No. 654,373. Patented July 24, 1900.

M. WIKSTROM.

TUBE BENDING MACHINE.

(Application filed Mar. 29, 1899.)

(No Model.) 3 Sheets—Sheet 1.

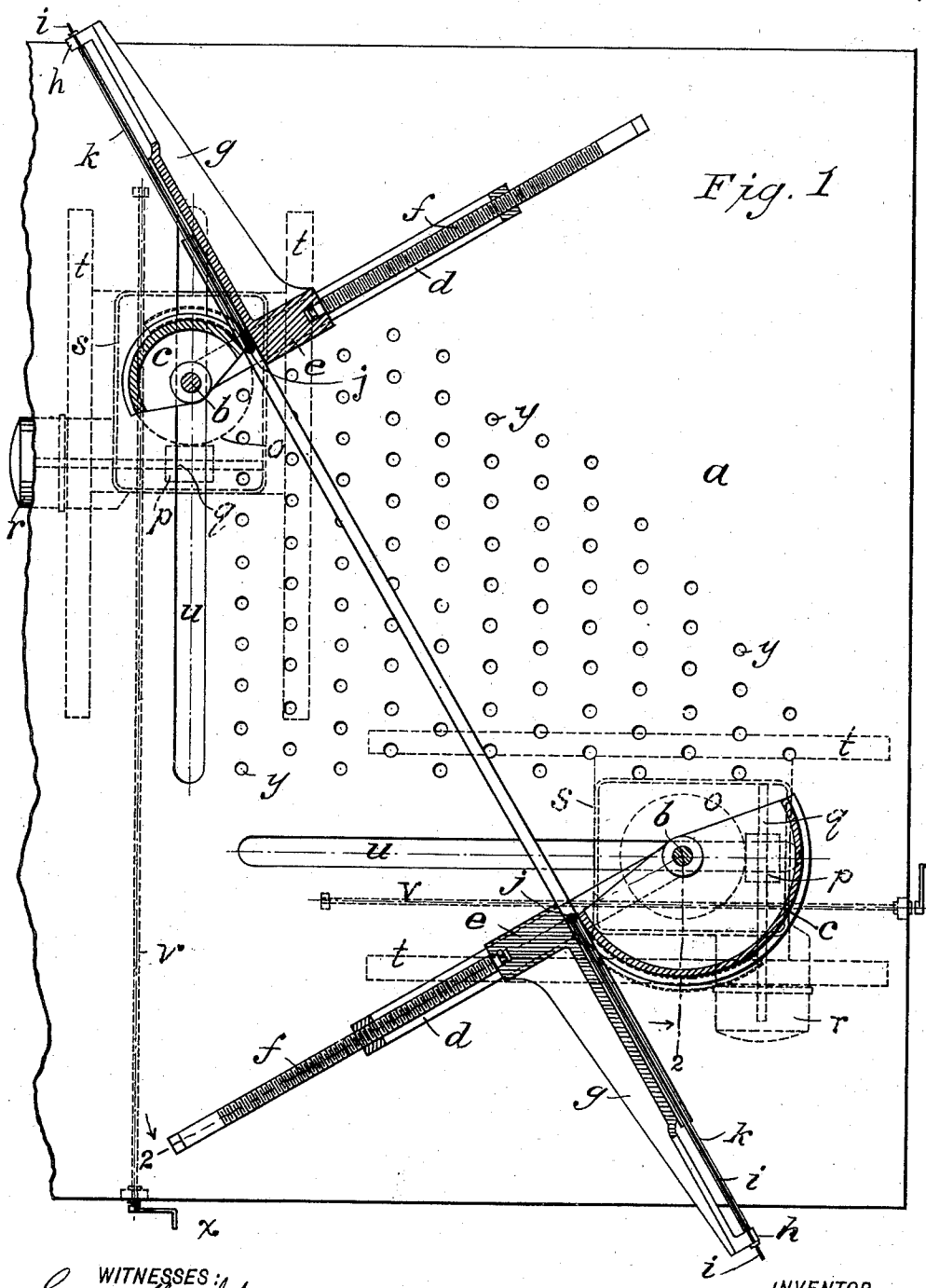


Fig. 1

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Fig. 2.

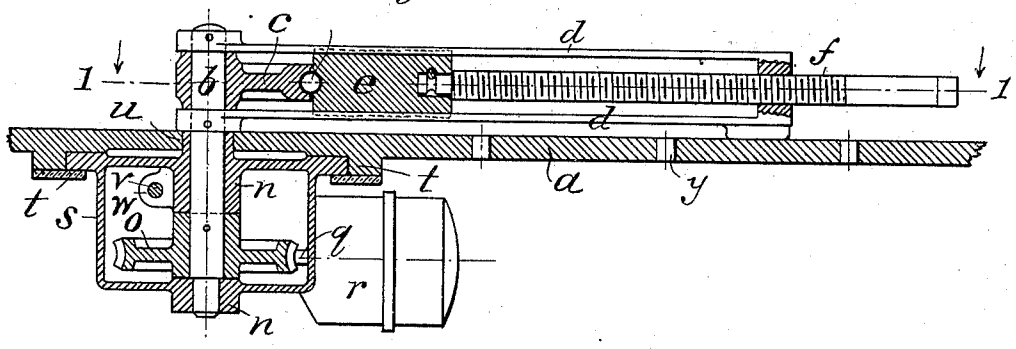


Fig. 3.

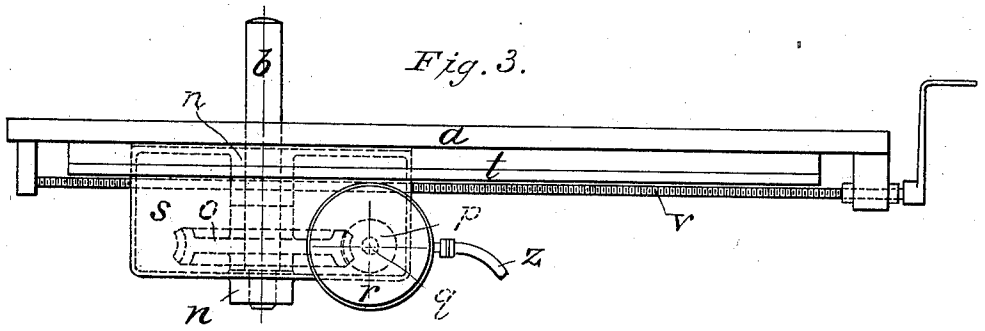


Fig. 4.

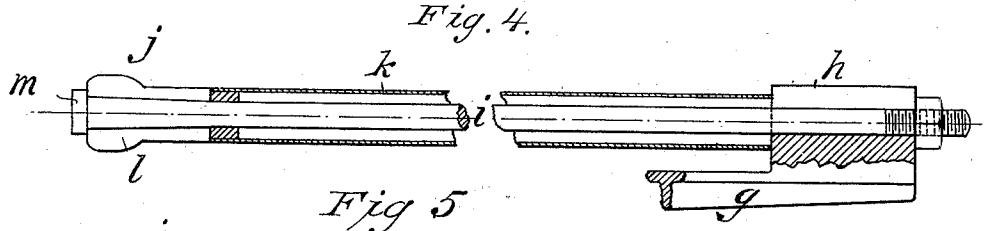
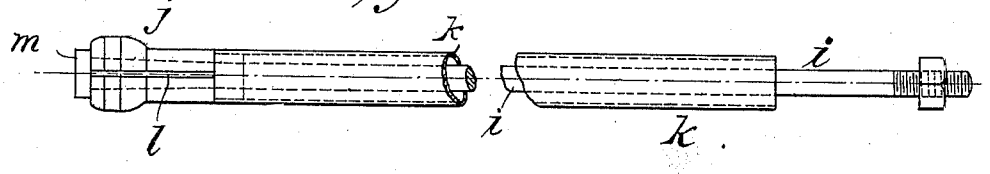


Fig 5



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(No Model.) 3 Sheets—Sheet 3.

Fig. 6.

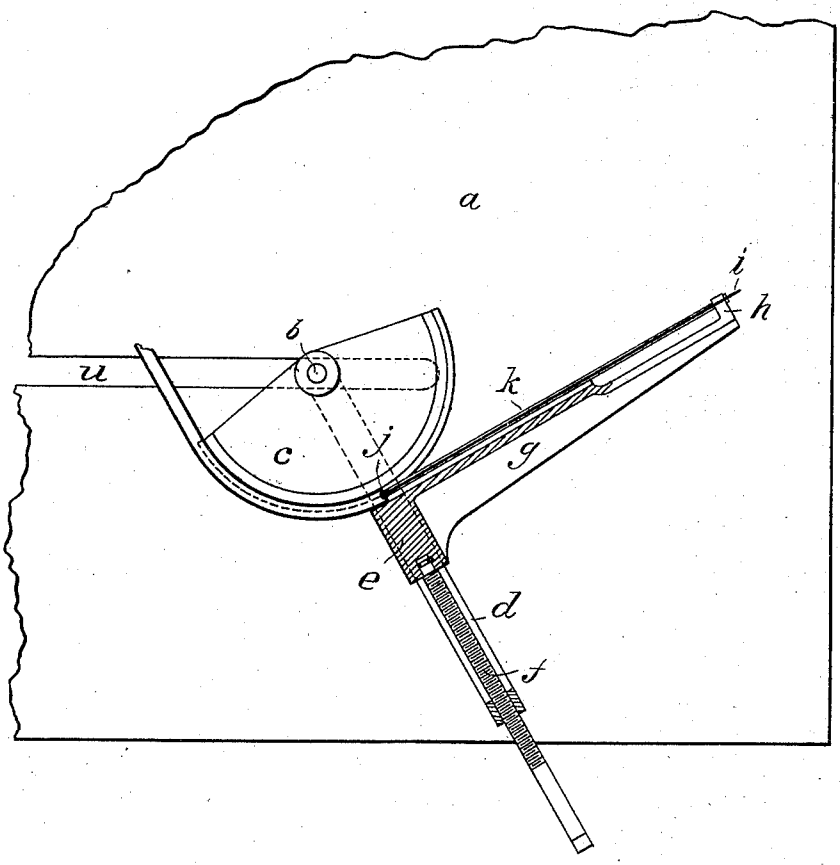
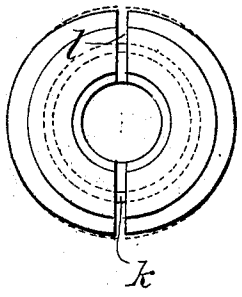


Fig. 7.



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UNITED STATES PATENT OFFICE.

MALCOLM WIKSTROM, OF SHELBY, OHIO, ASSIGNOR TO THE SHELBY STEEL TUBE COMPANY, OF PITTSBURG, PENNSYLVANIA.

TUBE-BENDING MACHINE.

SPECIFICATION forming part of Letters Patent No. 654,373, dated July 24, 1900.

Application filed March 29, 1899. Serial No. 710,957. (No model.)

To all whom it may concern:

Be it known that I, MALCOLM WIKSTROM, a citizen of the United States, residing at Shelby, in the county of Richland and State of Ohio, have invented a new and useful Tube-Bending Machine, of which the following is a specification, that will enable those skilled in the art to which my invention pertains to make and use the same.

The object of my invention is to bend tubes to any desired curvature without materially flattening or otherwise changing their cross-sectional form in their bent portions and without the use of any filling—such as rosin, lead, &c.—to be melted or otherwise subsequently extracted from the tube after it is bent.

The accompanying drawings show my invention and its application to use in the form now considered most desirable; but changes within the skill of a good mechanic and not requiring the exercise of invention might be made in the details of construction and in the relative arrangement of the parts without departing from the spirit of my invention as set forth in the claims at the end of this specification.

Figure 1 is a plan view of my improved bending-machine, with some of the parts partly in section, on the line 1 1 of Fig. 2, the parts being shown in the positions they occupy at the beginning of the bending operation. Fig. 2 is a vertical section of the same on the line 2 2 of Fig. 1. Fig. 3 is a side elevation of a portion of my machine. Fig. 4 is a vertical longitudinal section of the expansive mandrel head or bulb upon which the tubes are bent and the tubular shank and a portion of the support therefor. Fig. 5 is a plan view of the mandrel detached and showing the details of its construction. Fig. 6 is a plan view of one of my tube-bending machines with the parts in the position occupied by them at the end of the bending operation. Fig. 7 is an end view of the mandrel head or bulb.

The special features of my invention consist of a bending-block grooved at its periphery to embrace the inner side of the tube as it is bent, a swinging die also grooved on its face to embrace and slip along the outer side of the portion of tube to be bent, forcing it (the tube) out of a straight line and into the curvature of the bending-block, and a mandrel head or bulb which snugly fits the interior of the tube and which during the bending operation is drawn along the inside of the tube between the bending-block and the swinging die, moving in unison with the latter and always being substantially at the point of tangency, or the point where the bend in the tube is being formed, thus preventing any collapsing or flattening of the tube, which would occur at the point of bending if the tube were not thus interiorly supported. These special features of my invention may be assembled, supported, and operated in many ways other than those shown in the drawings, which represent what I now consider the preferred construction and will now proceed to describe in detail.

In Fig. 1 is shown a flat plate or table *a*, upon which are mounted two of my tube-bending machines adapted to bend both ends of a single piece of tubing simultaneously, if desired, and which may be adjusted on the table relatively to each other to make the bends as close together or as far apart in the length of the tube as required. As these two bending-machines are alike in principle and operation, a detailed description of one will apply to both. Considering the table as horizontal, a rigidly-supported vertical stud-pin *b* projects from its face. A bending-block or former *c* is loosely mounted on this stud-pin and is provided with a peripheral groove adapted to closely fit the exterior of the tube to be bent and is turned to the radius of the required bend of the tube, a different size of block being necessary for each different radius of bend of the tubing. This block is embraced by the two arms of a bifurcated lever or yoke *d*, which arms are mounted on the stud-pin and support and guide between them a bending-die *e*, which may be adjusted toward or away from the bending-block or former by a screw *f*, connected to the die and screwed through the closed outer end of the yoke. This die *e* is grooved to fit and close over the exterior of the tube to be bent, so that at the bending-point the tube is completely inclosed in the grooves of the bending-block and the die. An arm *g* extends from

the side of the die and is preferably formed integral with it. At the end of this arm is a lug *h*, slotted or grooved for the passage of the mandrel-bolt *i*, screw-threaded at its outer end and provided with a nut which bears against the outer face of the lug. The position of this lug is such that the axial line of the mandrel supported by it is always tangential to the curved axis of the bent portion of the tube. The mandrel consists of a head *j*, having an enlarged bulb at one end and a reduced shank at the other. One end of a tube *k* is fitted over this reduced shank, and the other end bears against the inner face of the lug *h*. The mandrel-head has a vertical split *l* of a sufficient length to make its sides yielding, and it is provided with a tapering bore, into which fits the conical portion of the bolt *i*, which has a head *m* at its extremity. This head contacts with the end of the bulb and limits the further movement of the bolt *i* in the bulb when the latter is spread to its proper width, thus insuring accuracy of the spread and also affording means for drawing the bulb by the direct pull of the bolt against the rear end of the bulb.

The mandrel-head is so fashioned that normally the bulb at its end is smaller than the inside diameter of the tube it is to operate upon, and this bulb is made to attain its maximum diameter by forcing apart the springy sides of the split head by the conical portion of the mandrel-bolt being drawn into the tapering bore of the head by means of the nut on the outer end of the bolt. This permits the easy insertion of the reduced bulb into the end of a tube to be bent, and it is then slightly expanded laterally to the required diameter or width to fill the tube across its radial diameter.

In bending a tube the tendency is to flatten or collapse it in cross-section in a radial direction from the center or axis of the curve about which it is being bent, its radial diameter decreasing, while its vertical diameter increases as the cross-sectional form changes from circular to oval. It is therefore only necessary to support it interiorly at its radial sides and to confine it exteriorly at its top and bottom to overcome this tendency. The expanded bulb therefore need only fill the inside of the tube laterally at the bending-point to prevent the sinking in of its lateral sides, while the exterior of the tube being embraced by the grooves in the bending block and die is prevented from spreading at its top and bottom side and assuming oval or flattened form. As the mandrel-head, with its bulb, is split vertically and springs or expands laterally, there would, if it were truly round, be no diminution of its vertical diameter when the conical portion of the mandrel-rod was pushed out of the tapering bore to allow of the lateral reduction of the width of the bulb to facilitate its entrance into the tube. As there is no work to be performed by the top and bottom sides of the bulb at or near the split openings *l* I prefer to cut away these portions slightly, as shown by full lines in Fig. 7, where the continuation of the true circle of the sides is shown by dotted lines.

When a tube is to be bent, a bending-block of the desired curvature and depth of peripheral grooves is mounted upon the stud-pin *b*, and the die, correspondingly grooved, is moved toward the bending-block and held in position by the screw *f* in the yoke-lever, the outer surface of the tube being embraced on all sides at the bending-point by these grooves. The collapsed mandrel-bulb is then inserted in the end of the tube and located at a point between the die and the bending-block where the bending operation is to begin. The bulb is then expanded by screwing the adjusting-nut and drawing the conical portion of the mandrel-rod into the tapering bore of the head, thus filling the inside of the tube laterally. The tube must be held against movement by some suitable means, preferably by dogs or clamps bolted to the table by means of bolts passing through the most convenient of the holes *y* in the table.

With the parts in the positions just described and as shown in Fig. 1, the bending operation may be effected by swinging the lever *d* around the axis of the pin *b*, the bending-die *e*, with its arm *g*, and the mandrel-bulb moving in unison with the lever, the die and its arm forcing the tube into the groove of the bending-block, the die on the outside of the tube and the bulb on its inside moving around the bending-block and along the length of the bending portion of the tube, but always at the tangent-point or the point where the bending is in process. It will be observed that as the mandrel-bulb moves along with the bending-point it leaves behind it the bent portion of the tube and is constantly advancing into the still unbent tangential portion of the tube yet to be operated upon and that in consequence thereof the mandrel as a whole is constantly pulling away from the bent portion of the tube, and so long as it remains in any portion of the tube that portion is unbent, straight, and tangential to the curved portion.

By means of my improved mechanism the tube may be bent and preserved in its true cylindrical form to its very end, so that it is unnecessary to make allowance, as in all previous methods of tube-bending of which I have knowledge, for surplus length to be trimmed off after the bending operation and wasted.

My bending-block is preferably made semicircular and is loosely mounted on the pin *b* in order that it may be swung around as much as one hundred and eighty degrees, if needs be, to release a bent tube from its peripheral grooves.

So far as I have described it my bending mechanism might be operated by hand, especially upon tubes small enough not to require more manual power than could conveniently

be applied to swing the forked lever *d*, with the die and mandrel-bulb carried by it, around the axis of the stud-pin *b*. In such a case the forked lever *d* should be free to swing on the pin or the pin should be rotatively mounted in its support in the table *a*. I prefer, however, to operate the bending mechanism by power, and to this end I mount the pin or shaft *b* in suitable bearings *n n*, so that it may be rotated by a worm-wheel *o*, keyed to the shaft and engaged by a worm *p* on the shaft *q* of a compressed-air, steam, or other suitable motor *r*, to which the power agent is conducted through a flexible connection *z* and controlled by any suitable valves or switches. In this construction the arms of the forked lever *d* are also keyed or pinned to the shaft *b*, as shown in Fig. 3, so as to rotate with it when the motor-power is applied.

In Fig. 1 I have shown the arrangement of the table *a* and two bending mechanisms by means of which I am enabled to make two bends in a single piece of tubing simultaneously. These bending mechanisms are so arranged that they may be adjusted toward or away from each other to make the two bends at any desired distance from each other in the length of a piece of tubing. To carry out this idea, I mount the pins or shafts *b* in bearings in movable frames or casings *s*, supported in guideways *t* beneath the table, which is slotted, as at *u u*, for the passage of the pin which extends above the table. The slots and the guideways of the respective bending mechanisms extend away from each other, preferably at a right angle, as shown in Fig. 1, though they might lie at any other angle or even parallel, if desired; or in some cases it would be advantageous to mount two bending mechanisms in a single slot and guideways of sufficient length to allow any desired distance between the bending mechanisms. With a single slot and its guides the two bending mechanisms may be brought into as close proximity as desired. I consider this, however, a mere matter of detail to be determined by the requirements of each case, two divergent slots requiring a wider but shorter table than a single slot, with which the table would be long and narrow. The casings *s* support and carry with them the pins and power-motors, and they are moved longitudinally to and held in any desired positions by means of feed-screws *v*, which are mounted in suitable bearings beneath the table and work in screw-threaded lugs *w* in the casings. These screws project beyond the edges of the table and are provided with hand-cranks *x*, by means of which they are turned.

Having thus described my invention, what I claim as new and useful, and desire to secure by Letters Patent, is—

1. In a tube-bending machine the combination of a bending-block grooved on its periphery, a radial arm or lever adapted to swing about the axis of the bending-block, a bending-die grooved on its face and carried by the radial arm, a rigid arm extending from the die, a mandrel supported by said arm with its bulb located between the die and the bending-block and the means for adjusting the die and the mandrel-supporting arm to and holding it at any position along the length of the radial arm.

2. In a tube-bending machine the combination of a bending-block grooved on its periphery and loosely mounted upon a pin or shaft, a radial arm or lever also mounted on the shaft, a bending-die grooved on its face and mounted on the radial arm, a rigid arm extending from the die and supporting a mandrel from its extremity with a screw passing through the end of the radial arm and connected to the bending-die and the mandrel-supporting arm to adjust and hold them in position on the radial arm.

3. In a tube-bending machine the combination of a bending-block grooved on its periphery, a bending-die correspondingly grooved on its face and adapted to swing around the periphery of the bending-block, a collapsible mandrel-bulb supported from and moving in unison with the bending-die with means for expanding the bulb laterally or toward the faces of the bending-block and the die.

4. In a tube-bending machine the combination of a bending-block grooved on its periphery, a bending-die correspondingly grooved on its face and adapted to swing around the bending-block, an arm extending from the die and having a recessed lug at its extremity, a mandrel supported by said lug in a line tangential to the bending-block and composed of a split head or bulb having a tapering bore, a rod or bolt having a conical portion adapted to fit said bore and an adjusting-nut to bear against the outside of the recessed lug with a tubular shank fitting over the end of the mandrel-head and bearing against the inner face of the recessed lug.

5. In an expanding-mandrel, the split bulb-head with springy sides and tapering bore, the tubular shank fitting upon the solid end of the head the mandrel rod or bolt having a head and a conical portion and provided at its other extremity with an adjusting-nut to push against the tubular shank and draw the conical portion of the rod into the bore of the mandrel-head and expand it after insertion into a tube.

6. In a tube-bending machine the combination of a semicircular bending-block grooved on its periphery, and loosely mounted on a shaft, a radial arm or lever keyed to the shaft and carrying a bending-die grooved on its face and a mandrel-bulb lying between the die and bending-block and moving in unison with the die, with a power mechanism connected to the shaft and adapted to rotate it and the radial arm when and as desired.

7. In a tube-bending machine the combination of a plate or table slotted in its surface, guideways beneath the table paralleled to the

slot, sliding blocks or casings mounted in said guideways, pins or shafts supported in suitable bearings in said casings and extending through the slot with tube-bending mechanisms substantially as described mounted on the upper ends of the pins above the surface of the table.

8. In a tube-bending machine the combination of a plate or table having a plurality of slots in its surface, a plurality of tube-bending mechanisms substantially as described operated above the table on pins or shafts which extend through the slots and are mounted in bearings in sliding casings supported in guideways below the table parallel to the slots, the respective guideways and slots lying at any desired angle to each other.

9. In a tube-bending machine the combination of a slotted plate or table, a movable casing supported in guideways below the slot, a vertical shaft mounted in bearings in the casing and projecting therefrom through the slot in the table, a worm-wheel keyed to the shaft and a worm engaging the wheel, a power-motor carried by the casing and driving said worm, with a tube-bending mechanism substantially as described mounted upon the upper end of the shaft above the table, with a feed-screw below the table engaging the casing to move it along its guideways and hold it in position, all arranged and operating substantially as described.

In testimony whereof I affix my signature, in the presence of two witnesses, at Shelby, Ohio, March 10, 1899.

MALCOLM WIKSTROM.

Witnesses:
MARSHALL F. CAPRON,
EUGENE MCL. LONG.