the work rolls, said supporting rolls being staggered with respect to the work rolls so that each work roll runs in contact with two supporting rolls, a wing section, comprising a plurality of spaced parallel work rolls and a plurality of spaced parallel supporting rolls, and means supporting said wing section for tilting movement with respect to said middle section about the axis of the supporting roll at the end of the middle section, so that the range of tilting movement of the wing section is not limited by the spacing nor by the diameter of the rolls.

4. In a roller leveler as defined in claim 3, a second wing section at the other end of the middle section from said wing section, and means supporting said second wing section for tilting movement about the axis of the supporting roll at said other end of the middle section.

5. In a roller leveler, a bank of parallel spaced elongated straightening rolls, adapted to engage sheet material moving transversely to said rolls, bearing means supporting said rolls, a yoke supporting said bearing means, independently operable means for raising and lowering the respective ends of the yoke corresponding to the ends of the straightening rolls, so as to tilt the bank of rolls transversely to the path of the sheet material, pivoted links connecting said raising and lowering means

to said yoke to permit independent operation of said raising and lowering means, and guide means to maintain one end of the yoke against horizontal movement.

6. In a roller leveler, two banks of straightening rolls arranged in staggered relation to each other for repeatedly flexing work material between them, each of said banks consisting of a plurality of straightening rolls, each of said straightening rolls having a bearing neck on each end, end bearing elements for rotatably supporting said straightening rolls on said bearing necks and thus confining the work region of the leveler to the length of the straightening rolls between said end bearing elements; support roll sections located along the work region of said straightening rolls intermediate said end bearing elements to prevent said straightening rolls from undesired deflection under load; a common driving gear-box away from the leveler, a first auxiliary gear-box located outside said work region of the leveler between one end of the straightening rolls and said common driving gear-box for rotating one bank of straightening rolls and their support rolls, at least one drive shaft operably connecting said common driving gear-box to said first auxiliary gear-box; a second auxiliary gear-box also outside the work region but located on the side of the leveler opposite said common driving gear-box for rotating the other bank of straightening rolls and support rolls, and at least one other drive shaft operably connecting said common driving gear-box to said second auxiliary gear-box.

7. In a roller leveler as defined in claim 6, a prime mover for driving said common driving gear-box for leveling cut-to-length sheets, and clutch means between said prime mover and said common driving gear-box to disconnect said prime mover from said common driving gear-box for pull-through operation.

8. A roller leveler as defined in claim 6, in which each support roll section comprises a plurality of short back-up rolls arranged in staggered relation with respect to their associated straightening rolls, bearing blocks for journaling said back-up rolls at their ends, a cradle for mounting said bearing blocks, a saddle for supporting said cradle, said cradle and said saddle having matching curvilinear sliding surfaces to permit said cradle to swivel on said saddle, adjusting means for vertically displacing said saddle, pivot plates secured to said cradle, cover plates fastened to said saddle, said pivot plates and said cover plates forming apertures for the convenient access to said back-up rolls, pivot pins between said saddle and said cradle at the center of curvature of said curvilinear sliding surfaces, said pivot pins being located substantially in the center of said back-up rolls, deflector bars secured to said bearing blocks substantially on the vertical center lines of said back-up rolls so as to bridge the gap between adjacent straightening rolls and to move said deflector bars into the required vertical and angular positions with respect to the straightening rolls when said saddle is vertically displaced and said cradle swivels on said saddle.

9. In a roller leveler, series of upper and lower straightening rolls arranged in staggered relation to each other for repeatedly flexing work material between them, upper banks of support rolls located above and intermediate the ends of the series of upper straightening rolls to prevent them from undesired deflection under load, lower banks of support rolls located below and intermediate the ends of the series of lower straightening rolls to prevent them from undesired deflection under load; a single common gear-box located away from the leveler for rotating all straightening and support rolls at substantially identical circumferential speeds, said gear-box comprising four rows of vertically spaced gear shafts, the first top row and third row of gear shafts being adapted to be rotated in one direction for driving said upper banks of support rolls and said series of lower straightening rolls, respectively; the second row and fourth bottom row of gear shafts being adapted to be rotated in opposite directions to said first and third rows for driving said series of upper straightening rolls and said lower banks of support rolls, respectively, and drive shafts connecting said gear shafts to said straightening and support rolls.

10. A roller leveler as defined in claim 9, in which banks of support rolls comprise a plurality of short back-up rolls arranged in staggered relation with respect to their associated straightening rolls, bearing blocks for journaling said back-up rolls at their ends, cradles for mounting said bearing blocks, saddles for supporting said cradles, said cradles and said saddles having matching curvilinear sliding surfaces to permit said cradles to swivel on said saddles, adjusting means for vertically displacing said saddles, pivot plates secured to said cradles, cover plates fastened to said saddles, said pivot plates and said cover plates provided with windows for the convenient access to said back-up rolls, pivot pins between said saddles and said cradles at the center of curvature of said curvilinear surfaces, deflector bars secured to said bearing blocks and positioned to bridge the gap between adjacent straightening rolls so as to move said deflector bars into the required vertical and angular positions with respect to the straightening rolls when said saddles are vertically displaced and said cradles swivel on said saddles.

11. A roller leveler as defined in claim 6, in which the first and second auxiliary gear-boxes include gears fastened to the respective opposite ends of the straightening rolls.

12. In a roller leveler, two banks of work rolls arranged in staggered relation to each other for repeatedly flexing work material between them, support roll sections located along the work rolls intermediate their ends to prevent said work rolls from undesired deflection under load and for deflecting said work rolls for correcting the mill shape of the work material, said support roll sections comprising a plurality of short back-up rolls, bearing blocks for journaling said back-up rolls at their ends, cradles for mounting said bearing blocks, saddles for supporting said cradles, said cradles and said saddles having matching curvilinear sliding surfaces to permit said cradles to swivel on said saddles, adjusting means for vertically displacing said saddles, pivot plates secured to said cradles, cover plates fastened to said saddles, said pivot plates and said cover plates provided with windows for the convenient access to said back-up rolls, pivot pins between said saddles and said cradles located at the center of curvature of said curvilinear sliding surfaces, deflector bars secured to said bearing blocks and positioned to bridge the gap between adjacent work rolls so as to move said deflector bars into the required vertical and angular positions with respect to the work rolls when said saddles are vertically displaced and said cradles swivel on said saddles.

13. A backed-up roller leveler as defined in claim 12, in which thrust surfaces are provided on said support roll sections to maintain said support roll sections against deflection in the direction of leveling.

14. A roller leveler as defined in claim 7, in which all the straightening rolls of the first roll bank extend through and outside first end bearing elements located on the side of the leveler nearest the common driving gear-box, and in which all the straightening rolls of the second roll bank extend through and outside second end bearing elements located on the side of the leveler opposite said common driving gear-box, gears fastened to the ends of the straightening rolls of said first roll bank outside said first end bearing elements, other gears fastened to the ends of the straightening rolls of said second roll bank outside said second end bearing elements; support roll sections including pluralities of short back-up rolls being spaced in alignment with respect to each other along the straightening rolls of said first and sec-

ond roll banks, bearing blocks for journaling the ends of said back-up rolls, said back-up rolls extending through said bearing blocks, flexible couplings connecting said aligned back-up rolls, a plurality of stub shafts extending through said first and said second end bearing elements, corresponding in number to and aligned with the back-up rolls, flexible couplings between said stub shafts and said back-up rolls for concurrent rotation, gears on said stub shafts in mesh with said gears located outside said first and second end bearing elements and forming auxiliary gear-boxes located outside the work region of the leveler, and a driving shaft between each one of the two auxiliary gear-boxes and said common driving gear-box.

15. A roller leveler as defined in claim 7, in which one of said banks of straightening rolls and associated support roll sections include a center group and two end groups of straightening rolls and support rolls, in combination with means for tilting each of said end groups around the longitudinal axes of the respective support rolls at the ends of the center group.

16. A roller leveler as defined in claim 10, in which one of said series of straightening rolls and associated support roll banks include a center group and two end groups of straightening and support rolls, in combination with means for tilting each of said end groups about the longitudinal axes of the respective support rolls at the ends of the center group.

17. In a backed-up roller leveler, two banks of staggered work rolls for repeatedly flexing stock passed between them, bearing means for journaling one of said

banks of work rolls at their ends, supporting rolls for said work rolls, bearing means for sustaining said supporting rolls at their ends, a yoke assembly for carrying said work rolls and associated supporting roll bearing means, screw-down means for vertically displacing said yoke assembly and for tilting the latter in the direction of the longitudinal axes of said work rolls to vary the roll opening between said two banks of work rolls, and pivot means including pin and link means near each end of said yoke assembly for tiltably connecting said yoke assembly and said screw-down means.

18. In a backed-up roller leveler as defined in claim 17, in which said vertical yoke assembly displacing means comprises means for selectively and independently adjusting each end of said yoke assembly.

References Cited in the file of this patent

UNITED STATES PATENTS

654,080	Townsend	July 17, 1900
1,516,627	Wise	Nov. 25, 1924
2,132,426	Maussnest	Oct. 11, 1938
2,219,163	Maussnest	Oct. 22, 1940
2,254,461	Todd	Sept. 2, 1941
2,324,855	Lane et al.	July 20, 1943
2,638,143	Maust	May 12, 1953
2,733,750	Todd	Feb. 7, 1956

OTHER REFERENCES

Ser. No. 360,151, Ungerer (A.P.C.), published May 11, 1943.