Aug. 31, 1937. A. J. R. GREER 2,091,921

PICKLING MACHINE

Filed June 10, 1937 5 Sheets-Sheet 1

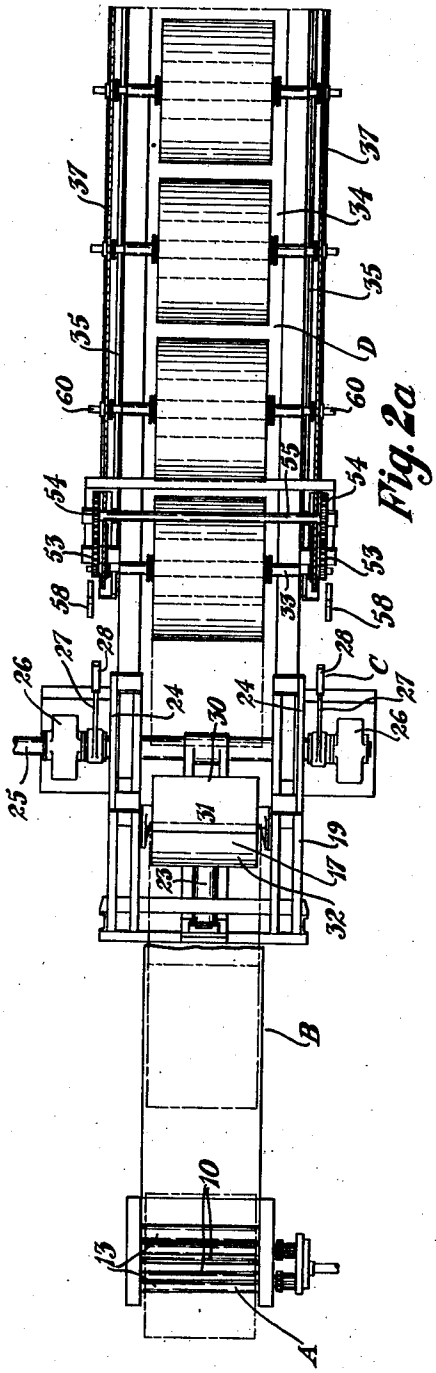

Fig. 2a

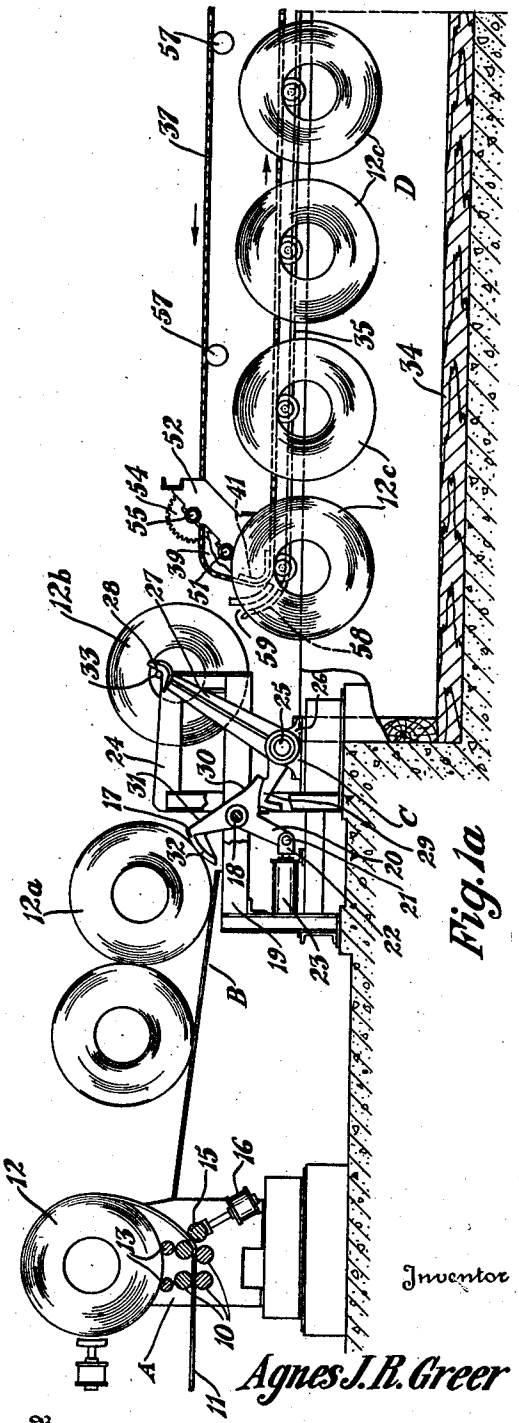

Fig. 1a

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PICKLING MACHINE

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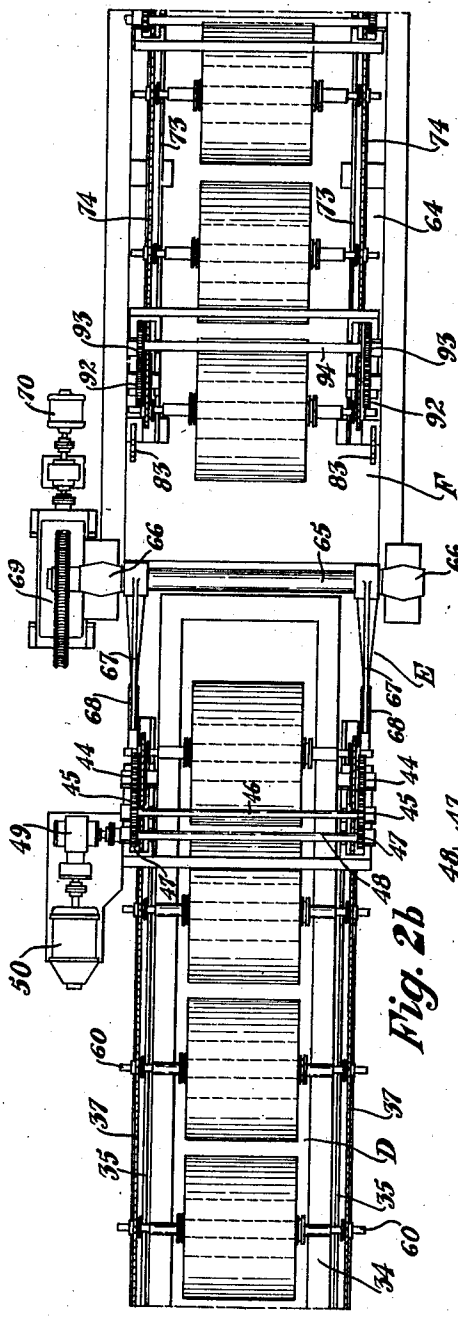

Fig. 2b

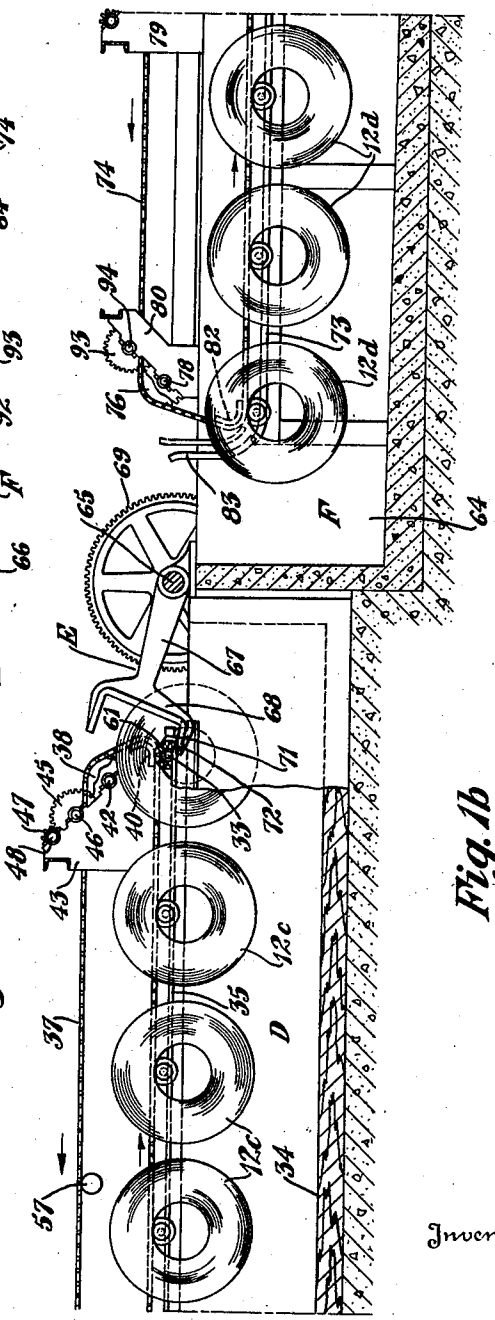

Fig. 1b

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PICKLING MACHINE

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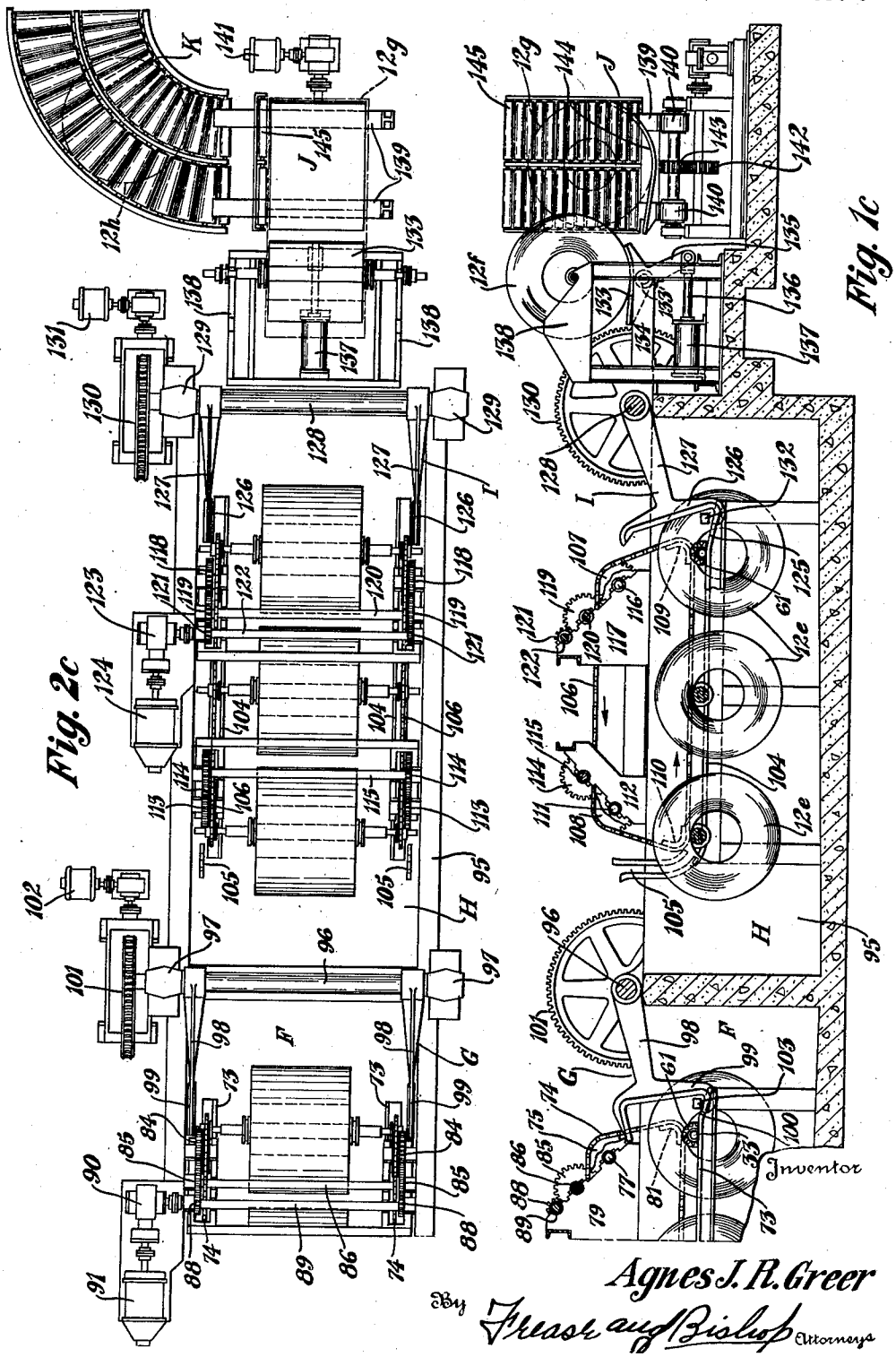

Fig. 2c

Fig. 1c

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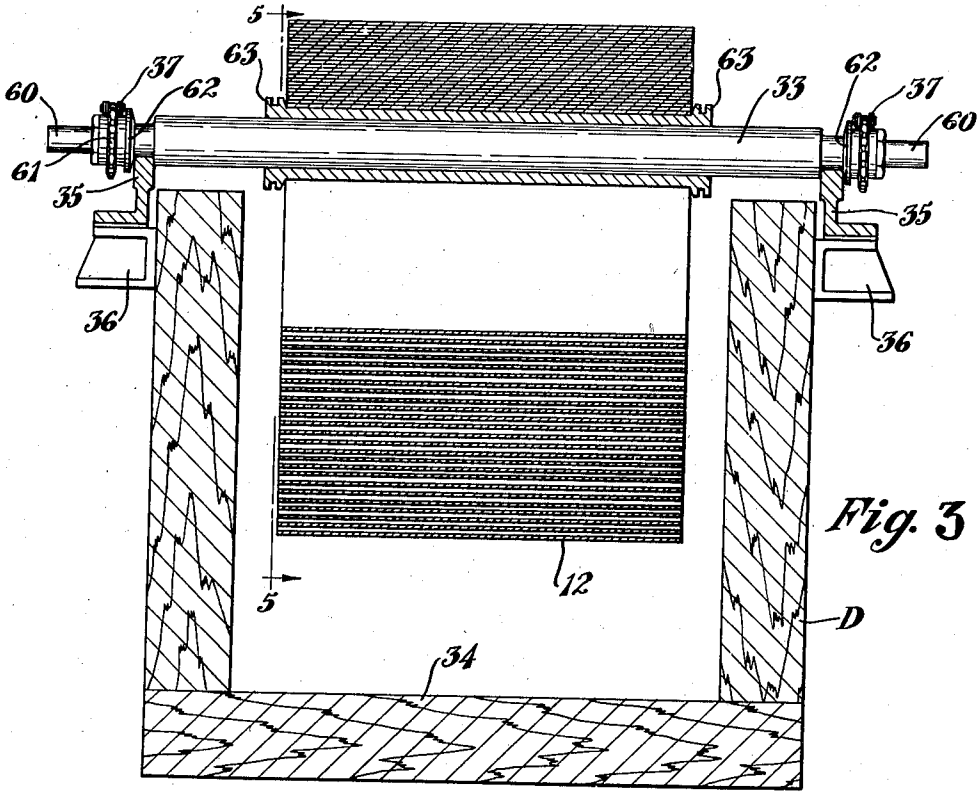

Fig. 3

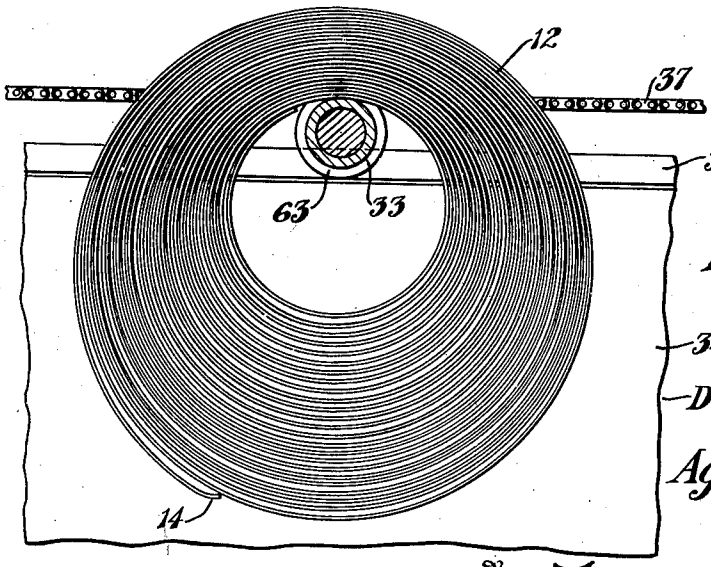

Fig. 4

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PICKLING MACHINE

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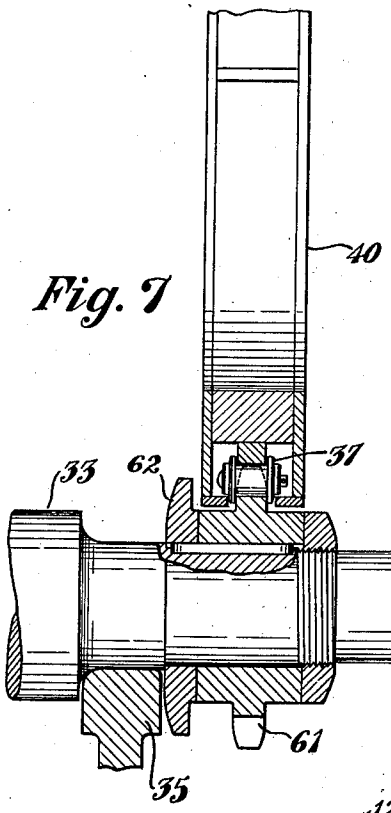

Fig. 7

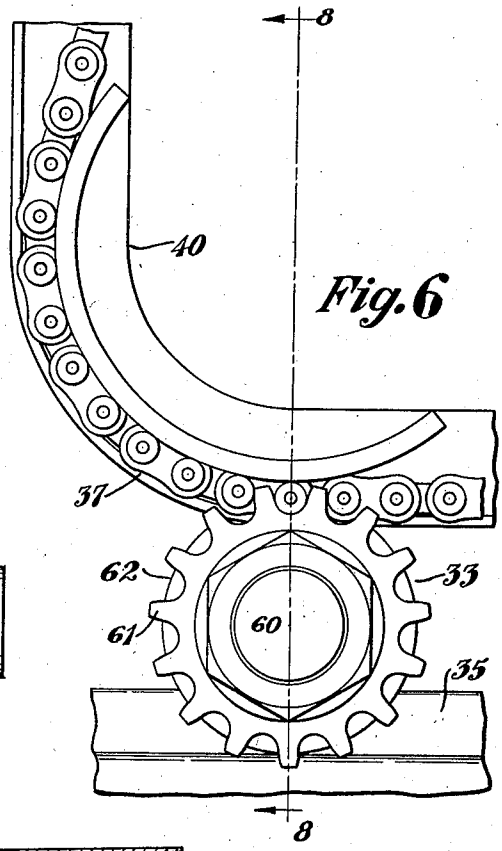

Fig. 6

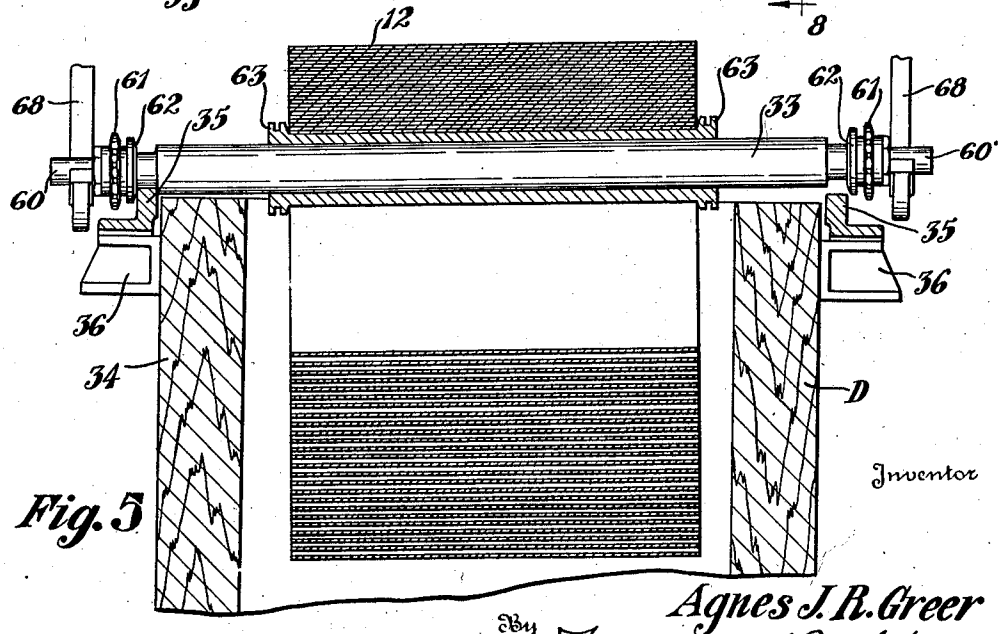

Fig. 5

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Patented Aug. 31, 1937 2,091,921

UNITED STATES PATENT OFFICE

2,091,921

PICKLING MACHINE

Agnes J. Reeves Greer, Morgantown, W. Va.

Application June 10, 1937, Serial No. 147,515

14 Claims. (Cl. 266—7)

The invention relates to pickling apparatus and more particularly to apparatus for pickling coils of metal strip and the like.

Under present practice considerable difficulty is experienced in the pickling of hot rolled strips of sheet steel which under modern methods are produced in great length and width. In some of the larger mills these hot rolled sheet strips are uncoiled after coming from the hot rolling mill and passed through a continuous pickling apparatus. Such pickling machines, however, are prohibitive, both because of the cost of installing and the great amount of space required, for use in the average smaller cold rolling plant, in which one of the chief difficulties encountered is the pickling of hot rolled coils of strip as received from the manufacturer of the hot rolled strip.

It is usually necessary for the average cold rolling plant to keep on hand a large stock of hot rolled strip of various gauges and widths so that they may quickly fill orders for any gauge or size of cold rolled strip required. Pickled hot rolled strip is not usually purchased by the cold rolling plant, not only because of the increased cost of the same but because the pickled coils will quickly rust if held in storage for any appreciable time before cold rolling.

It is therefore common practice in the smaller cold rolling plants to uncoil the hot rolled strip and pass it through a roll bending machine in order to break the hot mill scale and open the coil into which bent rods are inserted to maintain the desired spacing of the strip within the coil. The coil is then placed on end in a pickling tank in which relative agitation is produced between the coil and the acid, after which the pickled coil is washed as in usual pickling practice.

This method of pickling coils is slow and costly because of the considerable amount of manual labor required to open the coils, insert the spacing rods and remove them after the pickling operation. Difficulties are also encountered in this operation, particularly in the pickling of coils of wide strip where the upper edges may be properly separated by the bent rods while the lower edges may contact at places resulting in black or unpickled spots.

The object of the present improvement is to provide a pickling machine which overcomes the above mentioned difficulties encountered under present practice and in which coils of strip may be efficiently and economically pickled with a minimum of time and labor, as effectively as is possible with the expensive continuous type of pickling apparatus used in some of the larger mills.

An important object of the invention is to provide means for rotating a coil as it progresses through a pickling tank, the rotation of the coil producing the necessary agitation of the pickling acid.

A further object is to suspend a coil within a pickling tank by means of a mandrel or rod which is rotated as it moves across the pickling tank, consequently rotating the coil suspended thereon as it progresses through the acid.

Another object is to provide for loosely recoiling the strip so that when the coil is suspended upon the mandrel the lower wraps or layers of the coil will open up, permitting free access of the acid to all portions of the surface thereof and as the mandrel is rotated and moved forward across the pickling tank, the coil will be slowly rotated upon the mandrel, continuously opening up successive portions of the wraps or layers thereof and submerging them in the acid.

Still another object is to provide means for alternately agitating and submerging each portion of the coil in the acid and exposing the same to the atmosphere so as to produce clean pickling of all portions of the strip.

Another object is to provide means for tilting the coil endwise as it is removed from the acid tank so as to drain the acid therefrom before the coil is transferred into the first water tank.

A further object is to provide novel transfer means for transferring the coil from the pickling tank to the first water tank, from the first water tank to the second water tank, and from the second water tank.

A still further object is to provide an up-ender which receives the coil from the second water tank and up-ends the coil onto a conveyor or the like by means of which the coil may be transferred to the cold rolling mill or other destination.

A still further object is to provide a novel mandrel adapted to ride upon tracks associated with the pickling tank and water tanks and provided with sprockets adapted to be engaged by drive chains for rotating the mandrel along said tracks.

The above objects together with others which will be apparent from the drawings or which may be later referred to may be attained by constructing the improved pickling machine in the manner illustrated in the accompanying drawings, in which

Figure 1a is a longitudinal sectional view of

the loose coiler, gravity coil storage, coil loading mechanism and the entrance end portion of the pickling tank;

Fig. 1*b*, a similar view of the discharge end portion of the pickling tank, the tilting coil transfer which transfers the coils to the first water tank, and the first water tank;

Fig. 1*c*, a similar view showing the coil transfer which transfers the coils from the first water tank to the second water tank, the second water tank, the coil transfer which transfers the coils from the second water tank and the up-ender and conveyor;

Fig. 2*a*, a top plan view of the mechanism shown in Fig. 1*a*;

Fig. 2*b*, a top plan view of the mechanism shown in Fig. 1*b*;

Fig. 2*c*, a top plan view of the mechanism shown in Fig. 1*c*;

Fig. 3, an enlarged transverse sectional view through the pickling tank, showing a mandrel mounted on the tracks, driven by the chains and supporting a coil in the acid;

Fig. 4, a longitudinal sectional view taken as on the line 5—5, Fig. 3;

Fig. 5, a transverse sectional view showing the manner in which the coil is tilted to drain the acid therefrom as it is removed from the acid tank;

Fig. 6, an enlarged detail elevation showing the manner in which the sprockets upon the mandrel are engaged by the drive chains; and

Fig. 7, a section taken as on the line 8—8, Fig. 6.

Similar numerals refer to similar parts throughout the drawings.

The machine comprises generally the loose coiler A, the gravity coil storage B, the coil loading mechanism C, the acid tank D, the coil transfer from the acid tank to the first water tank E, first water tank F, coil transfer from the first water tank to the second water tank G, the second water tank H, coil discharge mechanism I, up-ender J and gravity conveyor K arranged in the sequence enumerated.

The loose coiler A may be of usual and well known construction, comprising a series of bending rolls **10** through which the strip **11** is passed and coiled loosely into a coil **12** which may be supported upon the rolls **13**. For the purpose of bending the outer end of the strip inward against the adjacent layer, as indicated at **14** in Fig. 4, a plunger **15** may be provided and operated as by the air or hydraulic cylinder **16**.

After a coil is loosely coiled upon the coiler A, it is discharged upon the gravity coil storage B which may comprise a platform inclined at a slight angle away from the loose coiler, the coil rolling down said platform to the position shown at **12***a* in Fig. 1*a* where it engages the stop **17** which is pivoted intermediate its ends as at **18** to the frame **19** and provided with the depending arm **20** pivotally connected as at **21** to the plunger **22** of an air or hydraulic cylinder **23** supported by the frame **19**.

Inclined rails **24** are mounted upon the frame **19** and located between the stop **17** and the loading mechanism C. This loading mechanism includes a rocker shaft **25** journaled as in the bearings **26** and provided with a spaced pair of upwardly disposed arms **27** having the forked upper ends **28**. A motor (not shown) or other suitable driving means, is provided for oscillating the shaft **25**.

A rearwardly projecting foot **29** is carried by the shaft **25** and normally located beneath the projecting end portion **30** of the stop **17**. It will be noted that the upper surface **31** of the stop curves upward at the forward end of the projection **30**.

When the cylinder **23** is operated the stop **17** is rocked upon its pivot, lowering the curved rear end **32** thereof out of the path of the coil and permitting the coil to roll onto the top surface **31** of the stop, the upwardly curved forward end of the projecting portion **30** thereof checking the forward movement of the coil.

A mandrel indicated generally at **33** is then inserted through the open center of the coil and as the cylinder **23** is reversed, the weight of the coil is transferred to the mandrel which is supported upon the rails **24**. The mandrel then rolls downward and forward upon these rails until it is caught in the forked ends **28** of the loading mechanism arms **27**, the coil being then in the position shown at **12***b* in Fig. 1*a*.

The pickling unit D is located directly beyond the coil loading mechanism and includes the elongated tank **34** preferably located below the floor level, as shown, and having the rails **35** carried at each side of the tank as by the bracket **36** which may be connected in any suitable manner to the side walls of the tank near the upper edges thereof.

Above each of the rails **35** is located an endless chain **37** located over sprockets **38** and **39**, positioned near the forward and rear ends of the acid tank respectively, and over the curved chain guides **40** and **41** located below the sprockets **38** and **39** respectively and positioned to guide the lower strand of each chain just above and substantially parallel to the corresponding rail.

Each sprocket **38** is mounted upon a short shaft **42** journaled in a bearing bracket **43** and gears **44** upon said shafts mesh with gears **45** upon a shaft **46** journaled through the bearing brackets **43**, the gears **45** meshing with pinions **47** upon a shaft **48** also journaled in said bearing brackets. The shaft **48** may be connected through suitable gear reduction or the like as indicated at **49**, to a motor **50** located at one side of the acid tank.

The sprockets **39** at the other end of the tank are mounted upon short shafts **51** journaled in bearing brackets **52**, a gear **53** being mounted upon each sprocket shaft and meshing with a gear **54** upon the shaft **55** which is journaled through both of the bearing brackets **52**. With this construction, both of the chains **37** may be driven in the direction of the arrows shown in Figs. 1*a* and 1*b*, the movement of the two chains being synchronized. The upper strand of each chain may be supported as upon rollers or rods **57**.

A downwardly and forwardly curved guide **58**, preferably having an upwardly flared entrance mouth **59**, is located near the entrance end of the acid tank adjacent to each of the chains **37** and adapted to receive the pintles **60** of the mandrels **33** to guide each mandrel into position beneath the lower strands of the chains so that the sprockets **61** upon the mandrels will engage said lower strands of the chains as the flanged wheel portions **62** of the mandrels are received upon the rails **35**, the chains thus driving the mandrels and causing them to roll forward upon the rails **35**, suspending at least one-half of each coil within the acid in the positions indicated at **12***c*, the rotation of each mandrel as it moves forwardly upon the rails causing the coil suspended

therefrom to be rotated through the acid, agitating the acid by the movement of the coil and alternately exposing each portion of the coil to the pickling acid and to the atmosphere.

It has been found that in the pickling of metal the best results are obtained by alternately submerging the metal in the acid bath and exposing it to the atmosphere and continually agitating the metal throughout the operation. It will be seen that this movement of the coils through the acid tank automatically produces this beneficial result.

As best shown in Figs. 3 and 4, as each loose coil hangs on the mandrel the bottom layers or wraps of the coil tend to hang open or loose, the weight of the coil tending to close the layers or wraps of the coil above the mandrel. This condition will vary somewhat depending upon the gauge of the metal strip forming the coil and the manner in which the coil is formed, whereby approximately anywhere from one-half to three-fourths of the coil may be submerged in the acid at one time.

It should of course be understood that the mandrels are formed of suitable acid-proof material so as to resist the action of the acid to which they are subjected, and if desired, annular shoulders 63 may be formed upon the mandrel to space the ends of the coil away from the side walls of the tank.

The first water tank 64, comprising a part of the first washing unit F, is located directly beyond the acid tank and preferably at a lower level than the acid tank, as best shown in Fig. 1*b*. The transfer unit E is located between the acid tank and the first washing tank and comprises a shaft 65 journaled in bearings 66 and provided with a spaced pair of coil transfer arms 67, each having a coil engaging hook 68 at its free end.

The shaft 65 may be connected through suitable gearing indicated generally at 69, to a motor 70 adapted to be operated by a limit switch located at 71 in the path of the mandrels and arranged to be automatically operated thereby as each mandrel is received in the hooks 68. As the sprockets of each mandrel become disengaged from the driving chains 37, the mandrel rolls down a slight incline 72 and is deposited in the hooks 68 of the coil transfer arms, at the same time operating the limit switch 71 to start the motor 70.

As best shown in Fig. 5, one of the hooks 68 is slightly longer than the other so that as the mandrel is raised to remove the coil from the acid tank, the mandrel and coil are tilted endwise, permitting the acid to drain from the coil back into the acid tank before the coil is transferred to the first washing tank.

The washing tank 64 is preferably of greater width than the acid tank so as to receive the entire length of the mandrel therein as best shown in Fig. 2*b*. Rails 73 are supported inside of the tank 64 and spaced from the side walls thereof, at a point considerably below the top of the tank to receive the flanged wheel portions 62 of the mandrels in such position that the entire coil is submerged within the water when the coils are received in the tank in the position shown at 12*d*.

A pair of driving chains 74, similar to the chains 37, are provided for moving the mandrels with the coils suspended thereon through the tank 64, these chains being located over the forward and rear sprockets 75 and 76 respectively, mounted upon shafts 77 and 78 journaled in the bearing brackets 79 and 80 located adjacent to the forward and rear ends respectively of the tank 64.

Curved chain guides 81 and 82 are located below the sprockets 75 and 76 respectively, for guiding the lower strand of each chain 74 into engagement with the sprockets 61 of the mandrels and downwardly and forwardly curved guides 83 are provided for receiving the pintles 60 of each mandrel to guide the mandrel into position upon the rails 73 where the sprockets 61 thereof will be engaged by the chains.

Gears 84 upon the sprocket shafts 77 mesh with gears 85 mounted upon a shaft 86 journaled in the bearing brackets 79, these gears in turn meshing with pinions 88 upon a shaft 89 also journaled in the bearing brackets 79. The shaft 89 is connected as through reduction gearing 90 or the like with a motor 91 for driving both of the chains 74 in unison.

A gear 92 may be fixed upon the shaft 78 of each of the sprockets 76, said gears meshing with the gears 93 upon a shaft 94 journaled through the bearing brackets 80 in order to assist in synchronizing the movement of the chains 74.

The second water washing unit H may include the tank 95 which is substantially similar to the tank 64 but which may be of less length, as indicated in Figs. 1*c* and 2*c*. The coil transfer mechanism G is located between the first and second washing tanks and may comprise a shaft 96 journaled in bearings 97 and provided with the spaced coil transfer arms 98 having hooks 99 at their free ends. Both of these hooks may be of the same length as it is not necessary that the coil be tilted endwise as it is lifted out of the washing tank 64, as is desirable in lifting the coil from the acid tank. At the point where each mandrel is released from the chains 74, the rails 73 are downwardly and forwardly inclined as at 100 in order to deposit the mandrel onto the hooks 99 of the coil transfer arms.

The shaft 96 of the coil transfer mechanism may be connected through suitable gearing indicated generally at 101 with a motor 102 which may be controlled by a limit switch indicated at 103 adapted to be operated by the mandrel as it is deposited in the hooks 99.

Rails 104 may be located within the second water tank 95 to receive the mandrels from the coil transfer mechanism as they are guided through the downwardly and forwardly curved guides 105. Drive chains 106 are provided above said rails for engagement with the sprockets of the mandrels to drive them along the rails in the manner above described relative to the acid tank and the first washing tank. These chains are located over sprockets 107 and 108 adjacent to the forward and rear ends respectively of the tank 95 and over the curved chain guides 109 and 110.

The sprockets 108 may be mounted upon short shafts 111 journaled in the bearing brackets 112 and gears 113 may be fixed upon said shafts and in mesh with gears 114 mounted near opposite end portions of the shaft 115 journaled in the bearing brackets 112.

The sprockets 107 may be mounted upon short shafts 116 journaled in the bearing brackets 117 and gears 118 may be fixed upon said shafts and meshed with gears 119 mounted upon the shaft 120 journaled through the bearing brackets 117. The gears 119 may mesh with pinions 121 upon the shaft 122 journaled in the bearing brackets

117, this shaft being connected as through gear reduction 123 with the motor 124.

The forward ends of the rails 104 may be inclined downwardly as at 125, at the point where the sprockets 61 of the mandrels are disengaged from the drive chains 106 in order to convey each mandrel forward and deposit the same in the hooks 126 of the coil discharge arms 127 forming part of the coil discharge mechanism I. These arms are carried by the shaft 128 journaled in bearings 129 at each side of the tank 95.

One of the hooks 126 may be longer than the other in order that the water will drain from each coil as it is lifted out of the tank 95. The shaft 128 is connected by suitable gearing indicated generally at 130 to a motor 131 which may be controlled by a limit switch 132 arranged to be automatically actuated by the depositing of a mandrel in the hooks 126 of the coil discharge arms 127.

The coil discharge mechanism includes a cradle 133 pivoted as at 133' upon a frame 134 located just beyond the discharge end of the tank 95. An arm 135 depends from the cradle and is connected to the plunger 136 of an air or hydraulic cylinder 137 by means of which the cradle may be rocked upon its pivot.

The coils, after passing through the second water tank 95, as indicated at 12*e*, are removed by the coil discharge arms 127 and deposited upon the cradle 133 which receives the weight of the coil, as shown at 12*f*, the mandrel being supported upon the notched brackets 138 from which it may be easily removed.

The up-ender indicated generally at J is adapted to receive the coil from the cradle 133, after the mandrel has been removed therefrom. This up-ender may include a pair of substantially semicircular rockers 139 mounted to oscillate upon rollers 140 and adapted to be operated as by a motor 141 through any suitable mechanism such as the pinion 142 and curved rack 143.

The platform 144 of the up-ender is adapted to receive the coil from the cradle 133, in the broken line position indicated at 12*g*. At this time the platform 144 is substantially horizontal and the platform 145 substantially vertical. The motor 141 may then be operated to rock the up-ender, bringing the roller platform 145 into substantially horizontal position so that the coil is located on end and discharged onto the gravity conveyor K in the broken line position indicated at 12*h* in Fig. 2*c*, the coil being conveyed upon the conveyor K to the cold rolling mill or other desired destination.

It is believed that from the above description the operation of the improved pickling machine will be obvious but the complete operation may be briefly described as follows:

After each coil of material is loosely coiled upon the loose coiler indicated generally at A, it is discharged onto the inclined gravity coil storage platform B and rolls down until it contacts the stop 32 as indicated at 12*a* in Fig. 1*a*. When the cylinder 23 is operated, the stop 32 is lowered out of the path of the coil, permitting the coil to roll onto the upper surface 31 of the stop, the upwardly curved forward end 30 thereof stopping the coil from further forward movement.

A mandrel 33 may then be inserted through the center opening of the coil and as the cylinder is operated to move the stop back to the full line position shown in Fig. 1*a*, the weight of the coil will be received upon the mandrel which is supported upon the inclined rails 24, permitting the mandrel with the coil thereon to roll forward on the rails until the ends of the mandrel are received in the forks 28 of the coil transfer arms 27.

When the motor or other driving means for the shaft 25 is operated, the arms 27 will be lowered, entering the ends of the mandrel into the curved guides 58 which guide the mandrel down onto the rails 35 where the sprockets 61 of the mandrel are engaged by the drive chains 37 which start the mandrel to rotate forwardly upon the rails.

With this forward rotation of the mandrel, the coil suspended therefrom will be rotated in the same direction, the lower portion of the coil being submerged in the acid in the tank 34 while the upper portion of the coil is exposed to the atmosphere. As the coil is continually rotating as it moves forward through the acid tank, each portion thereof will be alternately submerged in the acid and exposed to the atmosphere, producing a clean pickling of the strip.

As each coil reaches the discharge end of the acid tank, the mandrel thereof will be disengaged from the chains 37 and will roll down the inclined ends 72 of the rails and be deposited in the hooks 68 of the coil transfer arms 67.

At this point the mandrel will automatically trip the limit switch 71, starting the motor 70 to operate and swinging the coil transfer arms 67 in a clockwise direction as viewed in Fig. 1*b*. One hook 68 being longer than the other, the coil will be tilted as it is raised from the acid tank, draining the acid from the coil back into the tank.

The coil transfer arms will deposit the ends of the mandrel in the curved guides 83 which guide the mandrel onto the rails 73 in the first water tank 64, the sprockets upon the mandrel being engaged by the drive chain 74 rotating the mandrel forwardly along the rails 73 and carrying the coil suspended therefrom and submerged in the water.

As the coil reaches the discharge end of the first water tank, the mandrel will be released from the drive chains 74 and will roll down the inclined ends 100 of the rails 73 and be received in the hooks 99 of the coil transfer arms 98, at the same time operating the limit switch 103 and starting the motor 102 which swings the coil transfer arms 98 in a clockwise direction as viewed in Fig. 1*c*, depositing the ends of the mandrel in the curved guides 105 which guide the mandrel onto the rails 104 in the second water tank 95. The mandrel is engaged by the drive chains 106 which convey the mandrel forwardly along the rails 104 with the coil suspended therefrom and submerged in the hot water.

As the mandrel is released from the chains 106, it rolls down the inclined ends 125 of the rails 104 and is received in the hooks 126 of the coil discharge arms 127, tripping the switch 132 and starting the motor 131 which moves the arms 127 in a clockwise direction, depositing the coil upon the cradle 133 and depositing the mandrel upon the notched bracket plates 138 so that it may be removed from the center of the coil.

When the cylinder 137 is operated to withdraw the plunger 136, the cradle 133 is rocked forwardly and downwardly, discharging the coil onto the platform 144 of the up-ender. As the up-ender is rotated through a substantially 90° arc by the motor 141, the coil will be deposited on end on the conveyor K.

I claim:

1. Pickling apparatus for pickling a coil of metal including a tank containing liquid, a man-

drel upon which the coil is supported, a track associated with the tank upon which the mandrel is supported, and conveyor means for moving the mandrel along the track in a substantially horizontal direction and cooperating means on the conveyor means and mandrel for rotating the mandrel as it is moved along the track whereby the coil is rotated and moved in a substantially horizontal direction through the liquid.

2. Pickling apparatus for pickling a coil of metal, including a tank containing liquid, a mandrel upon which the coil is supported, and conveyor means for continuously moving the mandrel along the tank in a substantially horizontal direction and continuously rotating the mandrel as it is moved along the tank whereby the coil is continuously rotated and continuously moved in a substantially horizontal direction through the liquid.

3. Pickling apparatus for pickling a coil of metal, including a tank containing liquid, a mandrel upon which the coil is supported, means adjacent to the top of the tank for forwardly moving and rotating the mandrel for passing the coil partially submerged in the liquid through the tank in a substantially horizontal direction and rotating the coil as it is passed through the tank.

4. Pickling apparatus for pickling a coil of metal including a tank containing liquid, rails associated with the tank, a mandrel upon which the coil is supported, a sprocket upon the mandrel, a drive chain for engagement with the sprocket for moving the mandrel over the rails and rotating the mandrel as it is moved over the rails whereby the coil is rotated and moved through the liquid.

5. Pickling apparatus for pickling a coil of metal including a tank containing liquid, rails associated with the tank, a mandrel upon which the coil is supported, guides at the entrance end of the tank for guiding the mandrel onto the rails, a sprocket upon the mandrel, a drive chain for engagement with the sprocket for moving the mandrel over the rails and rotating the mandrel as it is moved over the rails whereby the coil is rotated and moved through the liquid.

6. Pickling apparatus for pickling a coil of metal including a tank containing liquid, rails associated with the tank, a mandrel upon which the coil is supported, a sprocket upon the mandrel, a drive chain for engagement with the sprocket for moving the mandrel over the rails and rotating the mandrel as it is moved over the rails whereby the coil is rotated and moved through the liquid, and transfer arms at the discharge end of the tank for removing the coil from the tank.

7. Pickling apparatus including a tank containing liquid, a second tank containing liquid located beyond the first named tank, a mandrel for supporting a coil of metal to be treated, conveyor means for moving the mandrel along the first tank, cooperating means on the conveyor means and mandrel for rotating the mandrel for passing the coil through the first tank in a substantially horizontal direction and rotating the coil as it is passed through the first tank, a second conveyor means for forwardly moving the mandrel along the second tank, cooperating means on the second conveyor means and mandrel for rotating the mandrel for passing the coil through the second tank in a substantially horizontal direction and rotating the coil as it is passed through the second tank, and transfer means for receiving the mandrel with the coil thereon from the first conveyor means and transferring it to the second conveyor means.

8. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, a mandrel for supporting a coil of metal to be treated, means adjacent to the top of the acid tank for forwardly moving and rotating the mandrel for passing the coil partially submerged in the acid through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for transferring the mandrel with the coil thereon to the water tank, and means within the water tank for forwardly moving and rotating the mandrel for passing the coil completely submerged in the water through the water tank and rotating the coil as it is passed through the water tank.

9. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, means for passing a coil of metal to be treated through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for removing the coil from the acid tank and tilting the coil as it is removed.

10. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, means for passing a coil of metal to be treated through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for removing the coil from the acid tank and tilting the coil as it is removed and for then transferring the coil to the water tank, and means for passing the coil through the water tank in a substantially horizontal direction and rotating the coil as it is passed through the water tank.

11. Pickling apparatus including a tank containing liquid, rails associated with the tank, a mandrel upon which a coil of metal to be treated is supported, a sprocket upon the mandrel, a drive chain for engagement with the sprocket for moving the mandrel over the rails and rotating the mandrel as it is moved over the rails whereby the coil is rotated and moved through the liquid, and transfer arms at the discharge end of the tank for removing the coil from the tank, hooks upon said transfer arms, one hook being longer than the other whereby the coil is tilted as it is removed from the tank.

12. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, a second water tank located beyond the first mentioned water tank, means for passing a coil of metal to be treated through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for removing the coil from the acid tank and tilting the coil as it is removed and for then transferring the coil to the first water tank, means for passing the coil through the first water tank in a substantially horizontal direction and rotating the coil as it is passed through the first water tank, means for transferring the coil to the second water tank, means for passing the coil through the second water tank in a substantially horizontal direction and rotating the coil as it is passed through the second water tank, and means for removing the coil from the second water tank and tilting the coil as it is removed.

13. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, a second water tank located

beyond the first mentioned water tank, means for passing a coil of metal to be treated through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for removing the coil from the acid tank and tilting the coil as it is removed and for then transferring the coil to the first water tank, means for passing the coil through the first water tank in a substantially horizontal direction and rotating the coil as it is passed through the first water tank, means for transferring the coil to the second water tank, means for passing the coil through the second water tank in a substantially horizontal direction and rotating the coil as it is passed through the second water tank, means for removing the coil from the second water tank and tilting the coil as it is removed, and means for turning the coil on end after it is removed from the second water tank.

14. Pickling apparatus including a tank containing acid, a tank containing water located beyond the acid tank, a mandrel for supporting a coil of metal to be treated, means adjacent to the top of the acid tank for forwardly moving and rotating the mandrel for passing the coil partially submerged in the acid through the acid tank in a substantially horizontal direction and rotating the coil as it is passed through the acid tank, means for transferring the mandrel with the coil thereon to the water tank, and means associated with the water tank for forwardly moving and rotating the mandrel for passing the coil through the water in the water tank and rotating the coil as it is passed through the water.

AGNES J. REEVES GREER.