

Illustrated catalogue and general description of improved machine tools for working metal

Sellers, William, & Co

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ILLUSTRATED CATALOGUE

AND

GENERAL DESCRIPTION

OF

IMPROVED MACHINE TOOLS

FOR WORKING METAL.

DESIGNED AND CONSTRUCTED BY

WILLIAM SELLERS & CO., INCORPORATED.

PHILADELPHIA, PA., U.S.A.,

MANUFACTURERS OF

Patent Quick-return Planing-Machines, Lathes, Drill-Presses, Drill- and Tool-Grinding Machines, Steam-Hammers, Steam- and Hydraulic-Riveters, Punches, and Shears, Bolt-Cutters, Wheel-Presses, Hoisting-Machines, Swing-Cranes, High-Speed Power Travelling-Cranes, Boring- and Turning-Mills, Cylinder-Borers, Car-Wheel Borers, Testing-Machines, Injectors for all kinds of Service, Shafting, Pulleys, Hangers, Couplings, Turn-Tables, etc., etc., etc.

PHILADELPHIA:

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INTRODUCTION.

OUR well-known "Treatise on Machine Tools," which passed through several editions, is now out of print. After reviewing the subject for the purpose of preparing a new edition of this treatise, we find that so many changes and improvements have crept into the forms of our standard tools, and so many new and important special tools have been devised and constructed, that we have decided to begin *de novo*,—to abandon the obsolete wood-cuts and substitute improved half-tone engravings, made by a photographic process which possesses the double merit of attractive appearance and faithful delineation of each machine, wood-cuts being used merely for detail drawings where necessary.

The following remarks in the introduction to our former treatise are equally *apropos* now: "The rapid advancement of engineering rendered possible by the invention of machines to do the work required, demands constant addition to the list of such machines. New wants are every day arising, requiring fresh exertion of designing skill in the production of tools to meet these wants, so that any book descriptive of this kind of machinery can only embody what was in operation at the time it went to press." Since these words were written, new and constantly enlarging fields of applied science have been opened to the machine-tool manufacturer, introducing many novel appliances, some of which are still in the experimental stage, while others have taken a recognized position: we refer particularly to the various applications of electricity to motive power.

Electric travelling cranes of great capacity and high speed are no longer rarities, while many isolated tools are being operated by independent motors. Great progress has likewise been made in the economy of steam- and water-power in their

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various practical uses; the capacity for work of all classes of machine tools has been largely increased, while the cost of construction and operation has been in many instances notably diminished.

The value of attention to detail in shop-work is becoming more appreciated, and special tools for accomplishing accurately and quickly minor operations formerly done in a perfunctory manner, without method or skill, are among the many advantages resulting from such careful study of "little things."

As an illustration, we may refer to the "Universal tool-grinding machine," by means of which all cutting tools for lathes, planers, etc., are accurately ground to a shape best suited to the special work they are to perform; the advantages accruing therefrom, as compared with the want of system heretofore in vogue in most establishments, are evident.

The constantly increasing use of steel and wrought-iron in place of cast-iron, and the growing magnitude of all kinds of engineering work, has necessitated the remodelling, enlarging, and strengthening of all forms of machine tools, while the active competition prevailing, combined with the cost of skilled labor, has stimulated the manufacturer of modern machine tools to continued improvements.

DESIGN OF CATALOGUE.

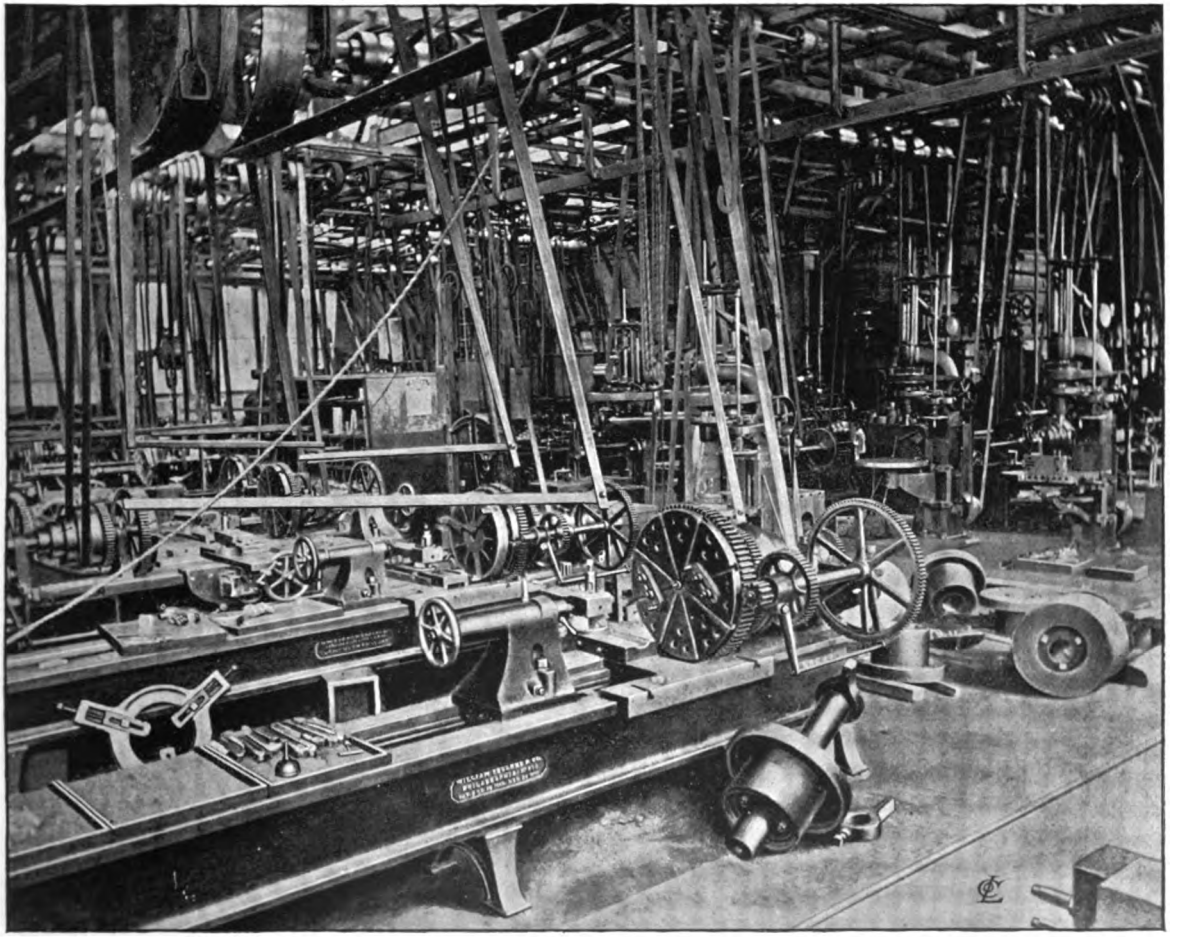
A twofold design is apparent in the arrangement of this catalogue. On the right hand pages, as a rule, will be found photo-engravings of "standard" or "special" tools, with brief specifications giving sizes, etc.

On the left hand pages will be found general descriptions of the tools illustrated in each class, with special mention of new designs.

The object sought by this arrangement is to present to our customers a book which shall combine the advantages of an illustrated catalogue of tools, with brief specifications for quick reference, together with a general discourse for more leisurely examination. A further object determining the size and shape of the book has been

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PLATE NO. 1.



VIEW IN MACHINE SHOP.

Showing a portion of the turning and drilling departments.

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to assist the convenience of the reader; the aim being to show all the tools, whether upright or horizontal, in the same position upon the page, and to avoid unwieldy size, while at the same time presenting illustrations of sufficient dimensions to exhibit details clearly.

When this house was founded in the year 1848, the manufacturing of machine tools in America was almost unknown, and the tools in use at that time were few in number and crude in design. As we were then pioneers in creating this special business, so we have continued not only to meet the ever-increasing demands of engineering establishments, but we have always endeavored to anticipate their requirements; tangible evidences of this may be recognized in many of the illustrations of new and special machine tools now first shown in this book.

AWARDS.

It is, perhaps, with a pardonable degree of pride that we allude briefly to the long list of awards granted to our various exhibits, both at home and abroad, at the national and international expositions; these include the gold medal at Paris in 1867, five medals at Vienna in 1873, together with the "Grand Diploma of Honor," awarded exclusively by the "Council of Presidents" upon the proposition of the International Jury of Awards.

The recommendation for this exceptional award reads as follows:

"SELLERS. For pre-eminent achievements in the invention and construction of machine tools, many of which have been adopted as patterns by the constructors of tools in all countries."

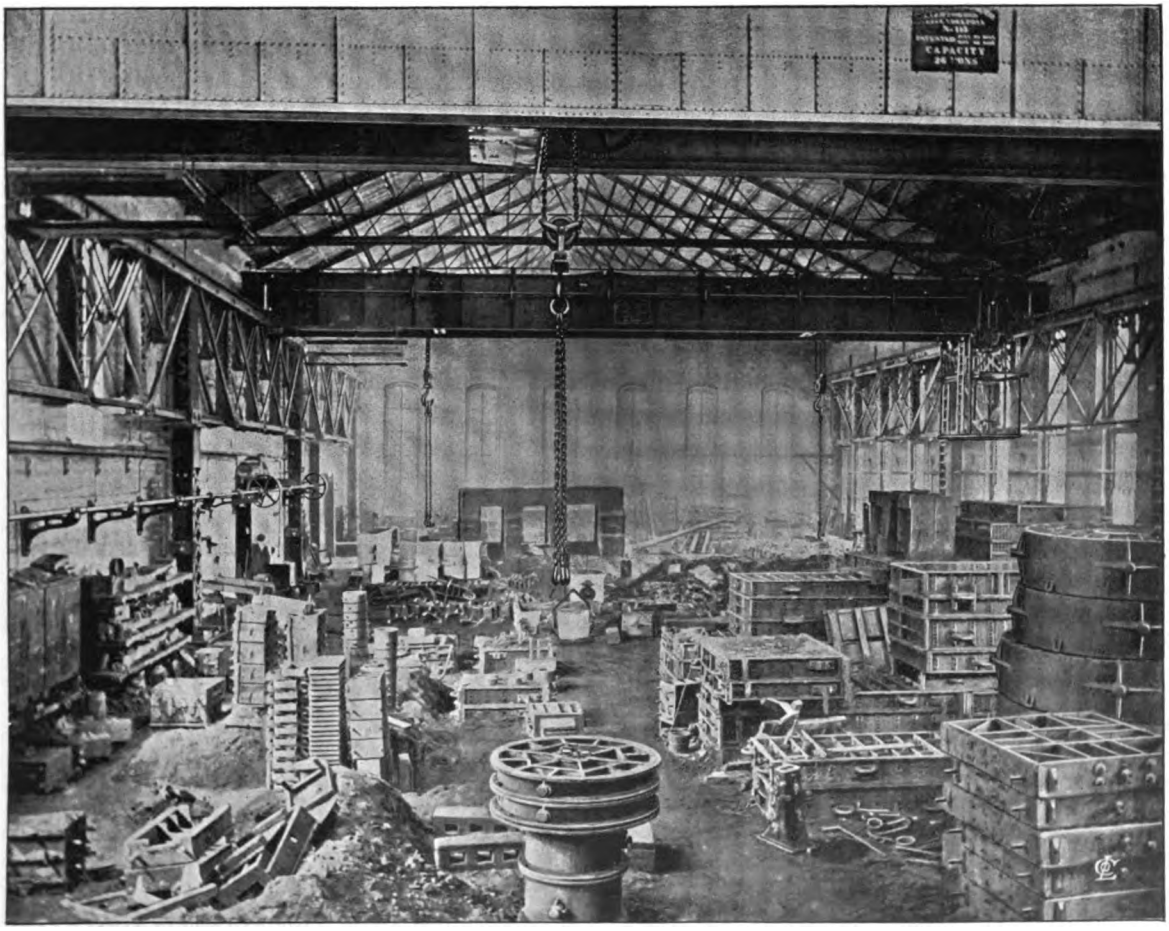
The diploma itself reads:

"World's Fair in Vienna, 1873. The international jury have decreed to the firm of William Sellers & Co., of Philadelphia, Pa., U.S.A., for machine tools, the highest distinction, THE GRAND DIPLOMA OF HONOR."

This award was furthermore "designed to bear the character of peculiar dis-

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PLATE NO. 2.



VIEW IN MAIN FOUNDRY. (LOOKING WEST.)

Showing one electric travelling crane, with five motors, capacity 26 tons; and one power travelling crane, 30 tons capacity. Span of bridges, 73 feet 10 inches, from centre to centre of wheels. Length of runway, 200 feet 10 inches.

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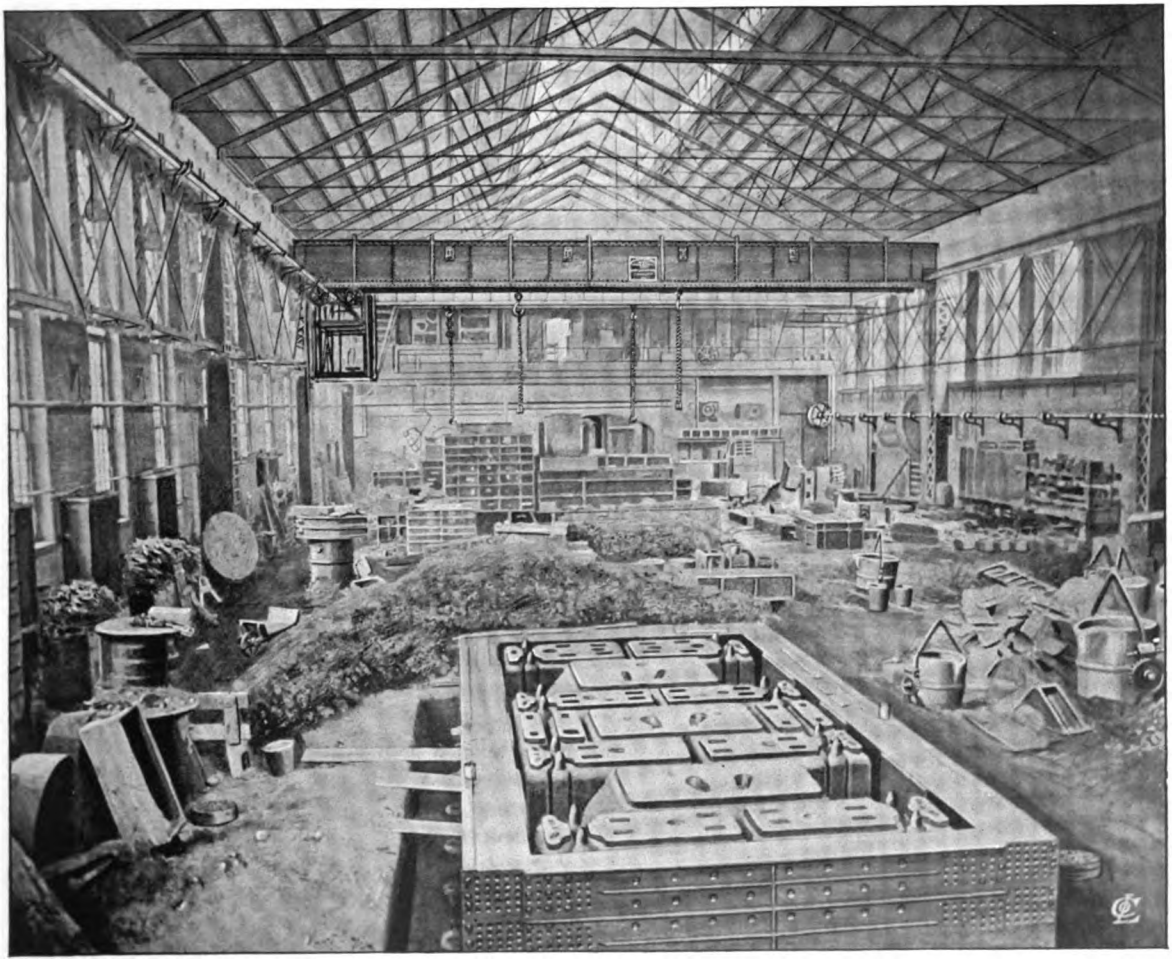
tinction for eminent merits in the domain of science in its application to the education of the people and the advancement of the moral and material welfare of mankind."

Next in chronological order we have three medals and awards for exhibits classified under three distinct groups at the Centennial Exposition; these were followed by "THE GRAND PRIZE" at Paris in 1889. But the testimonial which we esteem more highly than all of these is the comprehensive report of the jury of awards of Group XXI. of the Centennial Exposition; the value of this award, in our judgment, lies in the wording of the report, having regard to the international reputation both of the foreign and American members of the jury. This jury was so arranged as to assign both foreign and native judges to each group or subdivision. These Group Judges, in organizing, elected their own chairman. They then examined the most important exhibits in company, delegating one of their number to write the recommendation for award in each case, after which these recommendations were considered at the meetings of the group, and, if approved, were countersigned by all the members. This examination by the group in a body was designed to insure uniformity in methods pursued and, as far as possible, to grade the expressions of commendation of awards. The judges appointed for the examination of Group XXI., on Machine Tools, were:

Dr. JOHN ANDERSON, LL.D., C.E., etc.	*Woolwich Arsenal, Great Britain.*
Prof. C. A. ANGSTROM	*Sweden.*
Mr. AUGUST GOBERT, Jr. . . .	*Belgium.*
Mr. F. REIFER	*Austria.*
Commander F. PERRIER . . .	*France.*
Mr. GEORGE H. BLELOCH . . .	*Springfield, Mass.*
Mr. W. F. DURFEE	*New York.*
Mr. IRVING M. SCOTT	*Union Iron-Works, San Francisco, Cal.*
Prof. J. A. ANDERSON	*Manhattan, Kansas.*

Dr. John Anderson was chosen the Chairman.

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VIEW IN MAIN FOUNDRY. (LOOKING EAST.)

Showing in foreground a mould prepared for casting a very large bed-plate. Also 30-ton power travelling crane and 26-ton electric travelling crane in the distance.

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The judges of Group XXI., in thus complimenting Dr. Anderson by placing him at its head, recognized the practical value of his experience at all the other great international exhibitions. Few men had become so thoroughly identified with any one great industrial interest as he by his researches as a scientific expert in this particular division of mechanical engineering. He is the author of the wording of the award to us.

Dr. Anderson was an active participant in the Paris and Vienna Exhibitions, and in other great World's Fairs, so that, considering the fulness of his knowledge on this subject, his wording of the report carries special significance, and will thus be seen to be of greater interest and value to us than all the awards made upon the older plan of graded medals.

The opening paragraphs of this report are as follows:

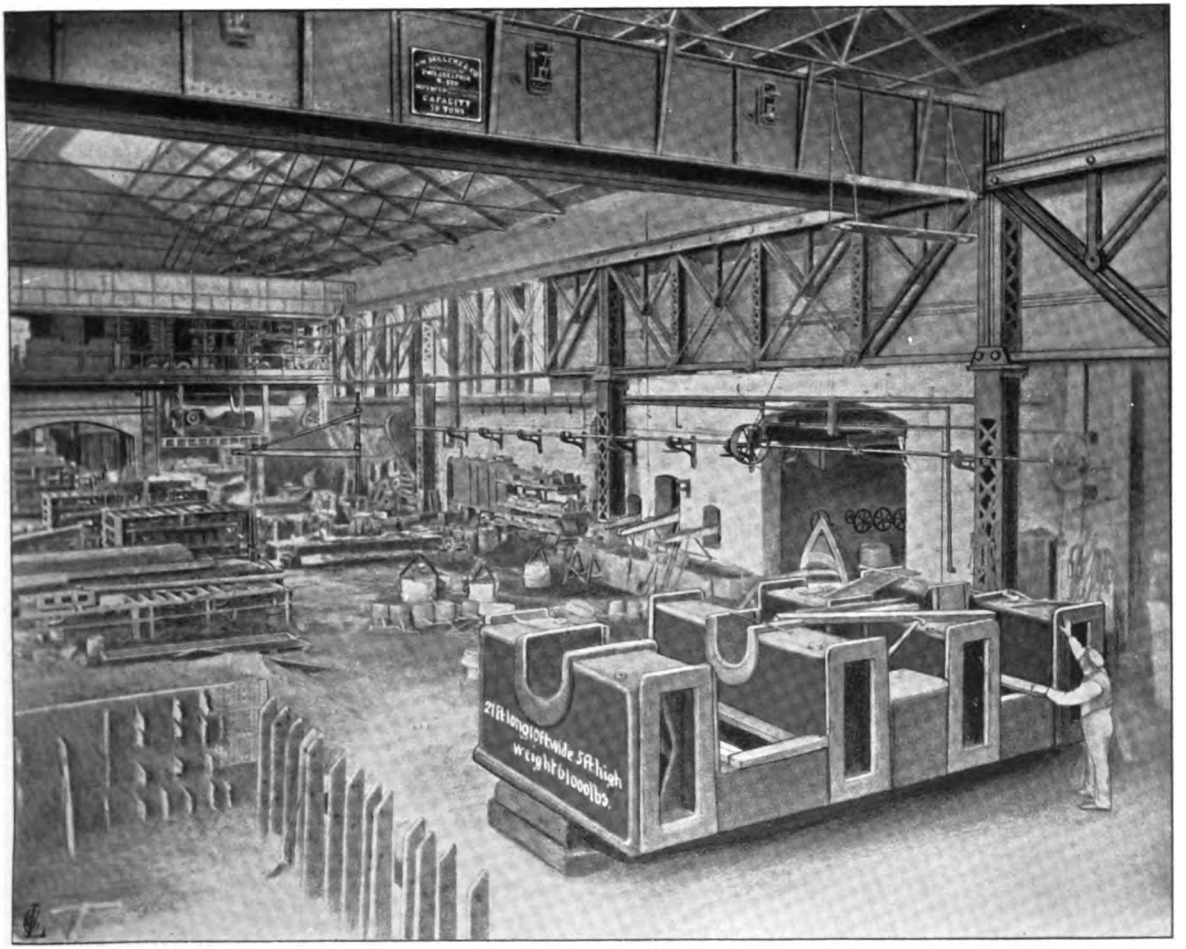
"Name and address of exhibitors: William Sellers & Co., Philadelphia, Pa.

"The undersigned, having examined the product herein described, respectfully recommends the same to the United States Centennial Commission for awards, for the following reasons, viz.:

"For a remarkable collection of machine tools for working metal. This exhibit, when considered in regard to its extent and value, its extraordinary variety and general excellence, and also for the large amount of originality that is shown in the numerous new devices that are introduced, is probably without a parallel in the past history of international exhibitions, and, taken as a whole, it is worthy of the highest honor that can be conferred.

"Every single machine tool or piece of apparatus that is displayed in this vast offering would for itself command the strongest recommendation for an award, even if it stood alone as a unit; but here every unit is surrounded by thirty-three distinct machines, each one being of the highest standard in its particular class. The whole of these machines are characterized by extreme refinement in every detail; by the superior quality of the material employed in their construction; by first-class workmanship, both in regard to nice fitting and precision, and for the mathematical

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VIEW IN MAIN FOUNDRY.

Showing bed-plate for air compressor and pit in which the casting was made. The 30-ton power crane is shown overhead, and the 26-ton electric crane in the distance. The pouring runners of three cupolas may be seen near the main entrance.

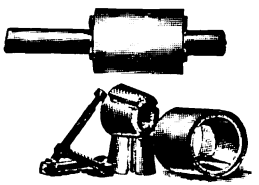
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accuracy of all the parts; by the beautiful outlines that are imparted to each structure; by the correct proportions that have been worked out in the determining of strength and form; and the disposal of material to take full share of duty. As it is impossible to realize the full measure of such refined mechanical, scientific, and artistic merit, by the foregoing remarks, it is deemed necessary to enumerate briefly some of the more prominent points in the several machines, both in justice to the exhibitors and to the judges."

Commendations here follow of twenty-two specified exhibits, representing as many different types of machine tools. Extracts from these will be found in small type, in this book, under their respective titles, and preceding the descriptive matter appertaining to the different classes of machine tools.

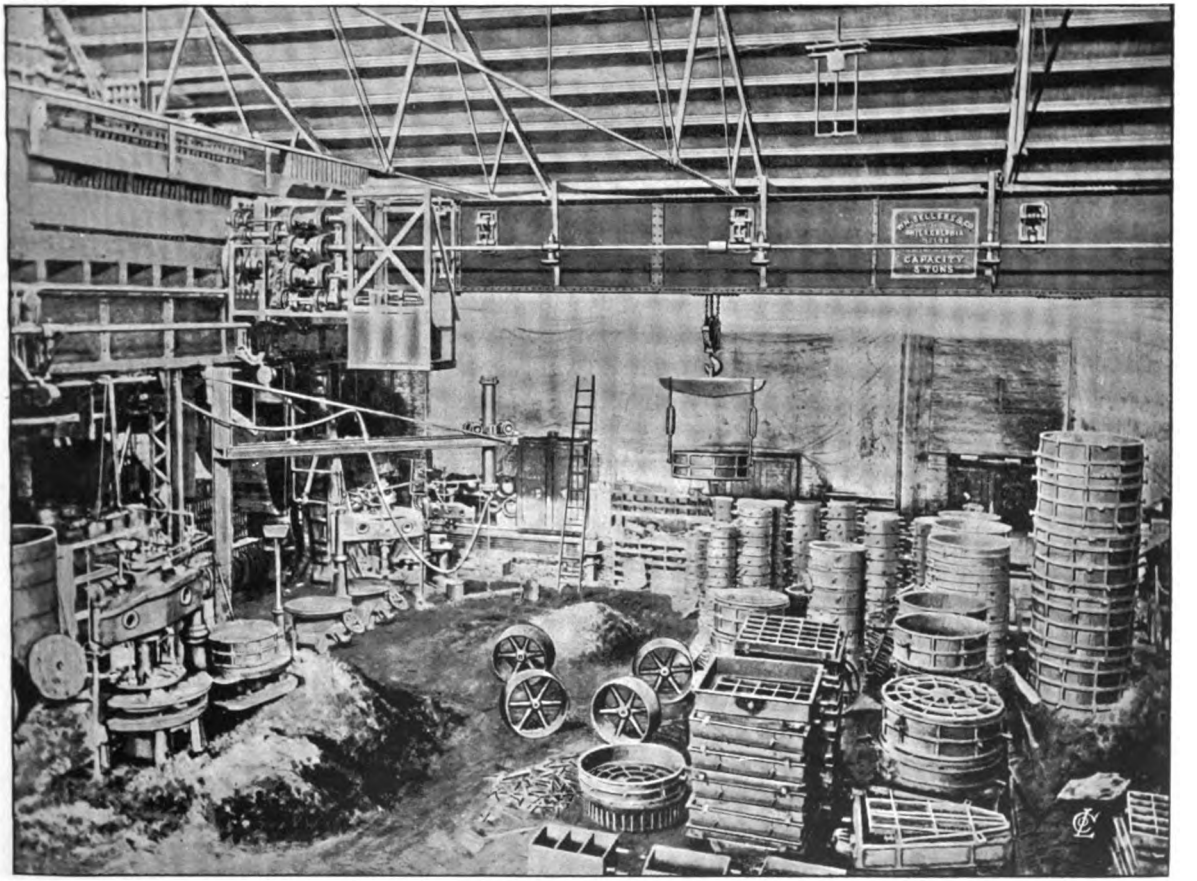
In concluding this introduction, we would say that, while we did not make an exhibit of machine tools at Chicago, we gladly welcomed the numbers of strangers who honored our establishment with a visit during the Fair, and those who receive this book at their homes may accept it as a souvenir of their recent visit to our works.

The manufacture of shafting, mill-gearing, etc., and of improved injectors for locomotives and stationary boilers, form important branches of our business, and illustrated hand-books relating to these are furnished to our customers on application.



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PLATE NO. 5.



VIEW IN PULLEY FOUNDRY.

Showing hydraulic pulley moulding machines and 5-ton power travelling crane. Span of bridge, 59 feet 6 inches, from centre to centre of bridge wheels. Runway 76 feet 10½ inches long.

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Bolt and Nut-Screwing Machines.

"RECOMMENDED for general excellence of design, and for many distinct points of originality, all pointing to increased efficiency as regards accuracy, rate of production, durability, and convenience; likewise for new devices to secure more perfect flooding of the work with oil during the cutting, and for the economizing of the oil so treated. This is probably the most perfect machine which has been constructed for this purpose, and deserves the highest commendation."—*See Introduction*, pages 6–12.



HE essential features of these machines were first put into practice by us, and for many years we were the only makers of Bolt-Cutting Machines that operated with self-opening dies, and yet cut the bolt as with a solid die. The advantages claimed are,—

1. The dies revolve and the bolt is stationary, which enables the workman to put in a fresh bolt without stopping the machine, and on long bolts is much more convenient than to revolve the bolt.

2. The motion of the dies is always in one direction, and the bolt is cut at one operation. The dies open while they are revolving, consequently they leave no mark on the thread.

3. The dies never run backward. The cutting edge will last much longer than when the motion of the die is reversed.

4. The dies are adjustable, so as to compensate for wear.

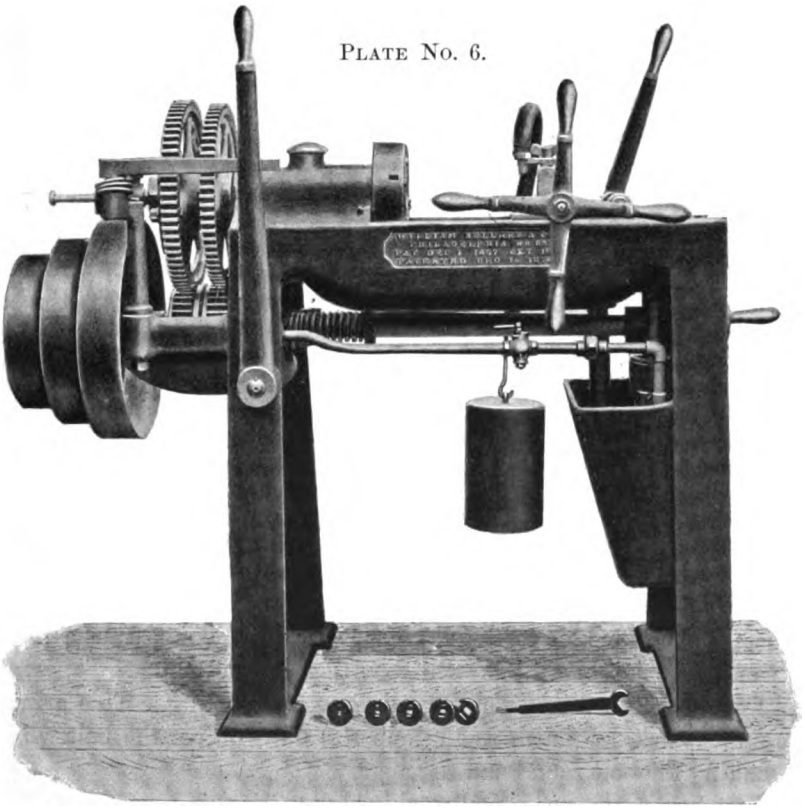
5. The dies can be changed without taking off any of the die-holding apparatus, and in less time than they can be changed in a common hand-screwing stock.

6. The bolt-holder is arranged so as always to chuck the bolts in the centre of the dies, thus insuring correct work.

7. The self-acting oil-feeder insures thorough lubrication of the dies, effectually prevents their heating, and is so arranged as to wash the chips out of the die-box.

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PLATE NO. 6.



¾″ BOLT AND NUT-SCREWING MACHINE.

With improved die-box; dies adjustable to compensate for wear; automatic die-opening attachment, adjustable to length of thread required; self-acting oil-feeder for taps and ties. Wrought-iron work case-hardened. Complete with countershaft, wrenches, oil pump, and eight sets of taps, tap-holders and dies from ¼″ to ¾″. Fast and loose pulleys on countershaft are 12″ diameter, 4″ face, and should make 200 revolutions per minute. Hobs and collars for recutting dies, extra.

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8. The automatic self-opening attachment insures uniformity in length of bolt threaded.

9. Die-box is provided with four dies, equally spaced, insuring accurate work. Each pair of dies calliper the bolt while being cut, thus making the bolt round and to gauge.

10. Is fitted for use as a nut-tapping machine, with automatic lubrication of the tap.

On the back of the large driving wheel is an index or pointer, which must be set to numbers given on a card sent with each machine. When so set, the bolt will fit a nut cut with the tap of corresponding size sent with machine. An adjustment of the index, one way or the other, will cause the bolt cut to be larger or smaller, thus permitting the thread to be adapted to the use required of it, and also permitting an adjustment of dies to compensate for wear.

Some important improvements have been added to these machines, viz., a slight change in the mode of driving has enabled us to run them at a higher speed, and a novel oil-feeding device supplies the oil to the back of the dies, whence flowing out, it thoroughly lubricates the cutters and the bolt end, and washes out the chips as they are cut from the bolt. A regulating cock in the feed-pipe directs the oil either to the dies as above stated, or to the tap when the machine is used as a nut tapper.

We construct our bolt-cutters with four dies in the die-box. These dies are equally spaced, and each die is diametrically opposite another. This arrangement insures accurate work, inasmuch as the opposite dies calliper the bolt while being cut, thus making the bolt round and to gauge.

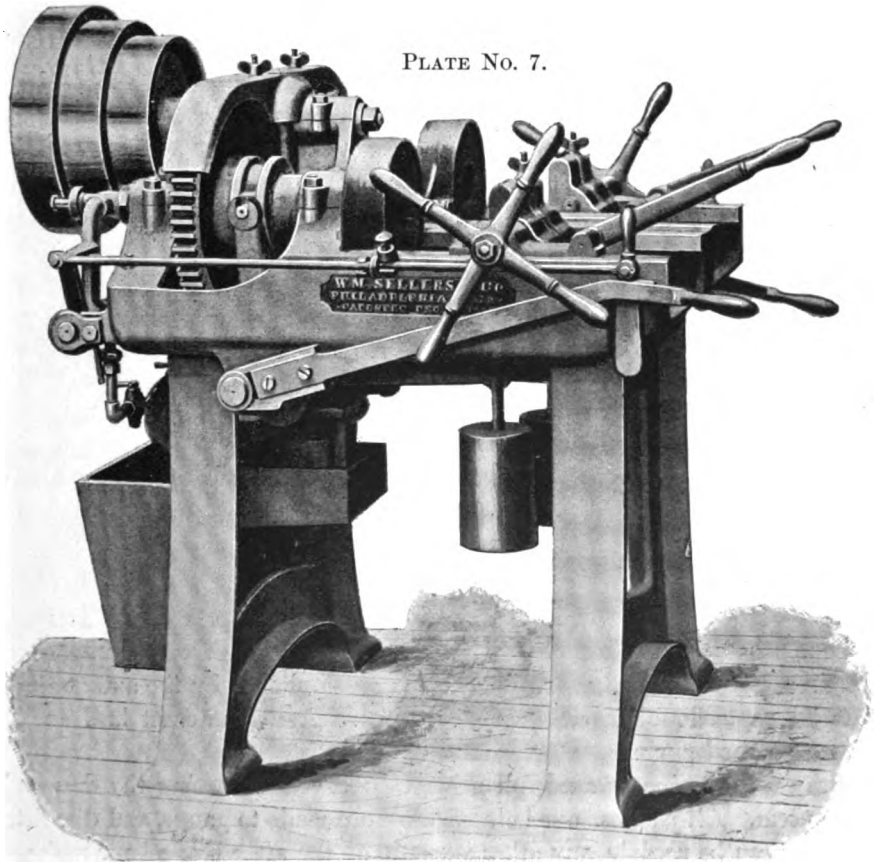
Added to this a convenient adjustable stop-motion is provided whereby the dies are opened automatically when a given length of thread has been cut.

These improvements have added greatly to the value of this important tool, which is made and used extensively in England and on the Continent, and is believed to have no equal in durability and efficiency.

These machines are fitted with dies for cutting V threads only, and, when not

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PLATE NO. 7.



1″ PATENT DUPLEX BOLT AND NUT-SCREWING MACHINE.

With improved die-box; dies adjustable to compensate for wear. Patent operating device. Automatic die-opening attachment, adjustable to length of thread required. Self-acting oil-feeders for taps and dies. Heads stopped and started independently. Complete with countershaft, wrenches, oil-pump, and eight sets of taps, tap-holders and dies from $\frac{5}{16}$″ to 1″. Fast and loose pulleys on countershaft are 12″ diameter, 4″ face, and should make 280 revolutions per minute. Hobs and collars for recutting dies, extra.

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otherwise specified, we furnish taps and dies corresponding with the United States standard, which was recommended for general adoption by the *Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, at a meeting held December* 15, 1864.

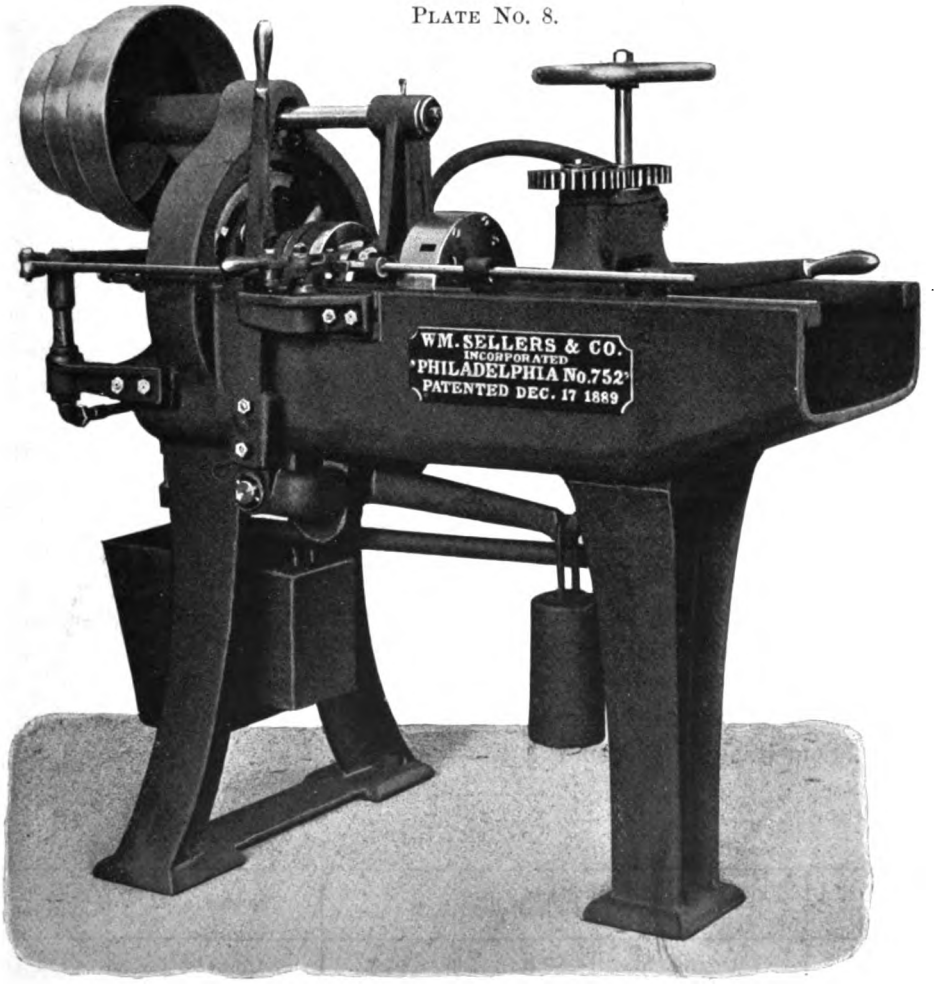
We can adapt dies for cutting coarse-threaded wood or "lag" screws, and so also dies for cutting square threads; in case of the latter, it is advisable to make the cut with more than once going over, to produce smooth work. Unless specially ordered to the contrary, our machines are always adjusted to cut threads to standard diameters, and if over-sized iron is used in bolts, it should be swaged down to the proper size on part where screw is to be cut.

To sharpen the dies, they must be softened, and then recut with hobs, which we make for this purpose, but which are not included in the price of the machine, inasmuch as when more than one machine is in the same shop one set of hobs and collars will do for them all. The hobs are guided in recutting dies by collars fitting in the hole in the spindle, which guide a prolongation of one end of the hob, while the other end is steadied in the clamp-vise on the saddle which is used for holding the bolts to be cut. This insures perfect concentricity to the dies. It must be borne in mind that in the use of bolt-cutters, oil should be freely employed upon the work. This on the new style machine is accomplished by the automatic feed; and the oil used should be *animal*, not mineral. The commonest lard or fish oil will answer a good purpose.

With each machine we send full printed directions for setting the dies and for repairing them. All parts of our bolt machines are made to gauge, and dies fitted to one machine can be used in any other machine of the same size of our make. We can therefore make new dies of any required thread to be used in any one of these machines, without having the machine in which they are to be used to fit them to.

This is of great importance in the case of special dies being needed for any purpose, when the user of the machine has no conveniences for producing new dies. The sharpening or recutting of the dies is readily done by any mechanic, but either

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1½" PATENT BOLT AND NUT-SCREWING MACHINE.

With improved die-box; dies adjustable to compensate for wear. Patent operating device. Automatic die-opening attachment, adjustable to length of thread required. Self-acting oil-feeders for taps and dies. Complete with countershaft, wrenches, oil pump, and eight sets of taps, tap-holders and dies from ½″ to 1½″. Fast and loose pulleys on countershaft are 10″ diameter, 4″ face, and should make 200 revolutions per minute. Hobs and collars for recutting dies, extra.

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blank dies or dies finished ready for use can be furnished to those who do not desire to make them.

Our 1″ and ¾″ bolt-cutters differ from the larger sizes in the clamp-vise for holding the bolt.

Plate 6 represents our ¾″ size of machine, intended to cut from ¼″ to ¾″. This size is admirably adapted to cut set-screws and small bolts. In using it with set-screws, it is well to arrange a socketed holder to be clamped in the bolt-vise, the head of the set-screw fitting the socket loosely. By the use of such a device the bolts can be set and removed more rapidly than when each one has to be clamped in the bolt holder.

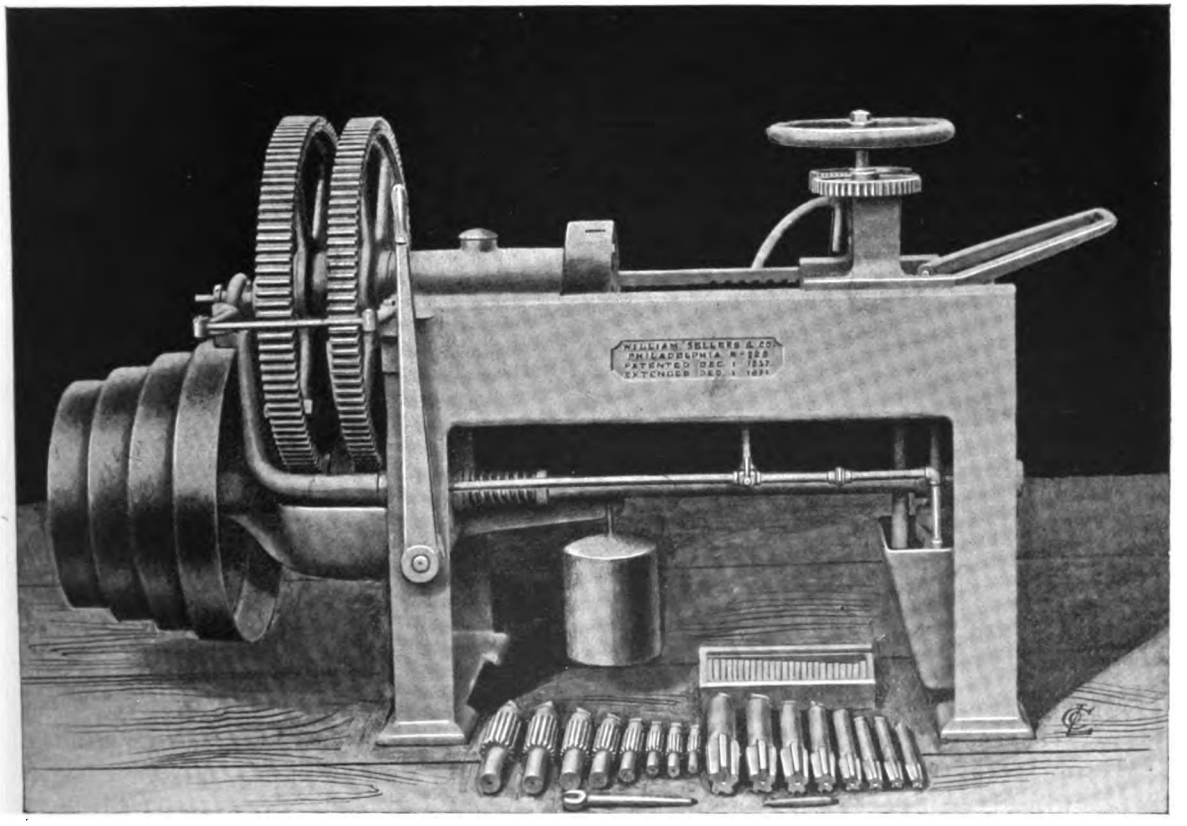
This machine has been run at the rate of 2800 bolts in ten hours on ¾″ bolts threaded two inches in length, but this rate is not economical, inasmuch as the excessive speed is too hard on the dies. We recommend the counter-shaft being speeded to 200 revolutions per minute, the speed on the dies of the fastest and the slowest speeds will then be at the rate of 12 feet circumferential motion per minute on ¾″ and on ⅜″ bolts. The ¾″ bolt having 10 threads per inch, will be threaded at the rate of six inches in length of bolt per minute, and if the thread be 1½″ long, at the rate of four per minute, exclusive of the time consumed in putting in and taking out the bolts; one man can at this rate very well run two machines cutting from 1500 to 1800 ¾″ bolts on each machine.

Table of Sizes.

Size of Machine.	Range of Cut.	No. of Taps sent with each.	Size of Machine.	Range of Cut.	No. of Taps sent with each.
¾″	¼″ to ¾″	8	2½″	1″ to 2½″	8
1″	5/16″ to 1″	8	3″	1⅛″ to 3″	9
1½″	½″ to 1½″	8	4″	1½″ to 4″	9
2″	¾″ to 2″	8			

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PLATE NO. 9.



2½" BOLT AND NUT-SCREWING MACHINE.

With improved die-box; dies adjustable to compensate for wear. Automatic die-opening attachment, adjustable to length of thread required. Self-acting oil-feeder for taps and dies. Complete with countershaft, wrenches, oil pump, and eight sets of taps, tap-holders and dies, from 1″ to 2½″. Fast and loose pulleys are 20″ diameter, 4″ face. 200 revolutions per minute. Hobs and collars for recutting dies, extra.

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Vertical Drill-Presses.

"RECOMMENDED for the general excellence of the design, and for certain original modifications by which the efficiency of the machine is improved both in regard to quality and quantity of produce."—*See Introduction*, pages 6–12.

SOME of the machines classed under the head of drill-presses are frequently called boring machines, the word "bore" being commonly applied to holes of a size requiring the use of independent cutters inserted in a "boring-bar." We are satisfied that a power feed is essential to all machines for cutting metal. The drill-press is no exception to this; yet it is almost the only machine-tool which has commonly been built with a hand-feed only. The conditions of cut and variations in the size and strength of the cutting tool make the application of an automatic feed to a drill-press a more difficult matter than to a lathe or a planing-machine, in which a given sized cutting tool of sufficient strength to do the work is possible. In a drill-press, the smaller and more delicate the drill the finer and more exact or uniform must be the feed. The requirements of a good feed-motion for a drill-press are: that it shall be continuous, not intermittent, like that of a ratchet-drill; that it may be quickly adjusted to the required amount; that it shall be positive in its action when at work; that its range shall be so great, and so fine a feed possible, as not to endanger the smallest drill, while at the same time it shall be capable of giving the utmost amount of feed a large drill or a boring-bar will stand; that it shall be so quickly and readily applied as to make its use more convenient than the hand-feed, and that it shall not in any way interfere with the quick operation of the machine by hand.

The introduction of our improved adjustable feed-motion fully satisfies all the requirements of a feed for drilling machines. In this we employ discs of metal to

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PLATE NO. 10.

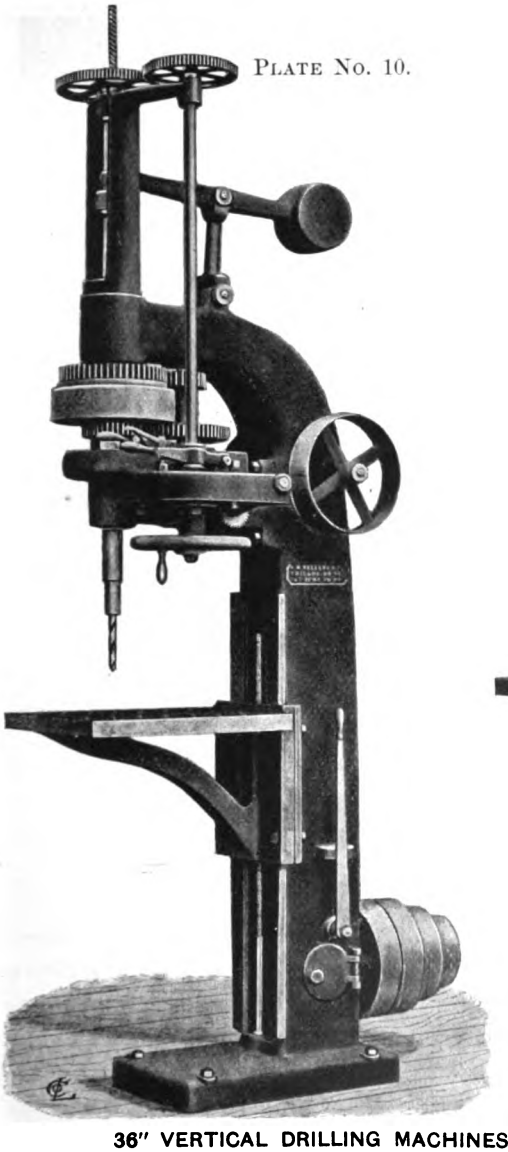
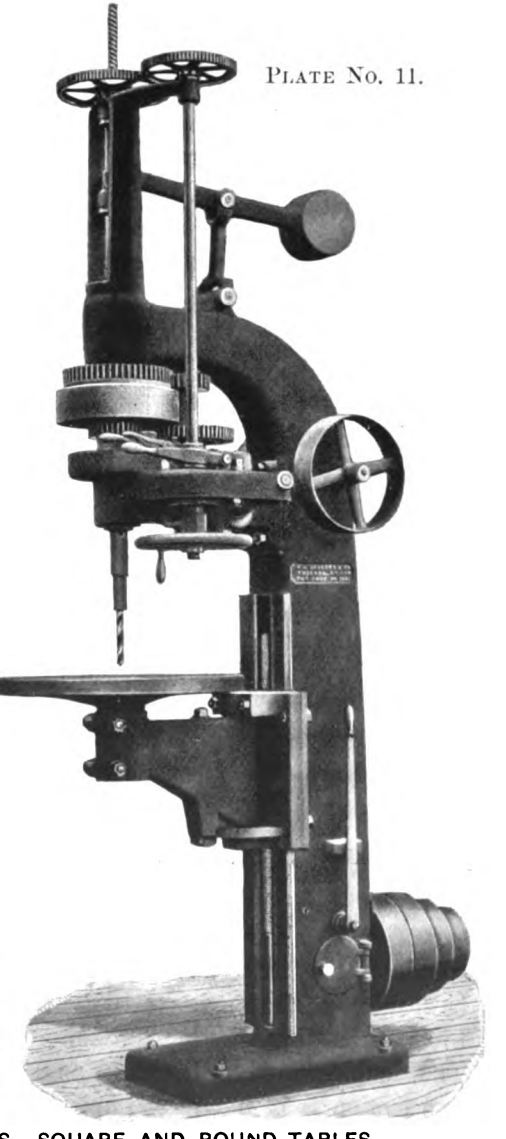


PLATE NO. 11.



36″ VERTICAL DRILLING MACHINES. SQUARE AND ROUND TABLES.

Plain table, 26″ long by 18″ wide; or circular table, 26″ diameter, carried on swinging bracket; table raised and lowered by power. Travel, 30″. Diameter of steel spindle, $2\frac{1}{16}$″. Stroke, 12″. Lower bearing 5′ above floor. Automatic power-feed adjustable instantly and through a great range. Depth gauge for counterbores, sample drill socket, countershaft, and set of wrought-iron wrenches provided. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face, and should make 110 revolutions per minute. Largest lift of cone pulley, 13″ diameter for 3″-belt. Ratio of back gears, $3\frac{3}{4}$ to 1. Made also without back-gear when so required.

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transmit motion by friction, which, being adjustable as to diameter of driving and driven circles, admits of an infinite variation of feeds between its extreme limits of greatest and least motion. This peculiar feed-motion is applied to those of our drill-presses in which range is desirable; but in machines for special work, such as our press for drilling steel rails, the feed is constant at what has been found to work the best, as the size of the drill used in such machines is also in a measure constant. In vertical drill-presses we always counterbalance the spindle, this is of great value, as the drill held up by the balance-weight will not drop into holes or cavities in the metal, and is much less liable to break.

We would also call attention to an improvement in horizontal drills, whereby we can readily and quickly shift from a fine feed for the roughing cut to an exceedingly coarse feed for the finishing cut. This enables the finishing or sizing cutters to be hurried through their work, with a great saving in time, with less wear of the cutters, and consequently with more accurate results, especially in long holes.

We have added to our list of drill-presses three sizes of radial drills, to which we call attention. These machines are made with many conveniences in the mode of handling, rendering them very efficient.

In regard to the proper shape of the cutting edges of the drills themselves, we refer to the article on our Patent Drill-Grinding Machine.

36″ Vertical Drill-Press.

The 36-inch vertical drill has overreach of 18 inches from the centre of the spindle to the face of the column. It is made either single- or double-geared, as may be required. The single-geared drill has a capacity of say one and a half inch hole in cast-iron, thus meeting the wants of a great part of the general shop practice. The double-geared drill can be used with larger drills or with boring-bars. The feed-motion is of our most improved kind, adjustable through a wide range, and instantaneous in its action. We make these machines with a plain table, to fill

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PLATE NO. 12.

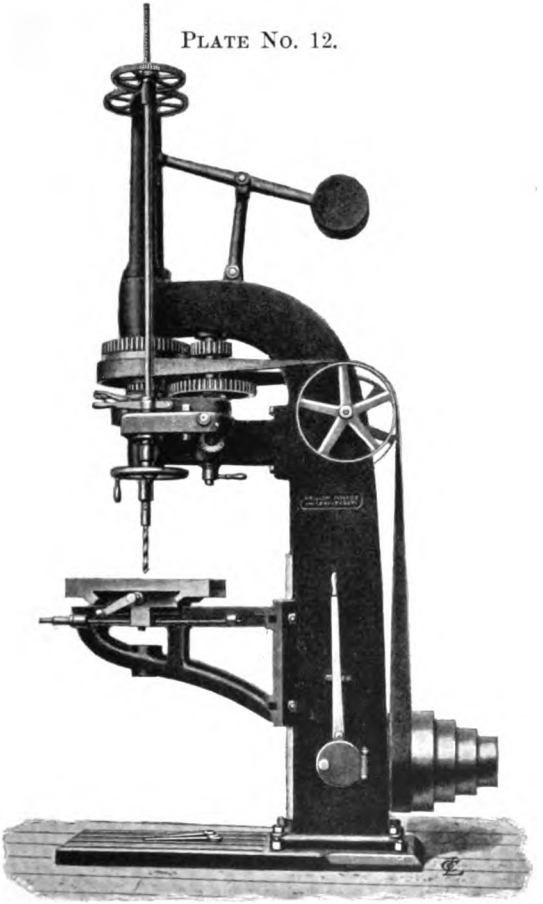
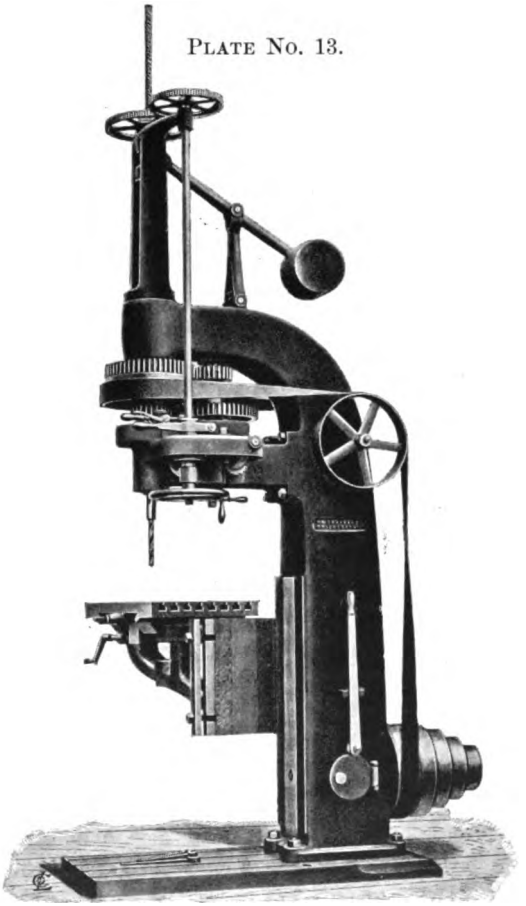


PLATE NO. 13.



45″ VERTICAL DRILLING MACHINE.

Upright secured to slotted floor plate. Compound table 22″ square, carried upon bracket raised and lowered by power and arranged to swing to one side to accommodate work on floor plate. Bracket carrying table is provided with a bearing to steady lower end of boring-bar. Vertical adjustment of table, 24″. Height of spindle bearing above floor, 5′. Diameter of steel spindle, 2½″. Stroke, 17¼″. Automatic power-feed adjustable instantly and through a great range. Machine furnished with depth gauge for counterbores, sample drill socket, countershaft, and set of wrought-iron wrenches. Fast and loose pulleys on countershaft, 10″ in diameter and 4″ face; they should make 110 revolutions per minute. Largest lift of cone pulley on machine is 15″ diameter for 3″-belt, and ratio of back gear 5½ to 1.

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the want for a cheaper tool than the patent double-geared drill-press shown in Plates 12 and 13; and we also furnish, when required, a rotating circular table, 26″ diameter, mounted on a swinging bracket. The peculiarly smooth motion imparted by the belt to these tools enables them to do more work, especially with small drills, than is possible with drills driven by bevel-wheels on the spindle. The absence of all noise and rattle at high speeds is itself a recommendation.

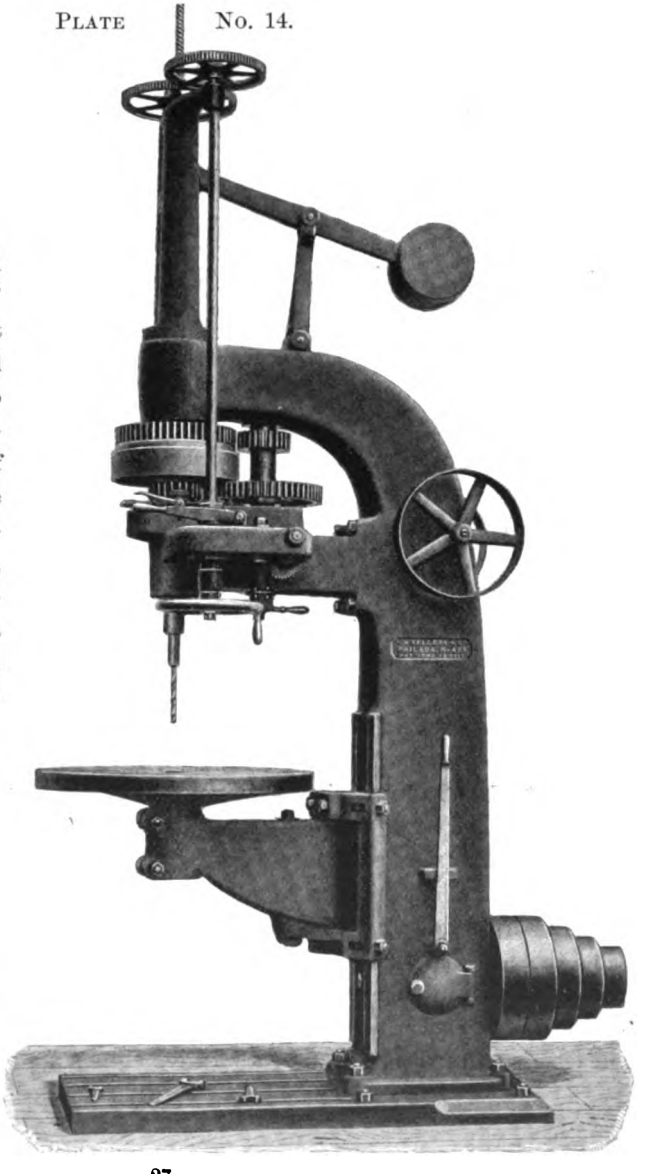
45″ Vertical Drill-Press.

Overreach, 22½ inches from centre of spindle to face of column. Provided either with compound table or circular rotating table, on swinging bracket, raised and lowered by power. Table arranged to swing to one side to enable work to be bolted to floor-plate. The knee carrying the compound table is provided with a bearing to steady the lower end of a boring-bar.

These machines have columns of improved rectangular form. They are driven by belt direct to the sleeve in which the spindle moves, and are provided with back-gear to be used for heavy work. Drill-spindles are of steel, counterbalanced and provided with quick hand-motion. The end thrust of the spindle is taken upon a hardened centre step, thus avoiding a large part of the friction of the usual collar bearings. The feed is automatic and variable through a very wide range, adjusted with ease, and engaged or disengaged instantaneously at will. The driving-pulley is on the sleeve, so that when back-gear is not in use the spindle is driven by belt only, producing a particularly smooth motion, which is very desirable when small drills are being used. The cone-pulley being conveniently placed at the base of the post, the belt is easily shifted from one step to another. The tables of both sizes are arranged to raise and lower by power, the elevating gear being controlled by the hand lever on the side of the post or upright.

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PLATE No. 14.



45″ VERTICAL DRILLING MACHINE.

Upright secured to slotted floor-plate. Circular table 32″ diameter, carried upon bracket raised and lowered by power, and arranged to swing to one side to accommodate work on floor-plate. Vertical adjustment of table, 24″. Height of spindle bearing above floor, 5 feet; diameter of steel spindle, 2½″. Stroke, 17¼″. Automatic power-feed adjustable instantly and through a great range. Machine furnished with depth-gauge for counterbores, sample drill socket, countershaft, and set of wrought-iron wrenches. Fast and loose pulleys on countershaft, 10″ diameter and 4″ face. They should make 110 revolutions per minute. Largest lift of cone pulley on machine is 15″ diameter for 3″-belt, and ratio of back-gear 5½ to 1.

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Rail-Drilling Machines.

THE introduction of steel rails has necessitated the use of drilling machines to make the holes for the joint bolts near the ends of the rails. In designing a machine for this purpose, we have had in view the most efficient mode of driving the drills, and the readiest means of adjusting them to the proper distance apart.

The frame of the rail-drill is a square column provided with a projecting knee to receive the rail; it is bolted upon a foundation or pier built up to the proper height to suit the trestles in the mill. The drills are adjustable horizontally from a minimum distance of 3 inches apart up to 8 inches, in the two-spindle machines, and 12 inches in those with three spindles. Powerful down-feed is provided for both drills simultaneously, and quick return by hand movement, the slide being counterbalanced. The feed is a positive, unvariable one, and is the utmost that has been found practicable to use.

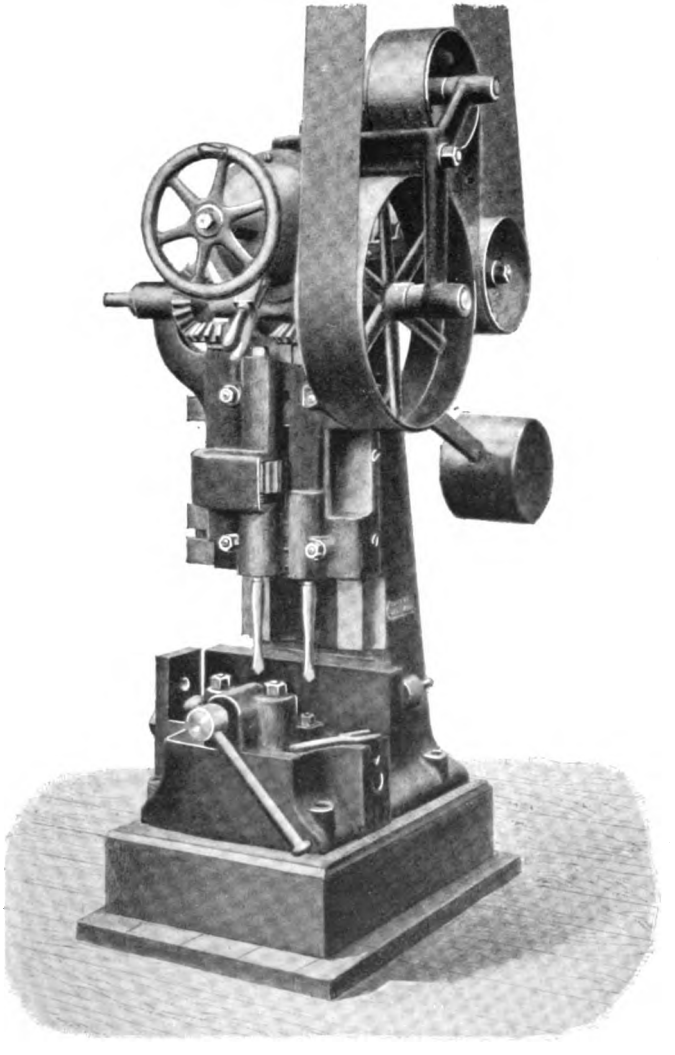
Rapid drilling in steel is attainable rather by high speed of cut with fine feed than by a slower speed with a coarser feed.

The spindles are made of steel, and the rail is held in position upon the bed by means of a clamp-vise and end-stop.

The rectangular column or frame is provided with a vertical bearing-surface carrying a saddle, which is counterbalanced by a lever-arm passing through the frame. This saddle carries the drill-spindles and all the pulleys and gears for operating them. The spindles are arranged in stands attached to the saddle, and are capable of drilling holes at any desired distances from 3 inches up. The feed is produced by moving the saddle downward, and, of course, all drills move together. The feed is thrown into gear by a positive clutch, acting instantly and readily disen-

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PLATE No. 15.



TWO-SPINDLE RAIL-DRILLING MACHINE.

With square column having projecting base to receive the rail. Clamp-vise with adjustable backing for securing rail in correct position. Reversible end-stop. Spindles adjustable from 3″ to 8″, centre to centre. Spindles fed simultaneously by powerful feed-gear. Saddle counterweighted and provided with quick hand adjustment. Positive feed-clutch operating instantly. Spindle supported close to drills. Machine complete with countershaft, wrought-iron wrenches. Fast and loose pulleys on countershaft, 20″ diameter, 4″ face; should make 186 revolutions per minute. Feed of drills $\frac{1}{180}$″ per revolution of spindle.

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gaged, while the hand movement enables the saddle to be readily raised or lowered. One of the important points about our design is that the spindles are surrounded by their bearings to the extreme end, the drills are thus supported as closely as possible to the work. The end thrust of the spindles is taken upon hardened steps provided with centre lubrication. A convenient vise is arranged on the base of the machine to clamp the rails, having an adjustable backing, which may be set to suit the height of the rail being drilled. An adjustable end-stop is also provided to limit the end-motion. The machine is very substantially designed. All the gears in the front of the machine are carefully protected with neat cast-iron covers. In order to compensate for the vertical movement of the pulley on the saddle, the belt is passed around idler pulleys on the machine; and it is requisite that the countershaft be placed vertically over the machine.

The countershaft has fast and loose pulleys, 20 inches diameter, 4 inches face, which should make 186 revolutions per minute. The wrought-iron work is case hardened.

These machines are always used in pairs, one machine to each end of the rail; but not necessarily both drilling at the same time on the same rail.

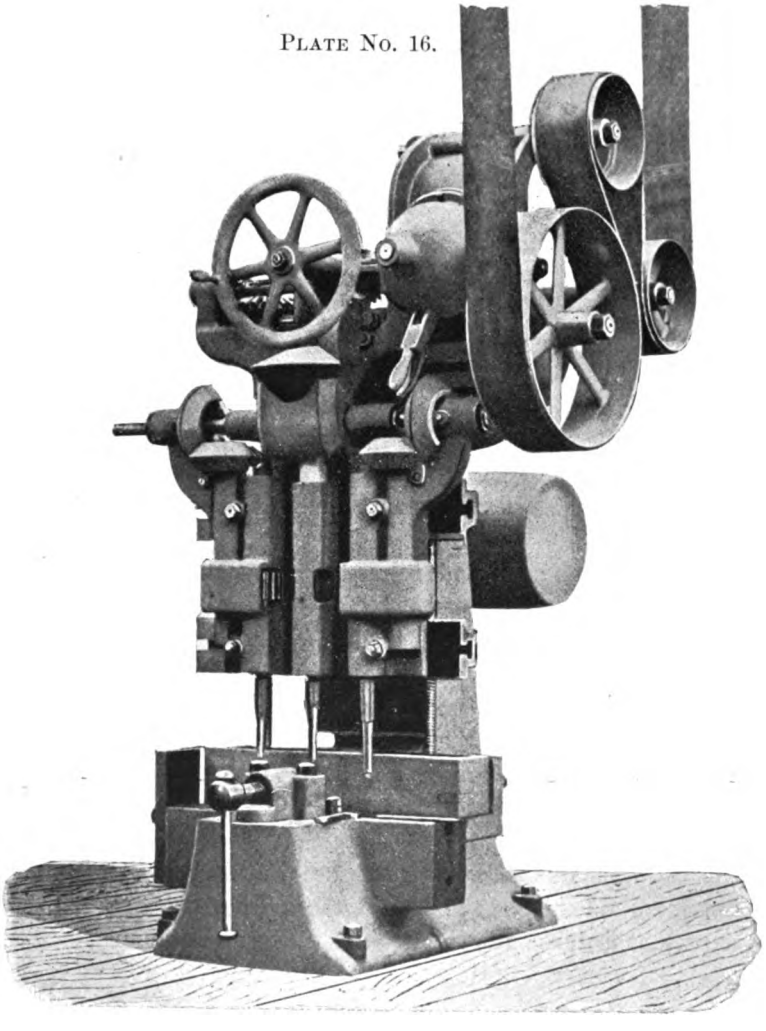
We have also arranged these machines on a bed-plate, upon which they traverse back and forth, enabling them to be used as a multiple drilling machine for special purposes.

Animal oil should be used in drilling steel and wrought iron; coal oil will not do. A free use of water containing soda or soap will answer a better purpose than coal oil, and will do almost as well as lard or whale oil.

To keep the drills in proper order for work, we recommend our drill-grinding machines.

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PLATE NO. 16.



THREE-SPINDLE RAIL DRILLING MACHINE.

With square column having projecting base to receive the rail. Clamp-vise with adjustable backing for securing rail in correct position. Reversible end-stop. Spindles adjustable on the saddle from 3″ to 12″ from centre to centre. Spindles fed simultaneously by powerful feed-gear. Saddle counterweighted and provided with quick hand adjustment. Positive feed-clutch, operating instantly. Spindle supported close to rails. Machine complete with countershaft; wrought-iron wrenches. Fast and loose pulleys on countershaft, 20″ diameter for 5½″-belt; should make 250 revolutions per minute.

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Eye-Bar Drilling-Machine.

THIS is a special form of double traverse-drill used in preparing links for bridge work. In order to insure accuracy, it is found advisable to bore the holes for the pins in both ends of the links simultaneously. The machine shown in Plate No. 17 consists of two traverse-drills, right and left hand, sliding on a solid cast-iron bed, and adjustable to or from each other to suit the required length of links.

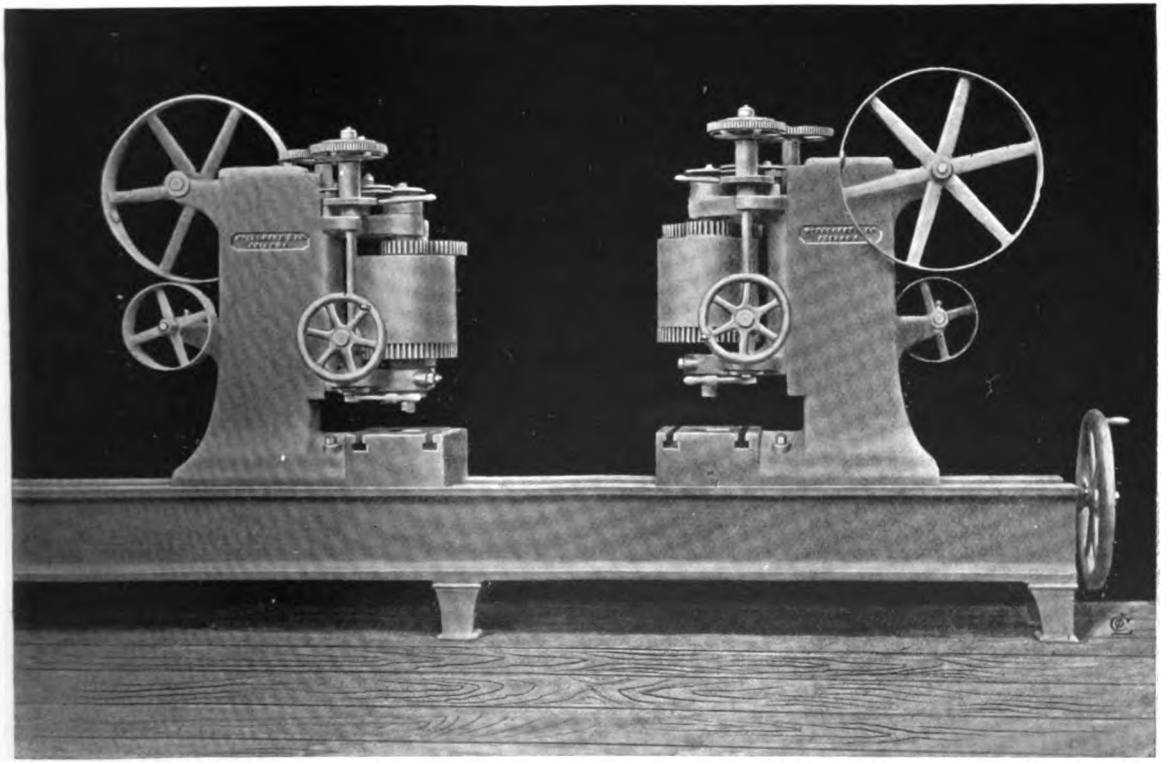
The drilling-machines are so placed as to permit the links to be put in place from one side, and, when done, passed out on the other side of the machine. The driving is effected by horizontal belts passing over guide-pulleys, and around a drum on the spindles. The cutters used in this machine are kept cool by water fed to them through the centre of the spindle.

In the link drilling-machine the two heads are united by bars of wrought-iron and can slide freely on the cast-iron bed. The expansion of the wrought-iron bars being the same as the expansion of the link being bored, insures uniformity in the length of the finished work.

In this form of machine the work is supported by a projection from the upright itself, and not independently by the bed of the machine, as in some other forms. This is an important feature and conduces to stiffness and accuracy.

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PLATE NO. 17.



EYE-BAR DRILLING MACHINE.

Drilling-heads counterbalanced by weights inside of uprights. Vertical adjustment of heads, 10″. Height from floor to top of table, 27″. Adjustable friction feed for heads with quick hand traverse. Diameter of spindle, $2\frac{1}{16}$″. Ratio of back-gearing, $5\frac{1}{2}$ to 1. Maximum distance between heads to suit requirements.

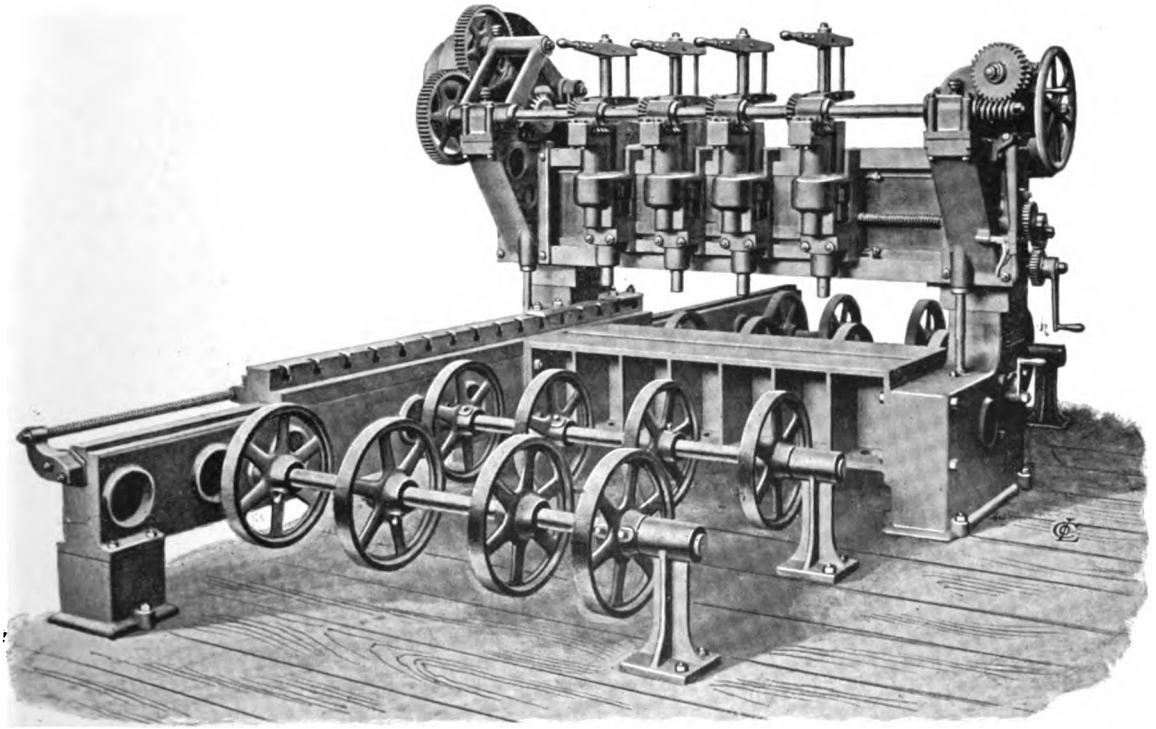
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Four-Spindle Vertical Drilling Machine.

THIS machine is designed for drilling holes in long plates, especially for drilling and counter-boring condensers for marine engines. The four spindles are carried on a saddle which travels in the cross-head joining the two uprights of the machine. The drills may thus be set at the proper distance apart and adjusted simultaneously by a screw operated from a crank at the end of the machine. The cross-head which carries the spindles is arranged to move up and down on the faces of the uprights, to produce the necessary feed, and, as it is fully counterbalanced, it is easily moved to and from the work by the hand-wheel. The spindles are driven by bevel-wheels carried on sleeves, through which passes a splined shaft, operated from a cone-pulley at one end of the machine, through gearing carried in a swing frame, which permits the cross-head to move up and down, as will be readily understood from the illustration. An important feature of this machine to which we would call attention is that each spindle is provided with an independent vertical adjustment. When it is desired to withdraw a single drill,—to replace a broken one, for instance,—or to adjust the drill-spindles to suit the varying lengths of drills, it is simply necessary to move the spindle up or down by the lever connected with it, and when the lever is released, the spindle is automatically locked at the height at which the operator leaves it. This important feature enables adjustments to be made very quickly and easily. The machine is provided with a stationary table, but long work is also supported on large rollers. A sliding-bar, carried upon extensions to the bed, clamps the sheet by one edge and guides it through the machine; this bar is moved by a screw operated by change gear and dividing apparatus, so that proper spacing between successive rows of holes can be readily obtained.

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PLATE NO. 18.



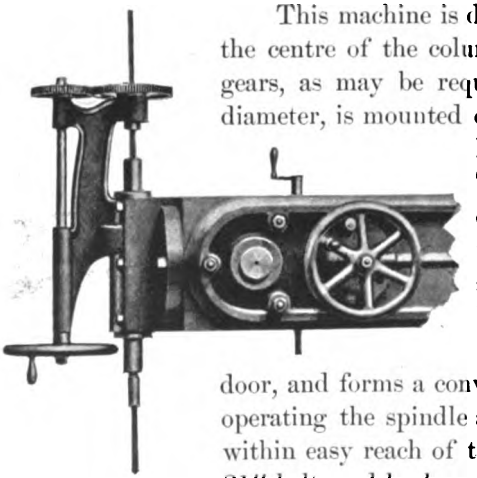
FOUR-SPINDLE VERTICAL DRILLING MACHINE.

For plates 5′ wide. Height under cross-head in highest position, 12″. Spindles are carried upon saddle moving in cross-head by which they may be adjusted simultaneously through dividing gear at the end of the cross-head. Minimum distance between any two adjacent spindles, 6″. Total length of saddle, about 4′. Guide-bar, 8′ long, provided with clamps for holding plates. Spindles all adjustable by hand, to suit length of drills used. The machine complete with countershaft, wrought-iron wrenches, change gear for clamping bar and saddle, four sets of supporting rollers, with shafts and stands. Largest lift of cone, 30″ diameter, 4″ face. Ratio of back-gearing, 2½ to 1. Fast and loose pulleys on countershaft, 24″ diameter, 5″ face. Speed of countershaft, 275 revolutions per minute.

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Universal Drilling Machine.

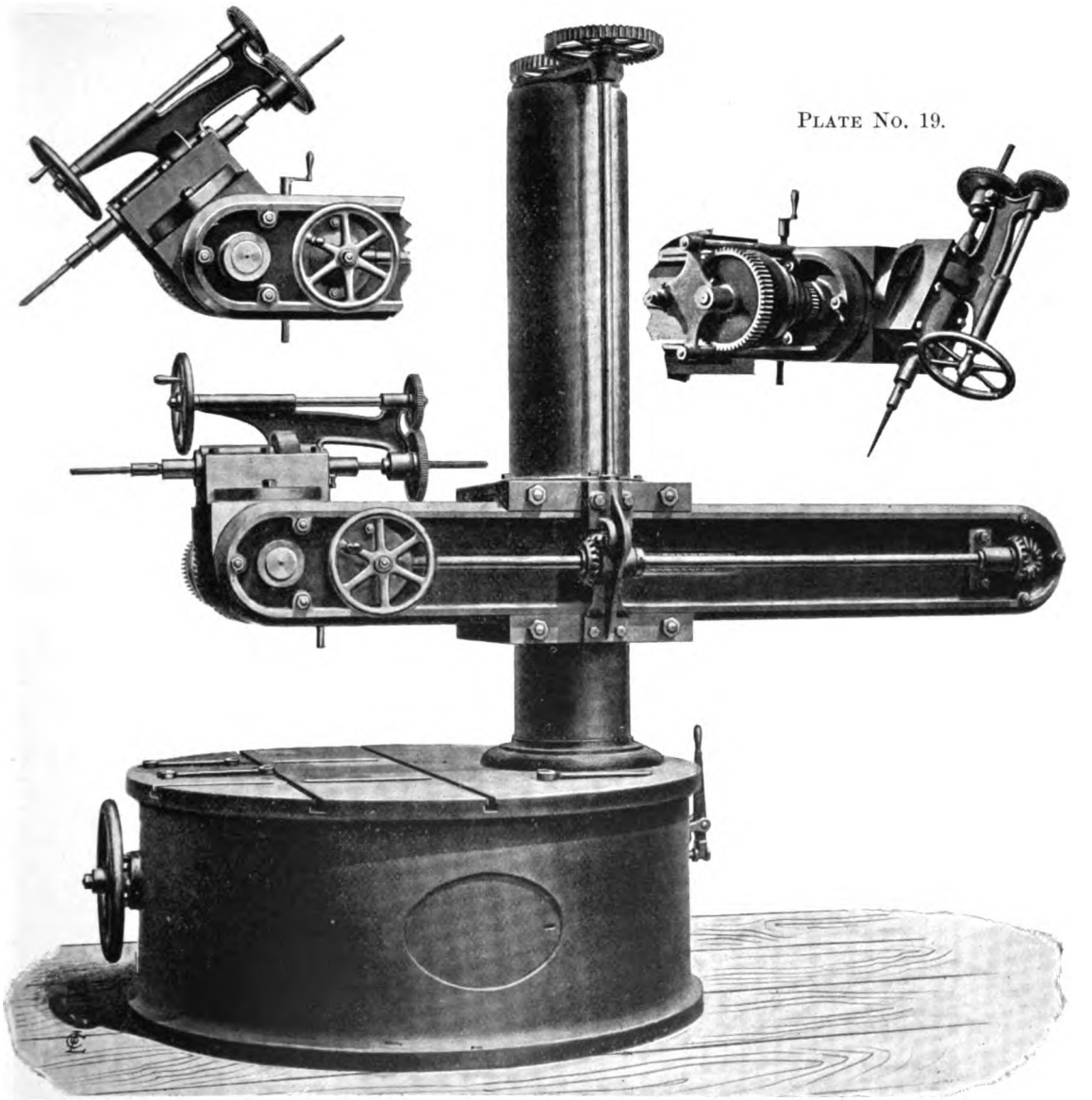
THE Universal Drilling Machine, shown on the opposite page, has been found very convenient for a great variety of work, especially for certain large pieces which it is difficult to move about. Such work is placed either in a pit at one side of the machine or upon a floor-plate. The drilling-head is carried on the end of the radial arm in such a manner that the spindle may be set in a horizontal plane, a vertical plane, or a plane inclined at any angle to the surface of the table, and it may be swung to any angle in either plane. The radius of the arm is adjustable in height above the table up to 4′. These features enable the machine to drill holes in almost any conceivable position within the space covered by its limits of travel.



This machine is driven by a vertical shaft passing through the centre of the column, carrying on its end, pulley or bevel gears, as may be required by the location. The column, 15″ diameter, is mounted on a circular table 6′ in diameter and 30″ high, convenient for holding small work. The operating cranks and hand-wheels are conveniently grouped for easy manipulation of the machine, and a clutch for stopping and starting is arranged at the base of the column.

The circular table is provided with a door, and forms a convenient closet for tools. The cone-pulleys operating the spindle are carried on one side of the radial arm, within easy reach of the operator. The cone has four steps for 2½″ belt, and back-gear has a ratio of nine to one. There is no power-feed, but the radial arm is adjustable horizontally by hand and vertically by hand or power. Extreme radius of drill from centre of column is 8′.

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UNIVERSAL DRILLING MACHINE.

Will rotate through complete circle. Diameter of drill spindle, 2½″. Stroke, 12″. Largest lift of cone, 12″ diameter, for 2½″-belt. Fast and loose pulleys on countershaft, 16″ by 4″, making 180 revolutions per minute. Complete with countershaft, pulleys and hangers, and full set of wrought-iron wrenches.

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Radial Drilling Machines.

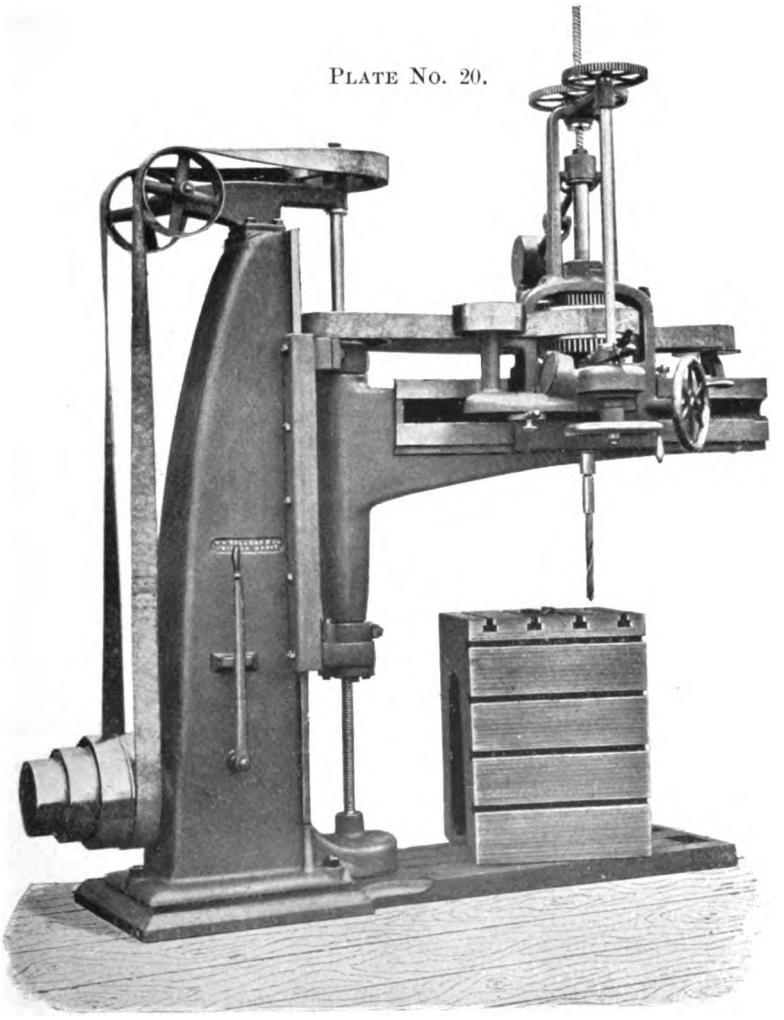
THREE sizes of these tools are shown, viz., 54″, 72″, and 96″; so called from the length of the radial arm. In these machines the arm is hinged to a saddle carried upon the face of a rectangular column or upright; it is easily rotated by hand and is raised and lowered by power, by means of a hand-lever at the base of the upright. The arm is thus quickly adjusted to the proper height to suit the work, and as the saddle, which carries the arm, is so fitted and is of such length as not to require any clamping to place, this adjustment of height is rendered extremely simple. These points are of great importance in a machine of this kind, since the value of a radial drill consists primarily in the ease with which the tool can be moved to the work or shifted over the various parts of the work requiring to be drilled. In another form of radial drill which is frequently seen, the arm is carried by a sleeve which rotates around a cylindrical column. In this case, the height of the arm is fixed, and the work must either be blocked up to suit the height of the machine, or extension pieces must be used to lower the drill to the work; while the large diameter of the bearing surfaces on the column makes the friction of turning unnecessarily great. These objections are both avoided in our machines.

The feed-motion is obtained through our improved adjustable feed-discs. It has a wide range through two series, one when back-gear is out, the other when it is in, and can be put on or off instantaneously by a tap of the hand on a lever close to the hand-wheel. All the adjustments of the machine are quickly made, the shifting of the back-gear into or out of use being as readily done as on any well-made turning lathe.

We arrange a convenient clamp at the bottom joint of the radial arm to enable

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PLATE NO. 20.



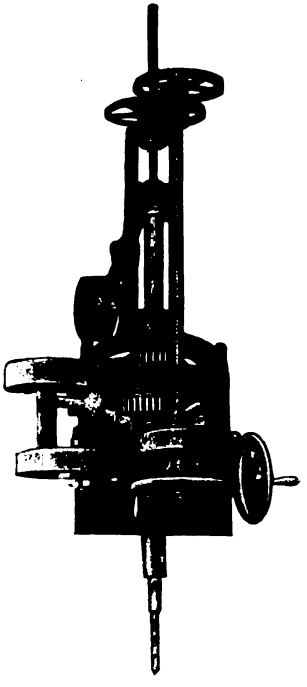
54″ RADIAL DRILLING MACHINE.

Upright carried by slotted bed or floor-plate. Maximum overreach of spindle from centre of rotation of arm, 43″. Spindle, $2\frac{1}{16}$″ diameter, 12″ stroke. Greatest height from floor to nose of spindle, 5′ 2″. Arm carrying drilling-head adjustable vertically by power. Improved friction feed, counterbalanced spindle. Machine complete with countershaft, wrought-iron wrenches, depth gauge for counterbores, and sample drill socket; and slotted table for work, 22″ square, 30″ high. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. They should make 110 revolutions per minute. Largest lift of cone pulley, 13″ diameter for 3″-belt. Ratio of back-gear, $3\frac{3}{4}$ to 1.

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it to be secured in position; but if the drills used are correctly formed and run true, the arm needs no clamping to place when drilling.

The machines are provided with substantial, well-braced uprights secured to a slotted bed or floor-plate. The cone-pulley is placed at the foot of the upright, in a convenient position for changing the speed; from this pulley belts are carried to the drill-spindle over guide-pulleys, and without the intervention of any gear-wheels, thus utilizing the system of belt driving, proved to be of so much value on all of our various styles of vertical and horizontal drills.



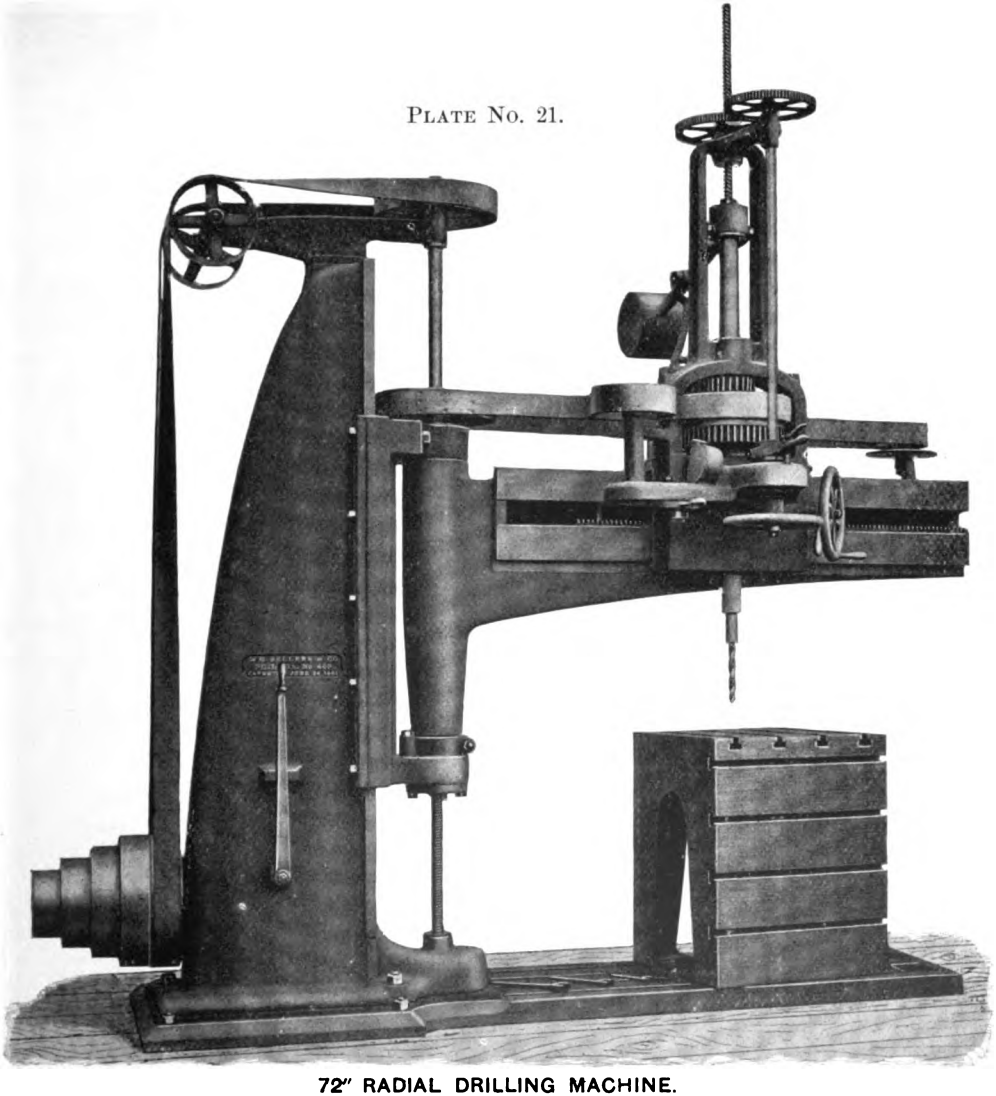
The excellence of design of our radial drills (the result of careful study and modification of the original machine) is universally admitted by all who have used these tools, and is frankly attested by other manufacturers, several of whom have brought out machines which are copies of ours in every respect,—excepting certain important details, which happen to be protected by letters-patent,—thus affording additional proof that the salient features of our machines are recognized as valuable, both by our customers and our competitors.

Among the merits which we claim for our designs, we may briefly call attention to the very convenient grouping of the operating levers and handles, which enables the attendant to move the drill by a hand-wheel on the saddle, rotate the arm, vary the feed, throw out the back-gear, throw in or throw out the feed, all without moving from his position, immediately in front of the drill.

Great attention has been paid to obtaining this convenient arrangement of operating parts, and equal care has been taken to properly proportion the various

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PLATE NO. 21.



72″ RADIAL DRILLING MACHINE.

Upright carried by slotted bed or floor-plate. Maximum overreach of spindle from centre of rotation of arm, 59″. Spindle, 2½″ diameter, 17½″ stroke. Greatest height from floor to nose of spindle, 67″. Arm carrying drilling-head adjustable vertically by power. Improved friction-feed, counterbalanced spindle. Machine complete with countershaft, wrought-iron wrenches, depth-gauge for counterbores, and sample drill socket. Slotted table for work, 24″ square, 30″ high. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. They should make 110 revolutions per minute. Largest lift of cone pulley, 15″ diameter, 3¼″-belt. Ratio of back-gear, 5½ to 1.

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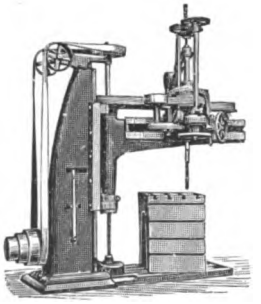
pieces in order to prevent springing or vibration, to reduce the friction and increase the durability of the machine.

It will be observed that the spindle is brought as close as possible to the face of the swinging arm so as to reduce to a minimum the tendency to twist the arm, and that the hinges or pintles of the arm are small in diameter and far apart, thus insuring, at the same time, great stiffness and ease of turning. The arm itself is proportioned with the view to making it rigid for the severest work to which the machine may be subjected.

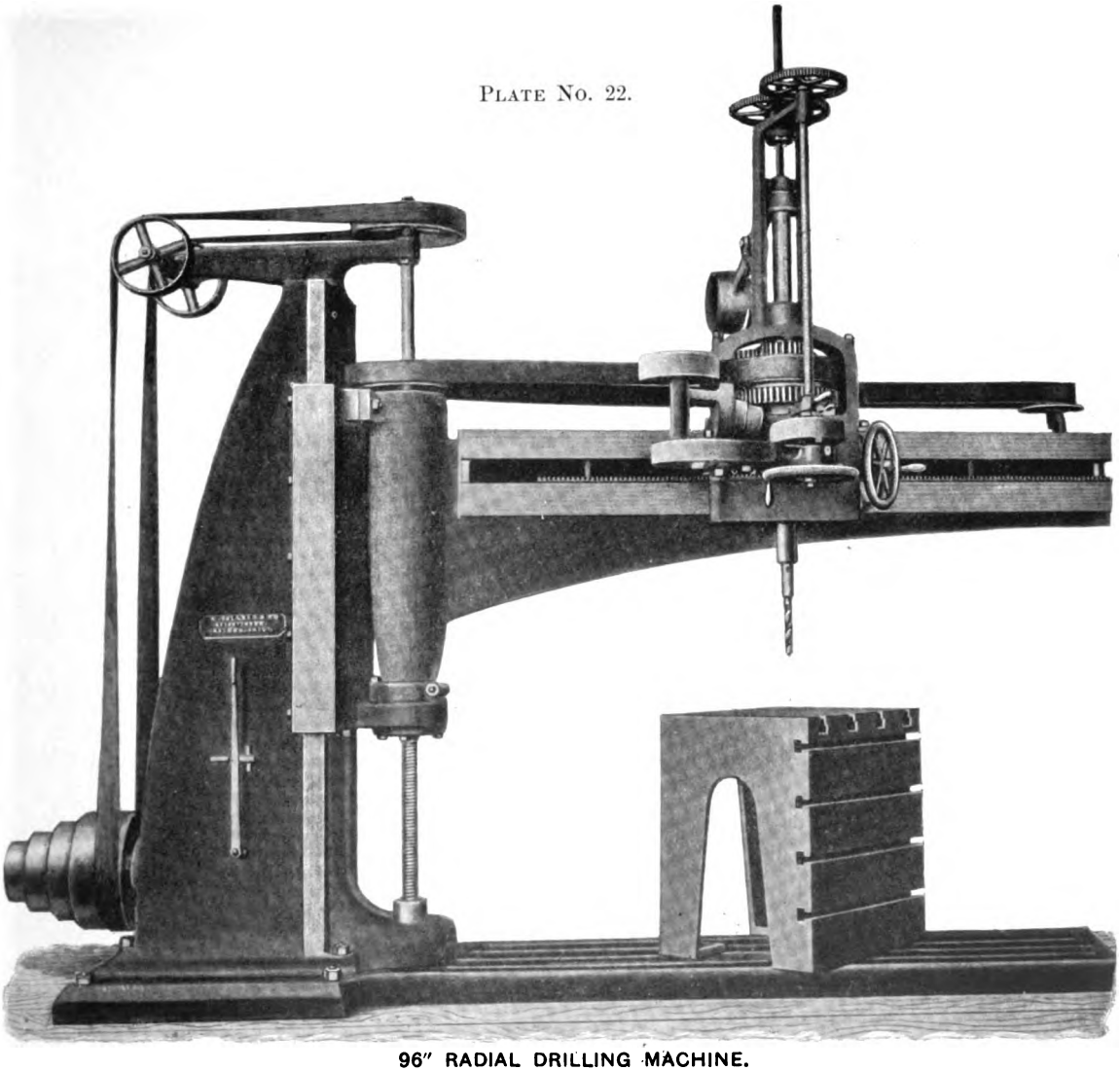
The raising or lowering of the arm and the shifting of the belt on the driving-cone do not require the close observation of the drill itself demanded in the other movements, and these are the only operations which take the attendant from his place in front of the drill.

The convenient arrangement of details which we have indicated conduces to the daily output (without undue effort on the part of the attendant) of the largest amount of work of which such tools are capable, while the generous proportions and correct distribution of metal insures stability of the machine in constant use.

A square table, 30 inches high, is furnished with slots for holding-bolts on top and one side for the convenient and quick clamping of small work.



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96″ RADIAL DRILLING MACHINE.

Upright carried by slotted bed or floor-plate. Maximum overreach of spindle through centre of rotation of arm, 83″. Spindle, 2½″ diameter, 17¼″ stroke. Greatest height from floor to nose of spindle, 67″. Arm carrying drilling-head adjustable vertically by power. Improved friction feed, counterbalanced spindle. Machine complete with countershaft, wrought-iron wrenches, depth gauge for counterbores, and sample drill socket. Slotted table for work, 24″ square, 30″ high. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. They should make 110 revolutions per minute. Largest lift of cone pulley, 15″, for 3¼″-belt. Ratio of back-gear, 5½ to 1.

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Improved Traverse-Drill with Cotter Attachment.

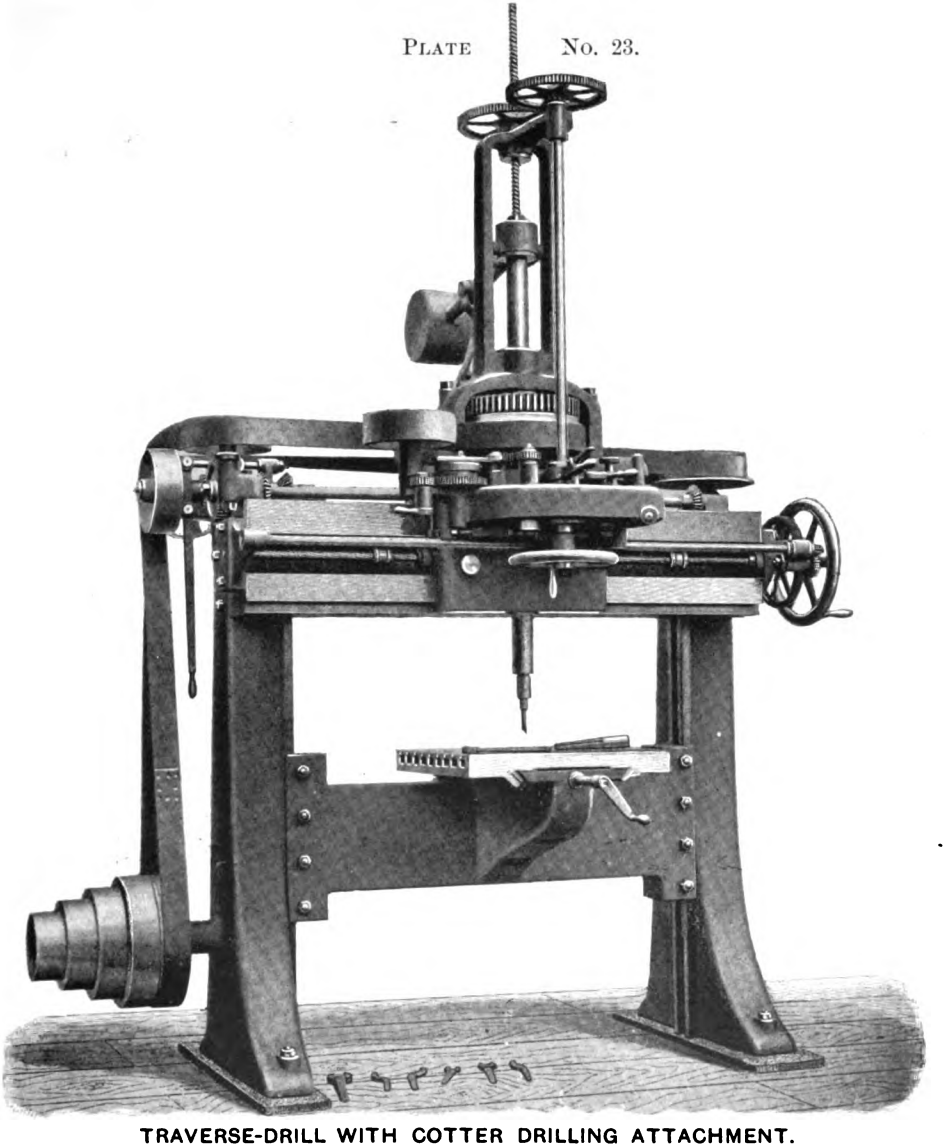
THE amount of cotter drilling in any one establishment is seldom enough to keep a machine for only that purpose busy. Most cotter-drills are of no use for any other purpose. The machine illustrated is designed to do the work of a drill-press in a superior manner, and is so arranged as to be instantly converted into a cotter-drill. When the cotter-drilling machinery is not in use, it is entirely idle and subject to no wear. Such a machine, it will be readily seen, need never be idle.

This drill-press is a traverse drill, with three feet of motion to the saddle carrying the spindle, this motion being at right angles to the motion of the table to which the work is bolted. The table motion is 24″, so that the space covered at one setting is 36″ x 24″. The table is quickly raised or lowered by power. The drilling-head is provided with back-gear, but the belt-pulley is on the sleeve which contains the drill-spindle. In this respect the machine is like all our belt-driven presses. As a cotter-drill the motions are uniform, the side-travel and the down-feed being both adjustable through a wide range of feeds. As a drill-press the power is the same as our 45″ vertical drill. The counter-shaft is provided with fast and loose pulleys 10″ diameter, 4″ face; they should make 110 revolutions per minute.

Upon the saddle is carried the mechanism required to work the tool as a cotter-drill. The attachment of the cottering devices, when required, is simple in the extreme,—moving one gear-wheel into position, and turning two eccentrics, is all that is required to be done.

The traverse of the saddle sideways in cotter drilling is accomplished by means of a peculiar arrangement of screw and adjustable nuts, which can be instantly set

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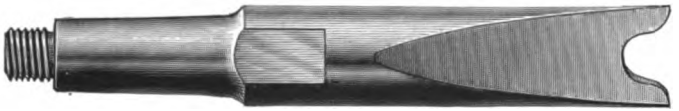
TRAVERSE-DRILL WITH COTTER DRILLING ATTACHMENT.

Space between uprights, 50½″. Height of cross-head from floor, 52″. Overreach of spindle, 10″. Transverse travel of drill-spindle, 3′. Will cotter or drill holes 10″ from the edge of a plate or key-seat cylinders 20″ diameter, of any length. Table, 24″ square, with 24″ motion at right angles to the plane in which the saddle moves; table raised and lowered by power. Complete with countershaft, full set of wrought-iron wrenches, and sample drill socket. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. Should make 110 revolutions per minute. Ratio of back-gear, 5½ to 1.

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to the required length of slot, and insures a uniform motion, back and forth, at each stroke, the length of the stroke being uniform, as is also the rate of its advance. The down-feed occurs at each end of the lateral motion, and the saddle is at rest when the down-feed is made.

The vertical position of the drill-spindle is of great advantage in cotter drilling wrought-iron or steel, as the slot in process of cutting can be kept full of oil.



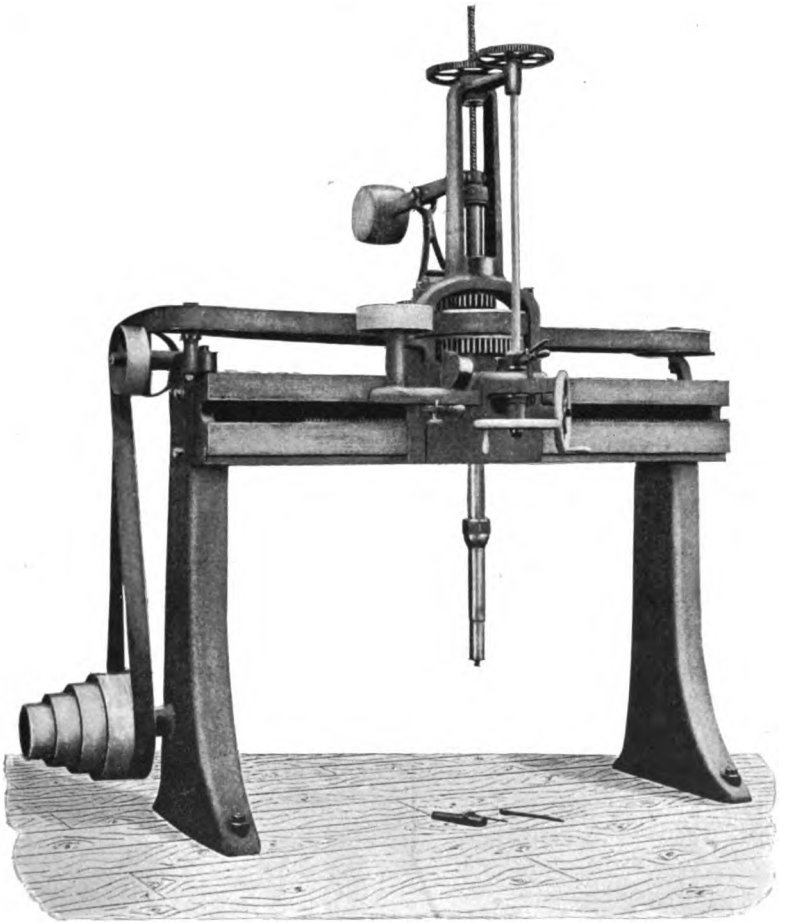
COTTER DRILL.

Traverse Drill without Cotter Attachment.

There are certain purposes for which a traversing drill mounted upon a fixed cross-head is extremely convenient, and the construction of the saddle and drilling mechanism of our radial drill is such that we are enabled to use it in this manner with great ease. Such a machine is illustrated in the accompanying plate, No. 24, and was first made to bore holes in certain long plates, carried upon cars running on a track between the uprights of the machine. In this case the distance between the uprights was 6′ 2″, but this may be readily increased or diminished to suit different circumstances.

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PLATE No. 24.



TRAVERSE DRILL WITHOUT COTTER ATTACHMENT.

Distance between uprights, 74″. Height under cross-head from floor, 52″. Diameter of spindle, 2½″; stroke of spindle, 17½″. Feed of saddle along cross-head by hand only. Power-feed of spindle through improved friction discs. Machine complete with countershaft, full set of wrought-iron wrenches, and sample drill socket. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. Should make 110 revolutions per minute. Ratio of back-gear, 5½ to 1.

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Horizontal Drilling and Boring Machines.

"RECOMMENDED for originality and general excellence in design, especially in regard to the introduction of the disc feed-motion, whereby the production of the machine may be increased. Also, for the addition of what is called a 'coarse feed,' by which finishing cuts may be performed more rapidly and with equal efficiency. Also, for the very convenient arrangement of the manipulation handles, and for avoiding all embarrassment to the workman in the performance of various operations to which the machine may be applied."—*See Introduction*, pages 6 to 12.



HESE machines, designed to bore and drill horizontally work resting on a table or platform, have been considered by some engineers as coming next to the lathe in usefulness in the shop. They will drill work that cannot be operated on in an ordinary vertical drill-press, and have all the advantages of a facing-lathe for some kinds of work.

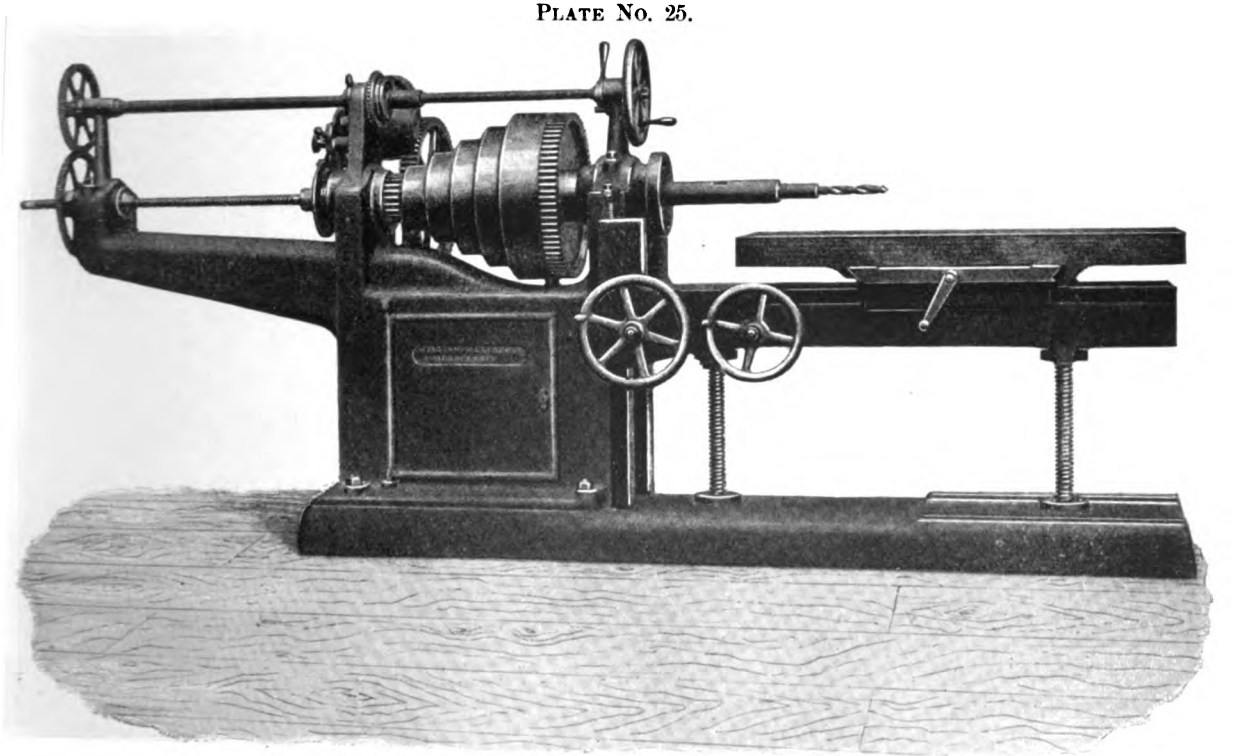
Marked advantages which these machines have over similar tools of other makers lie in the nature of the feed-motion, which, by use of the friction feed-discs, admits of an infinite variety of feeds between the finest and the coarsest; in the ready application of the feed, and its quick hand-motion; also in the manner of operating the compound table upon which the work rests, the handles to govern the motion of table being all on one side and within easy reach of the workman. The screws which raise the table require holes in the foundation below the bed; as they project below the base of machine when the table is lowered. If placed in damp places, the boxes or recesses in foundation for these screws should be made water-tight.

Out-Board Bearing or Yoke.

We provide an out-board bearing when that style of machine is required. This bearing is carried from the bed-plate, arching over the knee which carries the table;

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PLATE NO. 25.



HORIZONTAL DRILLING AND BORING MACHINE.—COMPOUND TABLE WITHOUT YOKE SUPPORT.

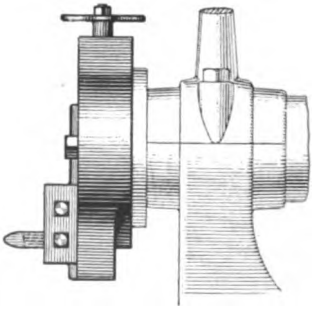
With improved variable feed in two series, varying from the finest drilling-feed to over ½″ per turn of spindle for finishing. Spindle, 2¾″ diameter; 30′ stroke. Very quick hand traverse. Power-feed instantly operated by positive clutch. Largest lift of cone, 20″ diameter for 3″-inch belt. Ratio of back-gear, about 12 to 1. Slotted table on bracket, 48″ long by 23″ wide. Adjustable along the bracket and across it. Height from centre of spindle to top of table in lowest position, 21″; to top of bracket in lowest position, 26½″. Machine complete with countershaft, full set of wrought-iron wrenches, and sample socket for drill. Fast and loose pulleys on countershaft, 16″ diameter by 4″ face, and should make 75 revolutions per minute. Revolving slide-rest for face-plate and adjustable support for boring-bar, extra.

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it bolts to the bed-plate, and to the knee also. It can be placed 29″ from the face-plate, or it can be moved off to 53″ from the face-plate; it does not interfere with the ready adjustment of the table vertically. For use with machines having no yoke, we make a very convenient adjustable bearing, or steady rest, readily applied and quickly set to suit the position of the boring-bar.

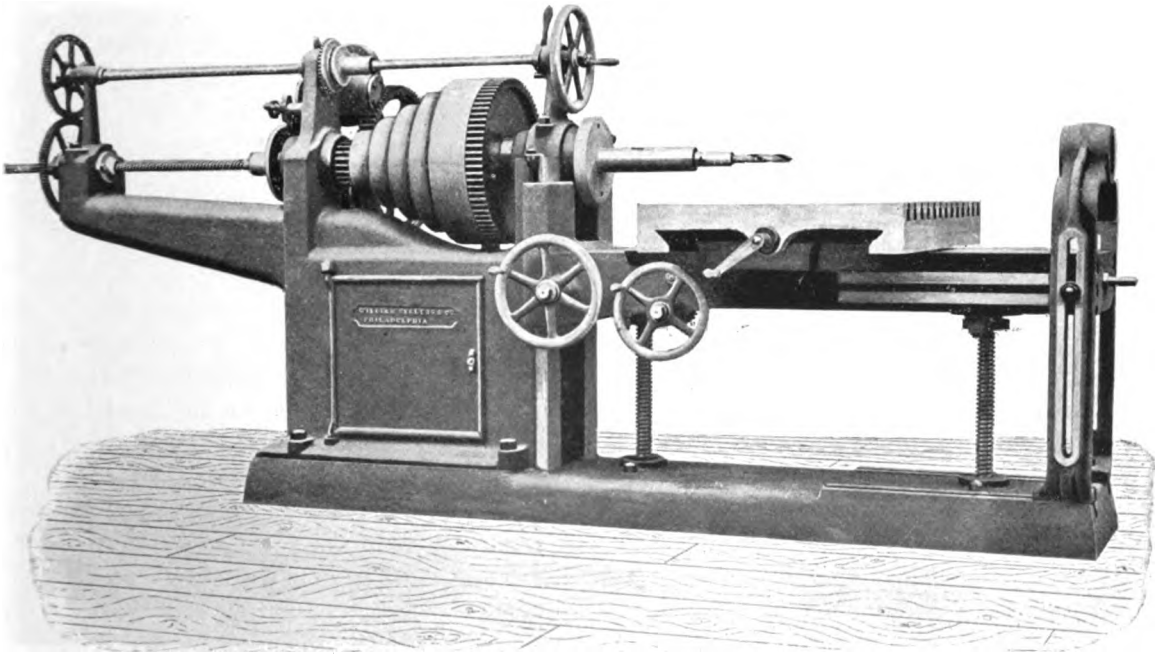
The feed-motion is arranged in two series, a fine and a coarse, both being applicable to any speed or any size of drill. The value of the coarse feed will be felt in all kinds of boring with bars and cutters, inasmuch as it is possible to rough out with a fine feed, and to finish with a light cut and a very coarse feed. In this way the finishing cutter is hurried through the work, is less liable to wear in the length of the hole to be bored, and much time is saved. These machines may be used for a great variety of work,—turning, drilling, boring, and milling. In fact, as has been said, they probably stand next to the lathe in general usefulness and adaptability.



Cylinders may be bored, faced on flanges, drilled and tapped for studs, valve-seat milled off and ports cut out, while for driving-boxes and other bearings, especially for interchangeable work done in jigs or fixtures, the machine is almost indispensable. For facing large surfaces we use a "revolving slide-rest," which may be bolted to the flange on the bed of the sleeve in which the spindle slides.

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PLATE NO. 26.



HORIZONTAL DRILLING AND BORING MACHINE.—COMPOUND TABLE WITH YOKE SUPPORT.

With improved variable feed in two series, varying from the finest drilling feed to over $\frac{1}{2}''$ per turn of spindle for finishing. Spindle, $2\frac{7}{8}''$ diameter, 30″ stroke. Very quick hand traverse. Power-feed operated instantly by positive clutch. Largest lift of cone, 20″ diameter for 3″-belt. Ratio of back-gear, about 12 to 1. Slotted table on bracket 48″ long by 28″ wide; adjustable along the bracket and across it. Height from centre of spindle to top of table in lowest position, 21″; to top of bracket in lowest position, $26\frac{1}{2}''$. Machine complete with countershaft, yoke support for boring-bar, full set of wrought-iron wrenches, and sample socket for drill. Fast and loose pulleys on countershaft, 16″ diameter by 4″ face; should make 75 revolutions per minute. Revolving slide-rest for face-plate, extra.

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Horizontal Boring and Drilling Machine, Fixed Table.

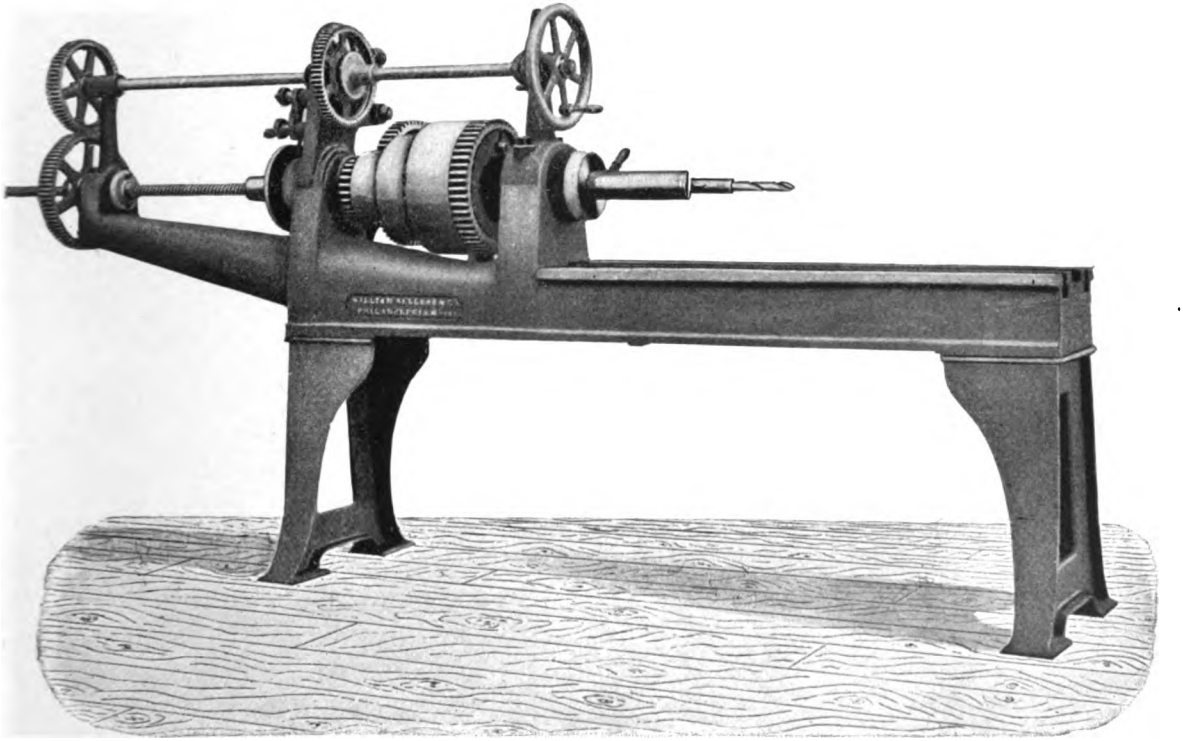
THIS machine is, in principle, the same as our larger horizontal drilling and boring machine just described, but is not provided with an adjustable table for work. The bed or shear extends beyond the boring-head 52," forming a table for work which is 13" inches wide, and has two "T" slots for the bolts used in securing the work to the table. The machine is provided with a very large range of feeds, in two series, varying from the finest drilling feed up to $\frac{1}{2}$" per turn for a light finishing cut. It is especially adapted for work in which there is sufficient repetition to permit special chucks or jigs for holding the pieces to be bored; thus it is largely used for car-boxes, driving-wheel boxes, hangers, hanger-boxes, and other similar work.

The change of feed is made instantly, and this, together with the rapid hand traverse, makes the machine extremely efficient. We sometimes make for the table a knee having a vertically adjustable shelf, upon which work can be held.

The ordinary height of the spindle above the fixed table is 8", but this can be made 10" if desired. We also make various other modifications of form, raising the spindle to a greater height, increasing the width or the length of the bed, and, in some instances, we have furnished the head complete without any table at all, to be attached to some special table provided by our customers. See also page 65.

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PLATE NO. 27.



HORIZONTAL DRILLING AND BORING MACHINE.—WITH FIXED TABLE.

With improved self-acting variable feeds, adjustable from .004″ to .5″ per rotation of spindle. Feeds instantly adjustable to the exact amount required. Quick hand adjustment to spindle and positive clutch for engaging power-feed. Largest lift of cone pulley, 14″ for 4″-belt. Ratio of back-gear, 5½ to 1. Diameter of spindle, 2⅝″. Stroke of spindle, 30″. Usual height of spindle above top of table, 8″. Machine complete with countershaft, full set of wrought-iron wrenches, and sample socket for drill. Fast and loose pulleys on countershaft, 14″ diameter by 4″ face, and should make 80 revolutions per minute.

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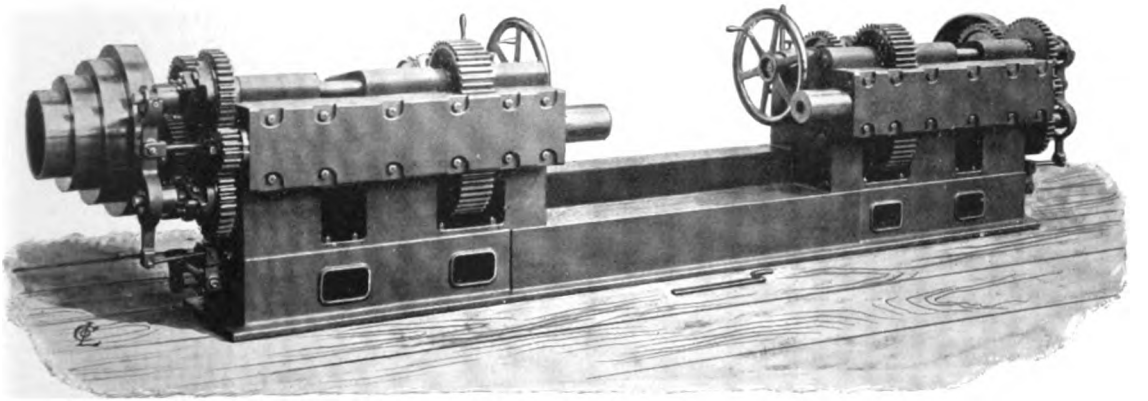
Double Horizontal Drill for Marine Engine Shafts.

THIS machine is a special one, designed to drill and ream the bolt holes in the flange couplings of large marine shafts. These flanges are usually forged on the shaft, and, as the two flanges forming one coupling should be drilled at the same time, a special machine is required for the purpose. The machine shown on the opposite page rough-drills from both ends at once, there being two spindles opposing one another; while the shafts to be operated upon are carried on "V" blocks on a bed alongside of the machine. The problem is to provide a powerful machine suitable for drilling these holes, which may be as large as $3\frac{1}{2}''$ or $4''$ diameter, and yet very close to the circumference of the shaft.

With this machine holes may be drilled having centres only $3''$ from the shaft, and the drill-spindles are $5\frac{3}{8}''$ diameter. When the two drills nearly meet, one is withdrawn, and the hole completed by the drill in the other spindle; these holes are usually finished taper by means of a reamer held in one spindle and supported in the other, which, being thus secured at each end, will do very accurate and heavy work. While this machine is strictly a special one, the amount of time saved by it makes it invaluable in an establishment having much work of this character to do.

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PLATE NO. 28.



DOUBLE HORIZONTAL DRILL FOR MARINE ENGINE SHAFTS.

Drilling-heads, 4′ 6″ apart, carried on opposite ends of bed, 12′ 5″ long. Spindle, 5⅞″ diameter. Distance from centre of spindle to face of spindle bearing next to shaft, 3″, thus enabling holes to be drilled about 3″ from outside of shaft. Stroke of spindle, 24″. Distance from centre of spindle to top of bed, 15″. Two rates of power-feeds only. Feeds engaged and disengaged by friction clutches operated by hand-levers. Spindle adjustable rapidly by hand. The heads are driven from separate countershafts. Machine complete with full set of wrought-iron wrenches and countershafts. Largest lift of cone pulleys, 24″ diameter, 3¼″ face. Ratio of back-gear, $9\frac{6}{10}$ to 1. Fast and loose pulleys on countershafts, 20″ in diameter, arranged in sets of three. Fast pulley, 7″ face; two loose pulleys, 4¼″ face; to be used with open and cross belts for reversing direction of spindle. Speed of countershaft, 240 revolutions per minute.

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Horizontal Boring Machine for Quartering Driving-Wheels.

"RECOMMENDED for, first, conception of the idea, and, second, for devising the way in which the idea was to be carried out, and for the extreme care and accuracy that have been bestowed upon its construction to insure absolute truth in the division. Considered for its manifest utility and perfect adaptation to perform a most difficult operation, this tool is a most valuable addition to the engineering workshop."—*See Introduction*, pages 6 to 12.

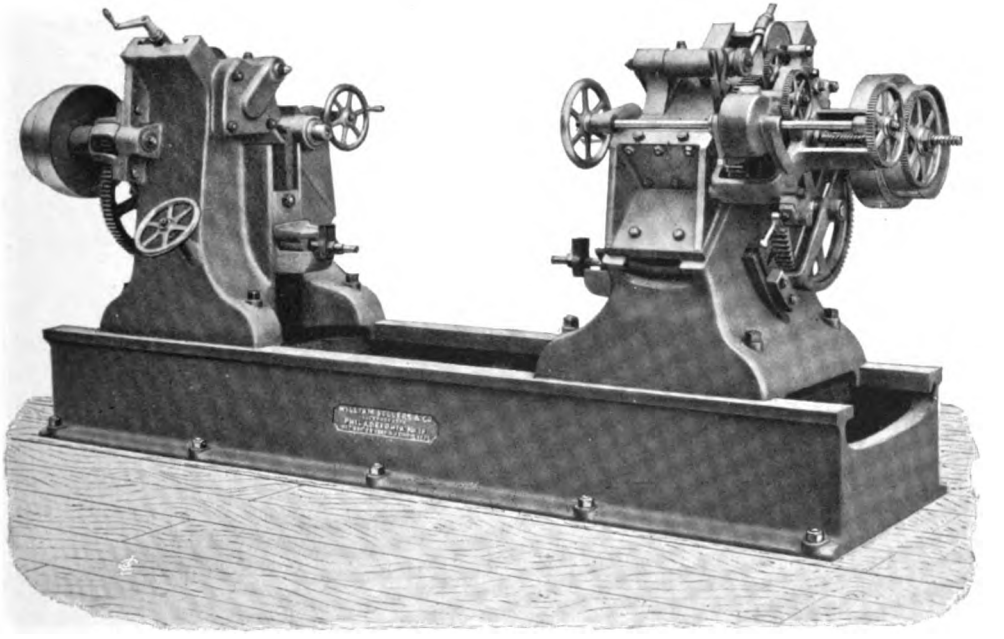


E illustrate wheel-lathes provided with removable quartering attachments; where there is much work of this character to be done, it is more economical to employ a special quartering-machine than to frequently monopolize a wheel-lathe for this purpose. The quartering-machine, illustrated on the opposite page, takes in engine-wheels from the smallest mine-engine on a narrow-gauge road up to locomotive driving-wheels 6 feet in diameter, 5 feet gauge.

The boring-spindles are outside of the wheels to be bored, and are entirely independent of each other, being operated from separate countershafts. The stopping of one does not delay work on the other, each being adjustable to its own requirements. The feed is of the most approved kind, as applied to all our vertical and horizontal drills, so wide in its range as to permit the use of a fine feed for the roughing cut, and a very wide or coarse feed for the finishing cut. The wheels on their axle are carried by their treads on adjustable cradles, upon which the wheels rest and to which they are firmly clamped. There are centres provided to control the position of the axle, but not to carry the weight of the wheels while they are being bored. In practice, the wheels rest on the centres until the cradles are brought up to the tread and made to carry the weight; shoes worked by adjusting screws on these cradles are then made to grasp the tread firmly to prevent the movement of the wheels while being bored, thus relieving the centres, which only serve to steady the axles sideways. This insures great stability, and entirely precludes the possibility of the wheels shifting under cut or from springing from pressure of cut.

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PLATE NO. 29.



WHEEL-QUARTERING MACHINE FOR LOCOMOTIVE DRIVING-WHEELS.

Will quarter from 5″ radius of crank up to 15″; right hand leading. Heads are adjustable to suit drivers from 5′-gauge to 18″, and up to 6′ diameter. Boring spindles $2\frac{7}{8}$″ diameter. 9″ stroke. Variable friction feed. Largest lift of cone, 19″, $4\frac{1}{4}$″ face. Ratio of back-gear, $4\frac{1}{2}$ to 1. Boring-heads operated independently from separate countershafts. Supports and clamps for wheels, securing them by tread and with great rigidity. Full set of wrought-iron wrenches. Fast and loose pulleys on countershafts, 19″ diameter by $4\frac{1}{2}$″ face; should make 80 revolutions per minute.

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Horizontal Floor-Boring Machines.

THE tendency of modern engineering work towards increased magnitude of steel and iron structures has produced a marked effect upon machine-tool construction, and many tools which were originally designed by us to meet special or extraordinary requirements have, in consequence, become ordinary necessities in daily work.

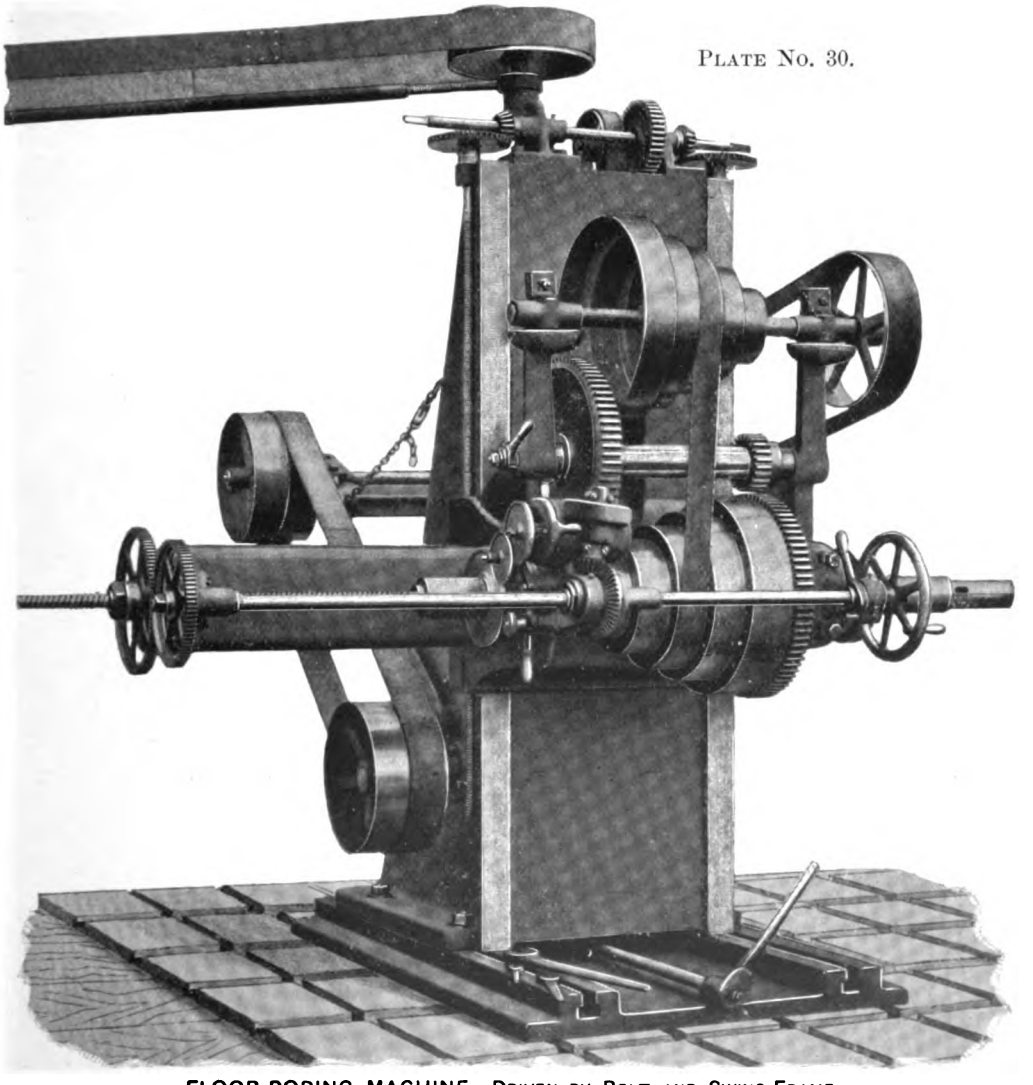
The floor-boring machine is an illustration of this development, and it has recently been greatly enlarged in its capacity to meet these constantly increasing demands. The adaptation of electricity to the driving mechanism has been found peculiarly advantageous, and machines of this type driven by electric motors are now constructed, and illustrated herein, which are adapted to work of the largest character without entailing the extravagant use of power.

Two Types.

There are two types of our floor-boring machines. In one of these the bed may be moved upon the floor-plate, presenting the spindle to the work at any horizontal angle. Such machines are necessarily of limited size, because they are, in a certain sense, portable machines.

When more horizontal traverse is required, another type of machine is produced in which the bed—upon which the upright slides—is fixed at one end or on one side of the slotted floor-plate to which the work is bolted. Machines of this kind have been usually driven from pulleys at one end of the bed, transmitting power through long shafts in the bed, and in the upright, and have a large amount of transmitting mechanism, which must be of considerable size to avoid excessive torsional deflection.

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FLOOR-BORING MACHINE.—DRIVEN BY BELT AND SWING-FRAME.

Minimum height of spindle above floor-plate, 14″. Maximum height, 6′ 2″. Horizontal adjustment of upright on slide, 4′ 10″. Spindle, 4″ diameter, 30″ stroke. Largest lift on cone pulley, 20″ diameter, for 3″-belt. Ratio of back-gear, 11 to 1. Feeds variable by our improved friction arrangement up to ½″ per turn of spindle. Driving-pulley, 16″ diameter, 4″-belt. 75 revolutions per minute. Slotted floor-plate and adjustable support for boring-bar, extra.

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Frictional Loss.

The frictional loss in such a machine is entirely out of proportion to the useful work done, and this led us to construct a machine in which long transmitting shafts are entirely avoided, and in which the power is applied directly to the spindle-gearing by means of a belt, driven by an electric motor, carried on the upright of the machine itself.

The screw for horizontal traverse of the upright is a stationary one in the bed, and the nut is rotated.

Speeds.

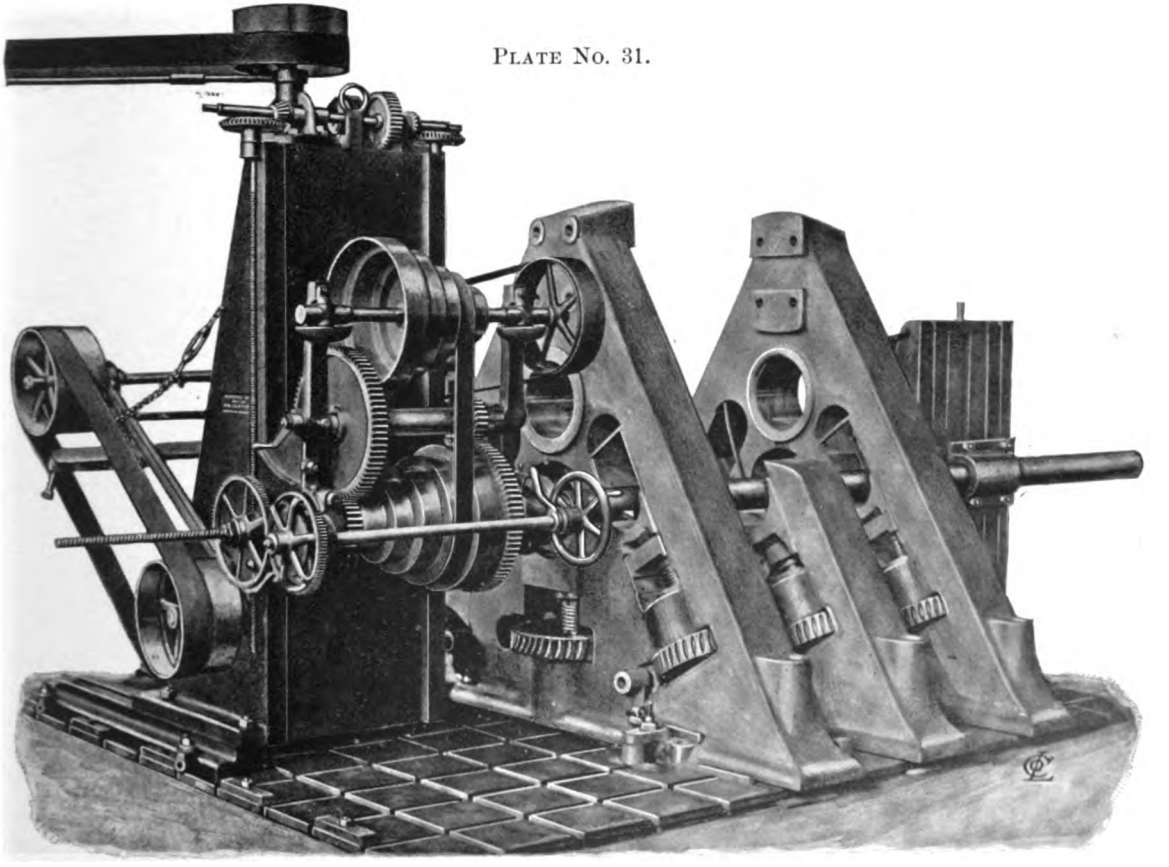
Thirty speeds are provided for the motor, either forward or backward. The various motions are engaged or disengaged by a simple system of clutches, which enables one at will to throw in any one of the feeds or of the rapid traversing motions, and the whole machine is controlled by the operator, who stands on a convenient platform opposite the spindle. From this point he can run the upright to any position on the bed he desires, and with the utmost nicety, or he can raise or lower the saddle to bring the spindle to the proper elevation, this motion being accomplished rapidly and with great accuracy. The great length of horizontal and vertical movements which is usual in such machines, renders this quick movement by power a necessity.

Milling-Feeds.

These machines, besides the ordinary drilling-feed, are often provided with milling-feeds, both horizontal and vertical, so that they may be used to face off surfaces, or do other milling work not usually covered by ordinary milling machines. The feed in each case is regulated by our improved friction discs. The height of upright and length of bed can be readily made to suit all requirements.

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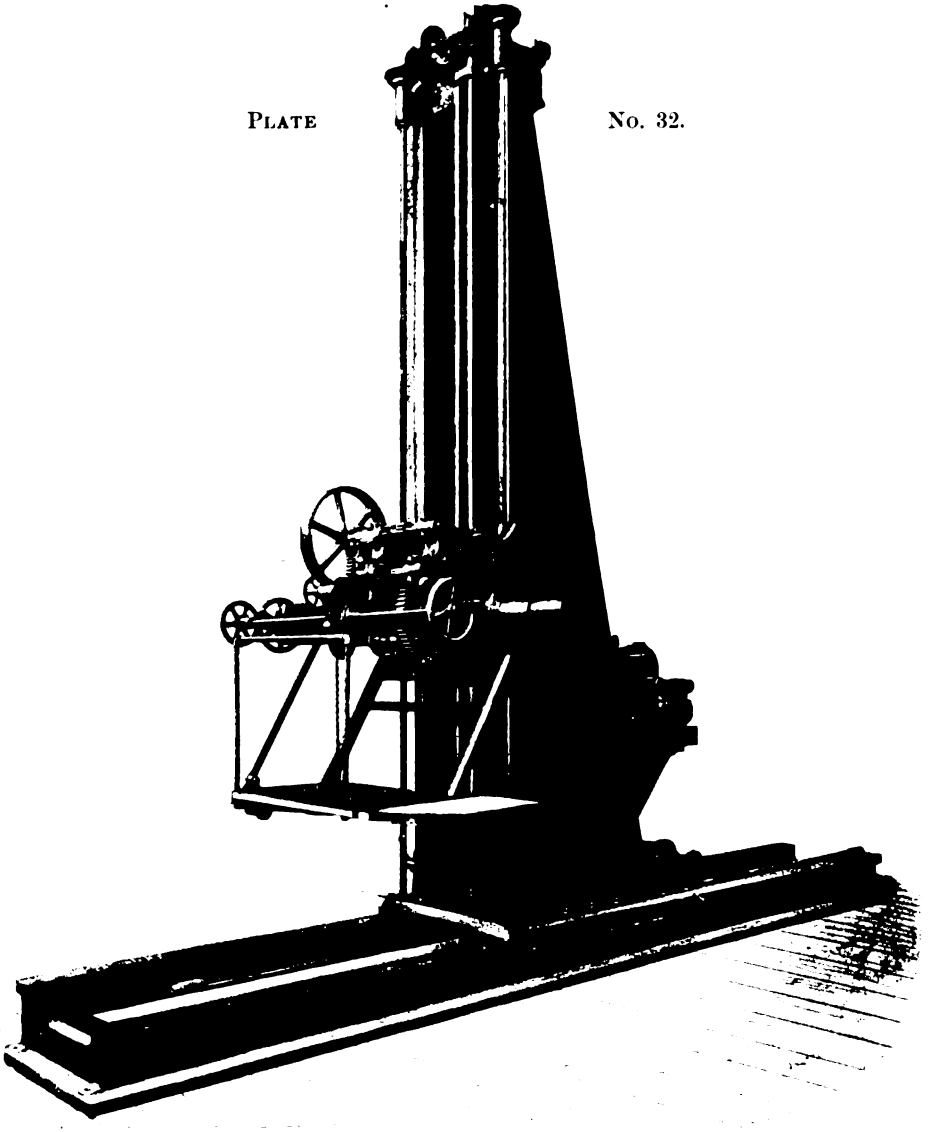
PLATE NO. 31.



FLOOR-BORING MACHINE.—BELT-DRIVEN. WITH WORK IN POSITION UPON FLOOR-PLATE.

This illustration from actual practice gives an excellent idea of the usefulness of these machines. Such work as shown in the illustration may be set upon the floor-plate and the machine moved from one hole to another, so as to insure their parallelism without the necessity of resetting the work.

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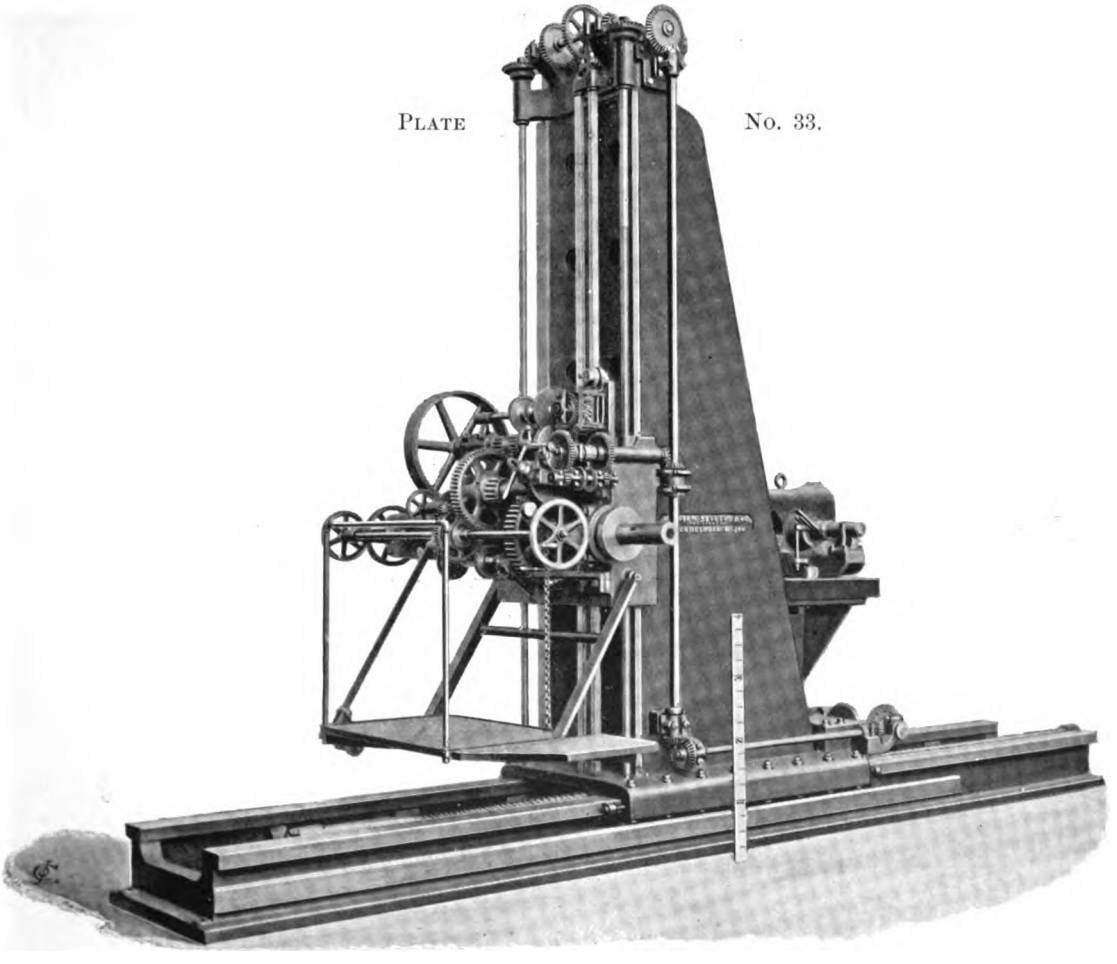


FLOOR-BORING MACHINE ON INDEPENDENT BED.—DRIVEN BY ELECTRIC MOTOR.

Diameter of spindle, 4″. Stroke, 30″. Face of upright to centre of spindle, 8″. Power-feeds variable through a wide range. Quick traverse by power, 20′ per minute, up and down the upright, and along the horizontal bed. Thirty speeds, varying from say two rotations of the spindle per minute up to about 180. Machine shown has vertical movement of 11′ 6″; horizontal movement of 16′. Motor, rheostat for regulating motor, full set of wrought-iron wrenches, sample drill socket. All movements are controlled by operator on hanging platform attached to head.

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PLATE No. 33.



FLOOR-BORING MACHINE WITH MILLING FEEDS ON INDEPENDENT BED.—DRIVEN BY ELECTRIC MOTOR.

Diameter of spindle, 4″. Stroke, 30″. Face of upright to centre of spindle, 8″. Power-feeds variable through a wide range. Quick traverse by power, 20′ per minute, up and down the upright and along the horizontal bed. Thirty speeds provided, varying from say two rotations of the spindle per minute up to about 180. Machine shown in illustration has vertical movement of 8′ and horizontal movement of 14′. Arranged with vertical and horizontal feeds for milling surfaces. Milling feeds adjustable through wide range. All movements controlled by operator on platform attached to head. Milling feeds variable by friction gear through wide range. Motor, rheostat for regulating motor, full set of wrought-iron wrenches, and sample drill socket.

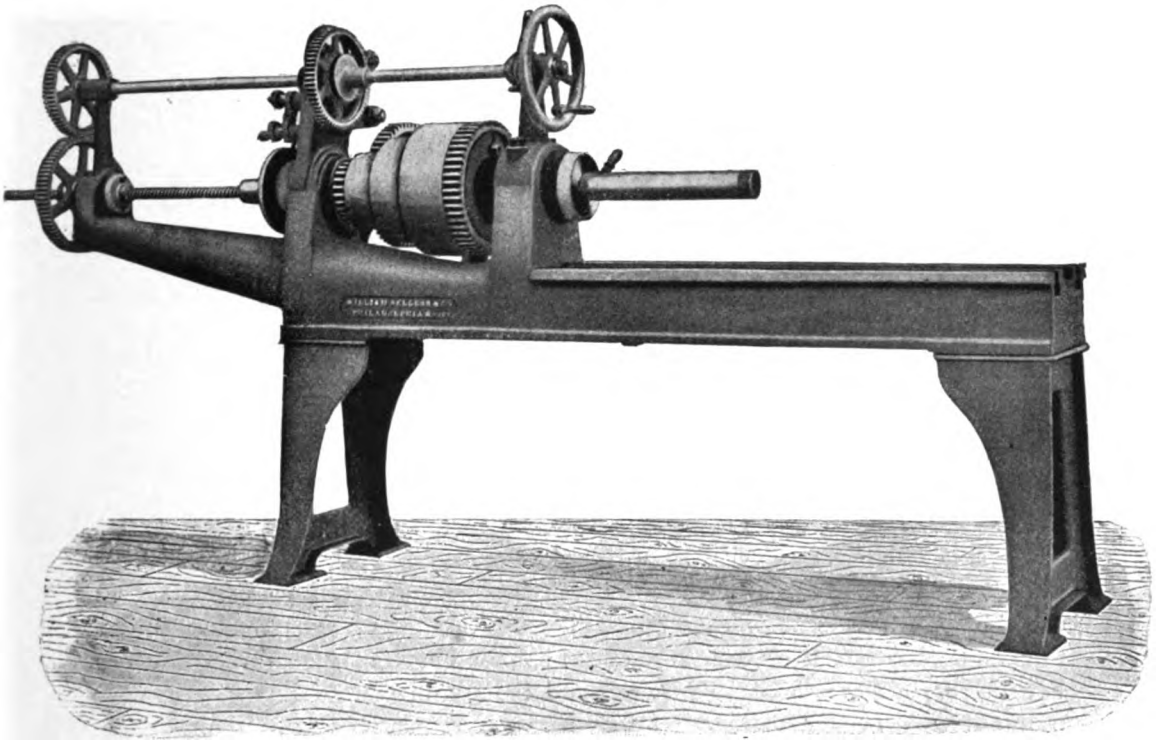
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Horizontal Boring Machine, with Fixed Table. Spindle, 2 7/8″ Diameter.

THIS machine, which we described under Horizontal Boring and Drilling Machines, page 52, is very largely used for boring such work as brake cylinders, small engine and pump cylinders, for which it is extremely well adapted. We make a variety of boring-bars for use with this machine, with boring-bar supports and cutter-heads of different sizes and design, varied to suit the requirements of the special work upon which it is to be used. When used for car or driving-wheel boxes, we can also provide a special chuck for holding the boxes to be bored. One common type of boring-bar is shown in a larger machine, Plate 35. The height of the centre above the table is ordinarily 8″, but we can also build it with a spindle height of 10″ or more, as may be required.

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PLATE No. 34.



HORIZONTAL BORING-MACHINE, WITH FIXED TABLE.—SPINDLE, 2⅞″ DIAMETER.

With improved self-acting variable feed, operated by friction discs, permitting any variation between fastest and slowest. Feeds arranged in two series, varying in the fine series from .004″ to .08″, and in the coarse from .02″ to .5″. Very quick hand traverse. Stroke of spindle, 30″. Ordinary height of spindle above table, 8″. Table, 52″ long beyond boring head, with longitudinal slots for attaching work. Largest lift of cone-pulley, 14″ for 4″-belt. Ratio of back-gear, 5½ to 1. Complete with countershaft and full set of wrenches. Fast and loose pulleys on countershaft, 14″ diameter, 4″ face, and should make 80 revolutions per minute. Boring-bars, cutter-heads, and outboard supports for boring-bars, extra.

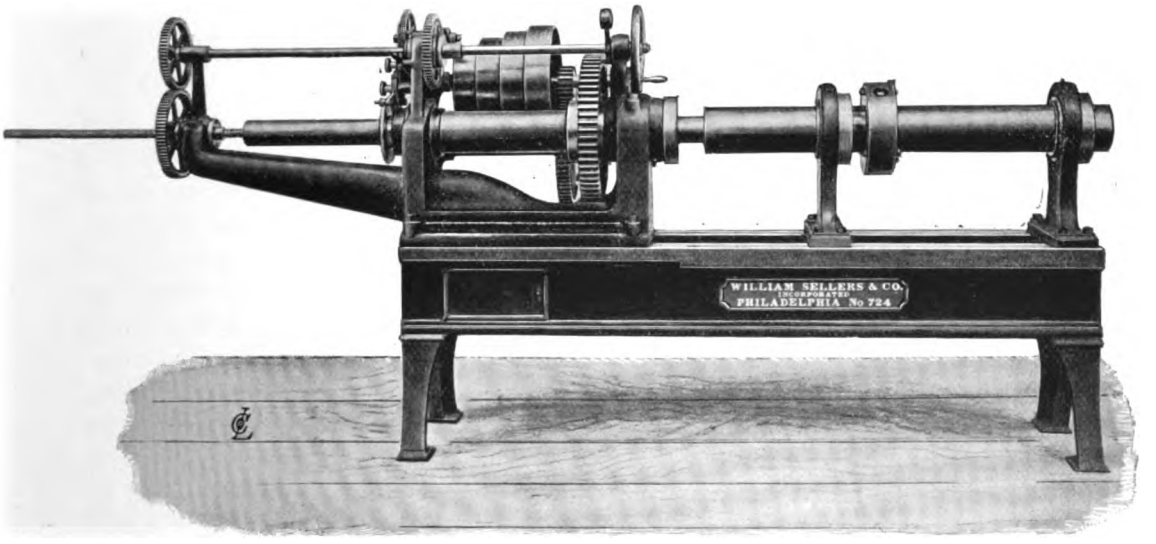
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Horizontal Boring-Machine, with Fixed Table. Spindle, 4″ in Diameter.

THE horizontal boring-machine shown in Plate 35 is provided with a fixed or non-adjustable bed, and is especially adapted for cylinder work, involving sufficient repetition to permit of special chucking devices for holding the work. The spindle, 4″ diameter, has 30″ stroke, provided with our friction feed in two series, giving a range from a fine drilling feed of say .004″ up to a coarse finishing feed of over ½″. It is powerfully geared; has a gear ratio of about twenty-one to one, with 18″ cone-pulley for 3½″ belt. It has a very quick hand traverse, and the feed-screw, which in the plate projects beyond the end of the machine, can, when it is desired to economize room, be made to enter the spindle instead of projecting beyond the machine. The bed has a tool closet, the door of which is provided with a Yale lock. As the machine is shown in the illustration, the height of the centre of the spindle above the table is 16″. This, however, we can vary if it be required, and the length of the table may be also changed. We make a variety of boring-bars and stands for these machines; the one shown in the illustration being intended for air-brake cylinders up to say 15″ or 16″ in diameter.

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PLATE NO. 35.



HORIZONTAL BORING-MACHINE, WITH FIXED TABLE.—SPINDLE, 4″ IN DIAMETER.

Table provided with slots for holding work, or boring-bar supports may be varied in length to suit requirements. Complete with countershaft and full set of wrought-iron wrenches. Fast and loose pulleys on countershaft, 16″ diameter, 4½″ face, and should make 135 revolutions per minute. Detachable boring-bar, cutter-heads, and outboard supports for boring-bar, extra.

N. B.—Bar shown in illustration is 6⅝″ diameter, with 14″ cutter-head.

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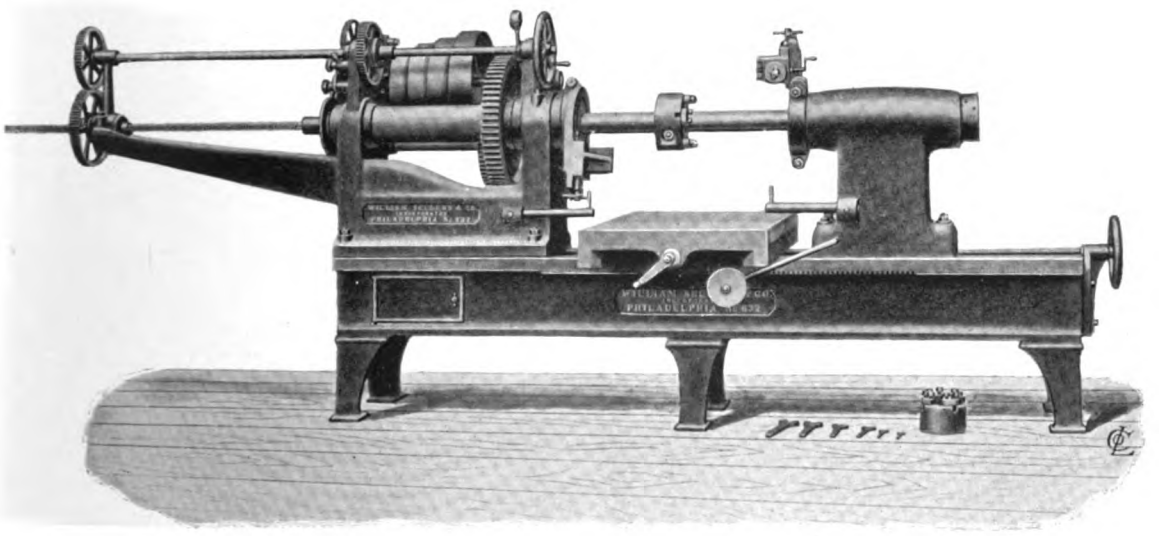
Horizontal Boring-Machine, with Compound Table and Facing-Rests.

IN this machine the spindle is extended to form a boring-bar; it is splined throughout its length and projects into a stationary bearing, adjustable by screw along the bed of the machine. This bearing steadies the end of the bar in a sleeve, which is enlarged at one end to carry a slide-rest for facing the ends of cylinders. A similar rest is carried upon the end of the hollow spindle in the live-head which forms the bearing for the boring-bar. The cutter-head is clamped to the bar and may be set in any position required for the work. When removing the work, the clamp is slackened and the bar run back as far as possible, when it will project sufficiently beyond the end of the sleeve to support the cutter-head, leaving a clear space for the removal of the work without shifting the position of the supporting bearing. The table which carries the work is adjustable along the bed and also transversely to it. The facing-rests are provided with adjustment for depth of cut and a "star" facing-feed for flanges. The head is powerfully geared, having a gear ratio of about twenty-one to one, with an 18″ cone-pulley for 3½″ belt.

The screw may be made to extend beyond the machine, as shown in our illustration, or, if preferable, to project within the boring-bar, thus economizing end room. There are two ranges of feeds, operated through our friction discs, varying from a fine drilling-feed up to a coarse feed of say ½″ inch for finishing work. It has a rapid hand adjustment of the boring-bar; all operating handles are very conveniently arranged. The bed has a tool closet, the door of which is provided with a Yale lock. It will readily bore cylinders 32″ long, and has been very satisfactorily used for pump cylinders from 7½″ to 14″ diameter, this range being covered by two cutter-heads, each provided for four flat cutters.

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PLATE NO. 36.

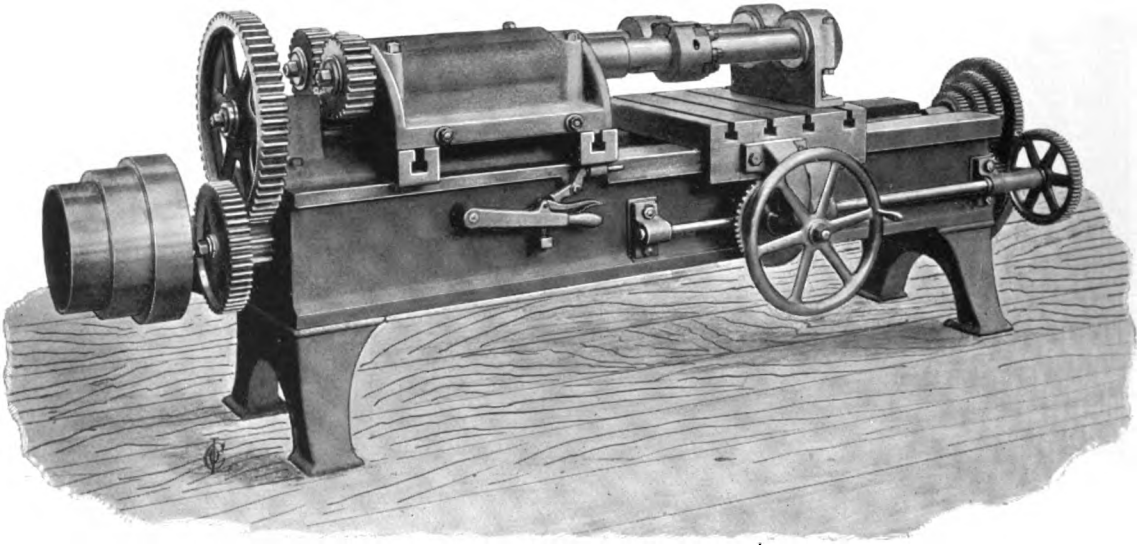


HORIZONTAL BORING-MACHINE, WITH COMPOUND TABLE.

Especially designed for boring and facing cylinders. Outboard support adjustable along the bed by screw, provided with sleeve carrying facing-rest on enlarged end. Similar facing-rest on sleeve in driving-head. Compound table, 28″ wide, 48″ long, adjustable on bed and provided with cross traverse of 24″. Height of boring-bar above table, 15¾″. Complete with boring-bar, countershaft, two facing-rests, two cutter-heads for cylinders from 7½″ to 14″ diameter. Fast and loose pulleys on countershaft, 16″ diameter, 4½″ face, should make 135 revolutions per minute. Also made with screw contained within the boring-bar, thus diminishing the total length occupied by the machine.

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PLATE NO. 37.

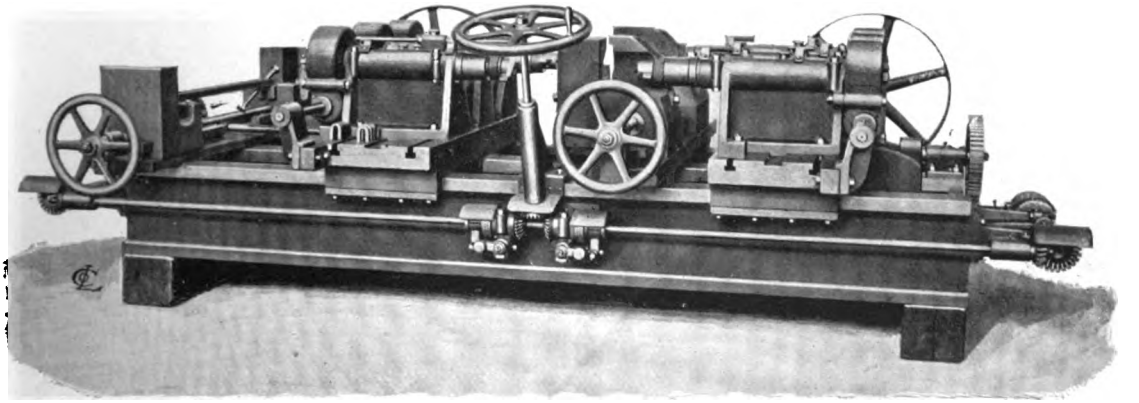


DOUBLE HORIZONTAL BORING-MACHINE.—DESIGNED FOR SMALL PUMP CYLINDERS.

Work is clamped to table which is fed towards the boring-cutters. Distance between boring-bars may be varied by changing the gears on the spindle, or different heads can be supplied to suit the various distances required between centres. Quick hand adjustment for table and geared power-feed, giving three changes, varying from a fine to very coarse. Largest lift of cone-pulley, 16″ diameter, 3½″ face. Detachable boring-bars are 3½″ diameter. Usual height from centre of boring-bar to top of table, 7″. Complete with countershaft, two detachable boring-bars with cutter-heads, outboard support for boring-bars, with running bushings, and full set of wrenches. Fast and loose pulleys on countershaft, 16″ diameter, 4″ face, should make 290 revolutions per minute.

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PLATE NO. 38.

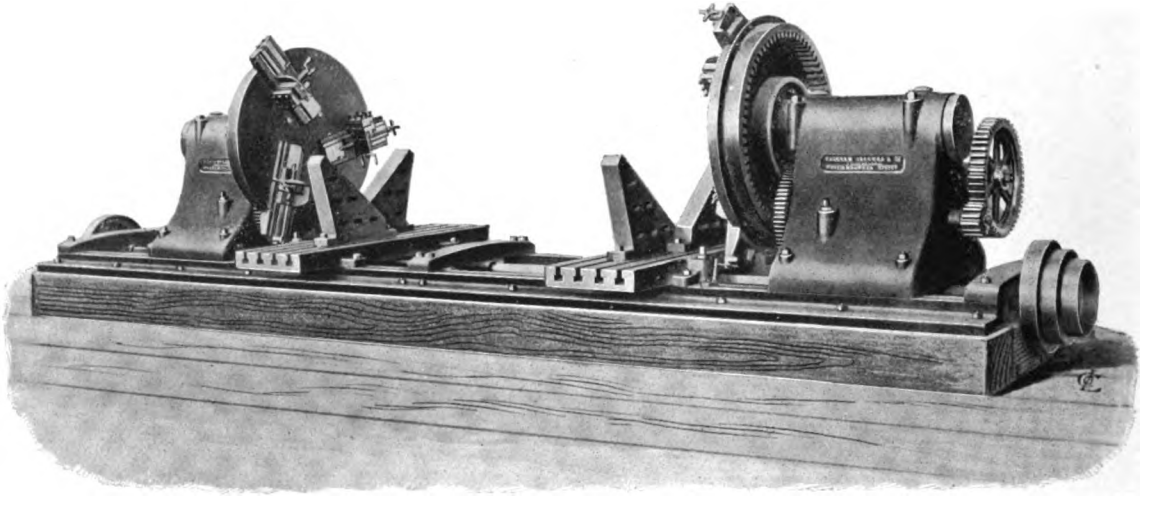


SIX-SPINDLE FACING MACHINE.

This machine is presented here as an illustration of one of those tools which are entirely special in character. This particular machine was designed to face the connections on a certain type of cast-iron boiler. The segments or units of the boiler are clasped in a chuck or holder, and the six cutters of the machine drawn up simultaneously or in groups of three, as preferred. The four outside spindles, with the boring-bars and cutters, are arranged in bearings which are adjustable to and from the centre to suit the various sizes of boilers, and are mounted upon two saddles, which slide on the bed of the machine. There is a prevalent idea that such a machine as this is not profitable unless there is sufficient work to keep it constantly employed; but, in fact, it frequently happens that the saving of time resulting from the use of such machines is so great, that it is profitable to employ them, although they are frequently out of use.

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PLATE NO. 39.

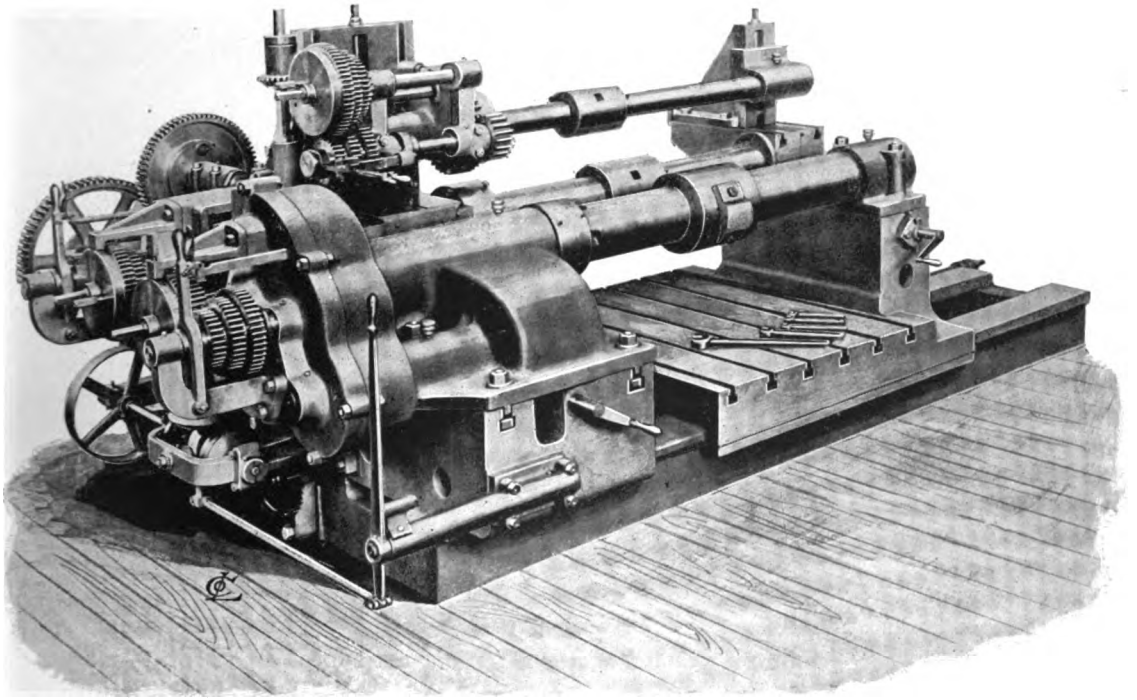


62″ FLANGE FACING MACHINE.

For facing simultaneously the flanges of large cast-iron pipes. Two adjustable tables with "V" blocks, in which the pipe can be held, and to which it may be bolted while the heads are also adjustable to suit the length of pipe to be faced. Heads and tables mounted on shoe-plates, carried upon foundation walls, are each moved by means of a pinion gearing into a vertical rack on one of the shoe-plates. There are three slides on each head, having a movement towards and from the centre, and also a movement perpendicular to the face-plates, which is used for regulating the depth of cut. A star-feed operates the long slides in facing. The machine is complete with shoe-plates for pipes 14′ long, and two countershafts—"V" blocks, ratchet wrench for moving heads, and full set of wrought-iron wrenches. The largest lift of the cone-pulleys is 24″ diameter, 3½″ face, and the ratio of gearing is 70 to 1. Fast and loose pulleys are 20″ diameter, 4″-belt. Two sets are provided which should make 120 and 200 revolutions per minute respectively.

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PLATE NO. 40.



TRIPLE BORING-MACHINE.—FOR CYLINDERS OF COMPOUND LOCOMOTIVES.

Designed especially for boring the cylinders and valve of the Vauclain Compound Locomotive. The work is carried upon a table, which also supports the outboard bearings for the boring-bars, and is adjustable along the bed to permit power, the work to be lifted from the table. The cutter-heads travel along their respective bars, which are proportioned to suit the diameters of the various cylinders. The bars are bolted to the spindles by flanges. Two bars are adjustable, so as to cover almost every position in which the three cylinders can be arranged. Each bar has its own feed-motion, operated by a lever working a toothed clutch. Back-feed for counterboring the ends of the cylinders. Table 5′ long by 4′ 1″ wide. The height from centre of the lower boring-bars to table, 21″. Machine has set of wrought-iron wrenches, three sample bars with cutter-heads complete, and outboard bearings for same. Countershaft has 24″ pulleys for 4″-belt, and extra countershaft for the table has 16″ pulleys, 2½″ face, speed of both, 250 revolutions per minute.

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Locomotive Cylinder Boring and Facing Machine.

"RECOMMENDED for the remarkable excellence of the general design, and for the sterling qualities that pervade the details throughout. This grand tool is an embodiment of all the tool virtues that can be enumerated, resulting in the transmission of mathematical truth and accuracy to the work performed, combined with great rapidity of execution and consequent economy, thus realizing the highest ideal conditions. Still more, this machine is constructed in such a manner as will enable it to maintain its inherent faculties unimpaired for a long time."—*See Introduction*, pages 6 to 12.

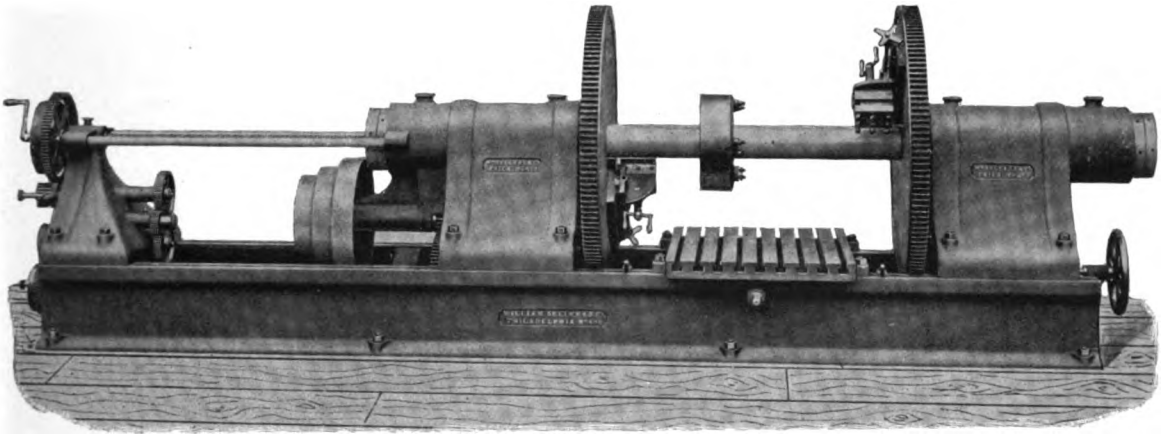


HIS is one of the most notable of the modern special tools; it was designed to bore locomotive cylinders; and is capable of boring and facing up the flanges, also counterboring for clearance of pistons at end of stroke of a cylinder of the largest size used in freight engines or express passenger engines, in three and a half hours. This is remarkable, when the quickest time ever known to have been made in the same work previous to the construction of this machine was *nine hours:* the usual time, however, being seldom less than thirteen hours on ordinary boring machines. In performing this work the same principle is brought into play that is mentioned in our notes on Boring Mills,—one cut with a fine feed takes out the greater part of the metal. While the roughing cut is being made, the sinking head is cut off by the face-plate slide-rests and the flanges turned up: two finishing cuts are then run through with a feed $\frac{1}{2}''$ broad, and the cylinder counterbored at end afterwards.

In case it is deemed advisable to turn the flanges up at a time when no cut is under operation, the increase of time still permits the work to be done in less than five hours to each cylinder. Fast and loose pulleys on over-head shaft are 18″ diameter, 4″-belt, and should run 140 revolutions per minute. This will give speed of cut on 22″ cylinder of 18′ per minute.

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PLATE NO. 41.



LOCOMOTIVE CYLINDER BORING AND FACING MACHINE.—FOR BORING LOCOMOTIVE CYLINDERS.

6″ steel boring-bar, driven at both ends of cylinder; independent slide-rests for facing off both ends of cylinder; six changes of boring-feed, with a quick hand-feed; usual cutter-heads to bore from 10″ to 22″. Bar draws entirely out of cylinder by hand or power, to allow the work to be shifted. Iron cone-pulleys turned inside, so as to be accurately balanced; over-head shaft, with ball-and-socket hangers and fast and loose pulleys, 18″ diameter, 4″ face, which should run 140 revolutions per minute. A full set of wrought-iron wrenches.

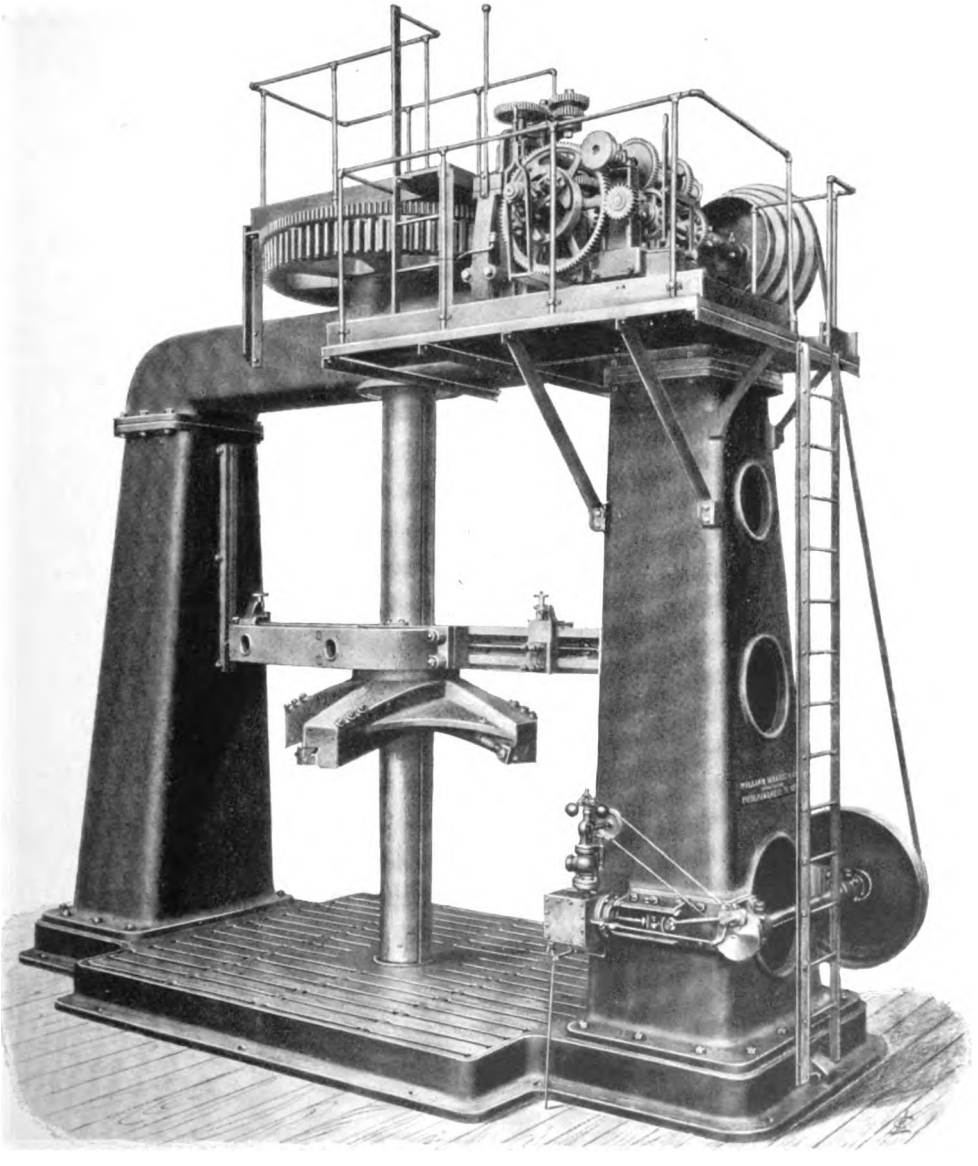
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Vertical Cylinder Boring-Machine.

THIS machine is intended for boring cylinders from 4′ to 9′ diameter, and up to 10′ long. It consists of a large bed-plate, carrying two massive uprights 13′ apart, joined at the top by a deep cross-beam, which carries the driving and feeding machinery and provides the upper bearing for the bar. The bar, which is 16″ in diameter, runs in a bushing in the cross-beam, and is supported by a step and bearing in the bed-plate. This bar is so arranged that it may be lifted up to clear the work when cylinders are being put into the machine or taken out. In lifting the bar, it passes through the large driving and feed-gears without disturbing them, as they are supported by the rotating bushing in which the bar slides. Upon the bar is a moving sleeve, provided with a central flange, and to this sleeve are secured the cutter-heads for various sizes of cylinders, and the double facing-rest which is used for turning off flanges of cylinders up to 10′ in diameter. The travelling sleeve is supported upon two feed-screws, which are provided with a hand adjustment, a power-feed variable from $\frac{1}{16}$″ to about $1\frac{3}{8}$″ per rotation of bar, and a rapid power traverse, by means of which the head can be quickly raised or lowered while the bar is standing at rest or rotating in either direction. The motive power is usually furnished by an 8″ x 8″ engine, bolted to one of the uprights, and carrying on the end of the crank-shaft a large cone-pulley. This cone is connected by belt to a corresponding cone on the cross-beam, from which the various movements of the machinery are actuated. The controlling levers, etc., are grouped together for convenient manipulation by an operator standing on a platform on the top of the machine, this platform being accessible by a ladder on one of the uprights. The variations in the power-feed are made through a set of change-wheels, and can be set for feeding either downward or upward.

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PLATE NO. 42.



VERTICAL CYLINDER BORING-MACHINE.

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The cutter-heads, of which there are three, covering the whole series of diameters, are arranged with adjustable tool-slides, and are especially designed to bore to the bottom of cylinders having a solid lower head. The cutter-heads are also arranged so that the same tools can be arranged to bore in either direction. In addition to the variations of speed obtainable through the cone-pulleys, the adjustable governor of the engine permits still further variation in the driving-speed. The train of gearing consists entirely of straight spur and bevel wheels, and is thus far more efficient and durable than any arrangement making use of worm gearing.

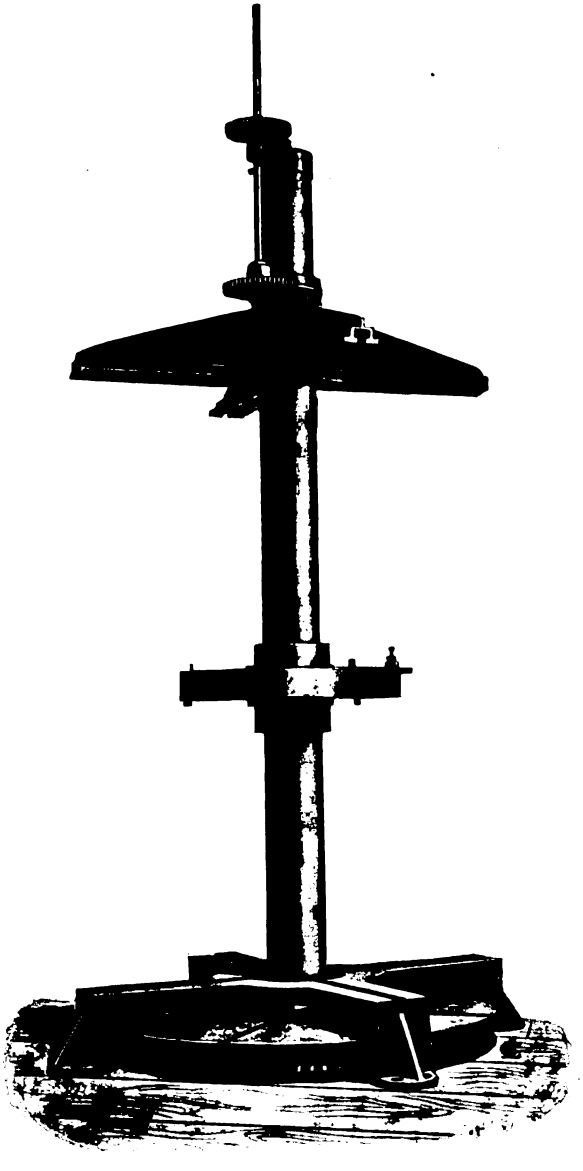
We are also prepared to build smaller machines of the same type, driven either by special engine, electric motor, or by belt from line shaft.

The Vertical Boring-Bar.

The vertical boring-bar illustrated in this plate is an admirable adjunct for one of our boring and turning mills. The spider spanning the face-plate or table of the boring-mill is used to carry the cylinder which it is desired to bore, while to the upper flanges of the cylinder is attached a second spider which forms bearing for the bar and operates the feed-gearing. The cutter-head travels up or down the bar as desired, the changes of feed being made by a swing-frame on the end of the bar. The bar shown is 10″ in diameter by 12′ long, and is capable of boring cylinders up to say 9′ in length. While not so efficient as the special boring machine just described, this device is really very serviceable in cases where the number of cylinders produced does not warrant the purchase of a special machine. This bar, which is bolted directly to the boring-mill table, may be removed when not required and the boring-mill employed for ordinary work.

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PLATE NO. 43.

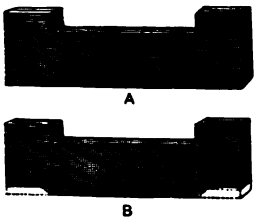


VERTICAL CYLINDER BORING-BAR.

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Pulley Boring-Machine.

THE demand for a boring-mill of simple and economical construction for car-wheels, pulleys, etc., led to the invention of the machine illustrated herewith which we patented a number of years ago. This is a useful tool for boring a great variety of work, using boring-bars with double-ended gib cutters, the bar being carried by a cross-head below the table, and readily removed when it is desired to use a larger or smaller one.



Owing to absence of uprights, wheels six feet in diameter may be bored on this mill, and, in some instances, where it is desirable to bore pulleys of larger diameter, the cone-pulley shaft has been lengthened to further increase the capacity.

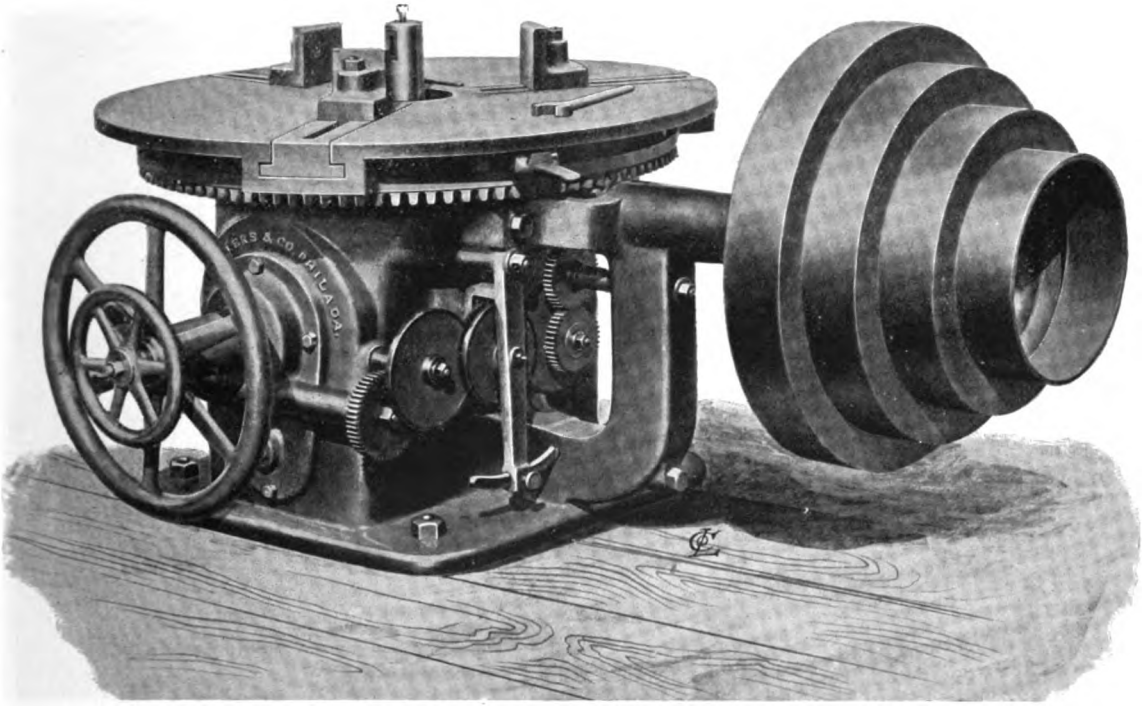
Proper guards are arranged to protect the sliding surfaces of the cross-head from chips which fall through the face-plate into a pit below the machine (as in mills where the bar is supported above the table), from which they can be removed when desired. The absence of any machinery above the table makes it very easy to place work upon the table and to set and fasten it in place.

The general shape of the cutters is indicated in Fig. A; they should be hardened at the ends only; as they become dull, they should be ground off on the side, as indicated in Fig. B; this affects the diameter but little.

The finishing cutter does not wear away very rapidly; in fact, its deterioration depends more upon the time taken to run it through the wheel than upon the amount of metal removed by it. A fine feed on the finishing cut wears the cutter more than a quick one. The coarser the feed, within reasonable limits, the longer the cutter will remain to size.

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PLATE NO. 44.



PULLEY BORING-MACHINE.—FOR PULLEYS, CAR-WHEELS, AND GENERAL WORK.

Table fitted with universal chuck, taking wheels 36″ in diameter. Will bore work up to 6′ in diameter if clamped to table. Cross-head for holding boring-bar counterbalanced and arranged with variable power-feed and quick hand-traverse in each direction. Sliding surfaces protected from chips, which can fall through bed of machine into pit in foundation. Length of boring-stroke, 14½″. Machine complete with countershaft, hangers, and full set of wrought-iron wrenches and lever to operate chuck. Sample boring-bar with machine, 2 1⅝″ diameter. Fast and loose pulleys on countershaft, 24″ diameter for 4″-belt. Speed of countershaft, 60 revolutions per minute.

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50″ Car-Wheel Boring-Mills.

"RECOMMENDED for the general excellence of design and construction, and the admirable adaptation to a special purpose, which has to be repeated an indefinite number of times in order to perform the operation accurately and economically. To meet these conditions, various adjustments are provided, by means of which the car-wheels are conveniently put on to the machine, then bored and faced, and removed from the machine in shorter time than would be required in the ordinary boring- and turning-lathe."—*See Introduction*, pages 6 to 12.

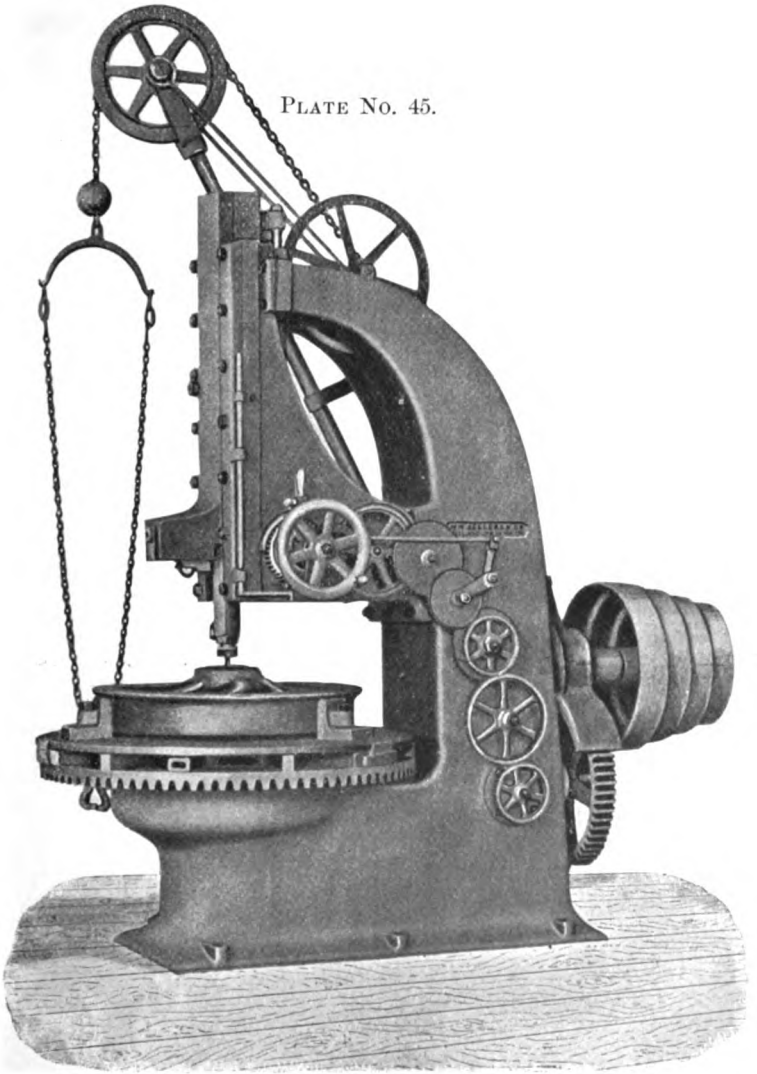


HESE machines have the same face-plate, chuck, and method of driving as the simple boring-mill illustrated on the previous page, but the boring-bar descends from above into the wheel, and may therefore be larger. We claim for the wheel-boring machine great convenience in manipulation, both as regards the stopping and starting of the feed and the method of placing the wheels in place by the power crane. We claim especial merit for the peculiar hub-facing attachment, which can be used for facing the narrow facing-strip on car-wheels without any lateral motion of the facing-tool, or the whole hub can be faced by feeding the tool over the face to be turned up. The claim we make for this device is that it is handy and does not prevent the use of any ordinary boring-bar, as the hub-facing attachment is distinct from the bar. The wearing-surfaces under the table are protected from chips and dirt by the extension of a cast-iron pipe in a stationary cylinder, which carries all the borings through to a pit below the machine and keeps the dust away from the bearings.

We were the first to introduce machines for boring in which the feeds are so arranged as to permit the roughing cut to be made on a comparatively fine feed but deep cut, while, on the other hand, the finishing cut is hurried through on a very coarse feed, taking off but little metal. It is now thirty years or more since we first made this principle an essential of boring-machines for car-wheels.

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PLATE NO. 45.



50″ CAR-WHEEL BORING-MILL, No. 1.

Table, 50″ diameter, with universal chuck for car-wheels, 42″ diameter and under. Improved friction-feed with automatic hold-fast. Improved double cutters. Crane attachment, with chain-sling and hooks, arranged to stop automatically at top and bottom of hoist. Facing-rest for ends of hubs. 24″ by 4″ pulleys on countershaft, 134 revolutions per minute; 18″ by 6″ pulleys, 290 revolutions per minute.

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Patent 50″ Car-Wheel Boring-Mill.

IN this novel machine we have designed to save the time heretofore lost in setting, centring, and removing the wheel from the mill, by making these operations practically automatic, and we have thereby succeeded in not only increasing the capacity of the machine, but in reducing the labor and responsibility of the attendant, and removing altogether the liability to error on his part in truly centring the wheel. These results are secured by means of a self-closing universal chuck on the table, so arranged that the act of starting the machine causes the chuck to close upon the work and hold it securely in the true position for boring. *Per contra*, the stopping of the table automatically opens the jaws and releases the work.

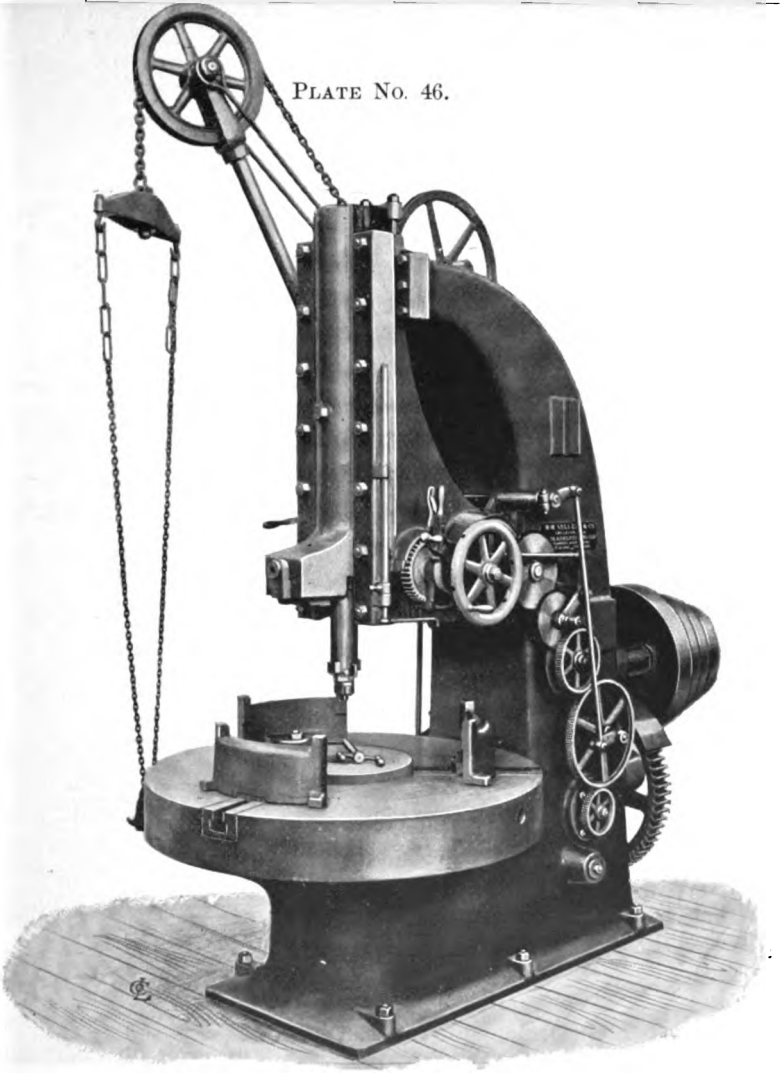
The time heretofore lost in the gradual stopping of the rotation of the table is also saved, as in this apparatus the table may be stopped instantly, without shock, by the simple movement of a hand-lever.

An unusually stiff boring-bar, with double cutters having four cutting edges, insures quick and accurate boring of wheels which are hard in the hub, a common source of trouble in less powerful machines. The value of the double cutter, with its four cutting faces, has been demonstrated by years of use, and the simplicity of the locking device on this mill, permitting, as it does, change of cutters without loss of time, will commend itself to every practical mechanic.

A special crane designed for and attached to this mill is a convenient auxiliary, and contributes to the increased speed of the machine and decreased labor of the attendant. The mechanism of the crane is such that when the wheel is raised to the proper height for swinging on the table, the hoist automatically stops, and when the attendant has swung the wheel into position it gently drops into its seat.

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PLATE NO. 46.



50″ CAR-WHEEL BORING-MILL, No. 2.

With self-closing and self-centring chuck for 42″ car-wheels. Table, 50″. Largest lift of cone-pulley, 24″ for 4″-belt. Ratio of gearing about 25 to 1. Improved friction discs, with automatic hold-fast. Feeds from .04″ to .87″ per turn of table. Machine complete with countershaft, crane attachment with chain-sling and hooks, arranged to stop automatically at top or bottom of stroke. Slide-rest for facing hubs and gauge for length. Sample boring-bar, 3½″ in diameter, with sample set of improved double cutters. Set of wrought-iron wrenches. Two sets of fast and loose pulleys on countershaft. 24″ by 4″ pulleys, 134 revolutions per minute; 18″ by 6″ pulleys, 290 revolutions per minute.

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Boring- and Turning-Mills.

"RECOMMENDED for sterling qualities as a machine tool, more especially with reference to its utility and accuracy. It is also distinguished for the manner in which the material is disposed as well as in regard to the forms and general proportions of the parts, and its adaptation to the intended special purpose, to obtain mechanical truth and accuracy at a moderate cost."—*See Introduction*, pages 6 to 12.

THE utility of machines of this type, combining as they do the functions of two separate tools, and possessing in addition thereto certain specific advantages, has given to them a permanent position in engineering establishments in this country. Considered merely as a turning-lathe, the facility of "chucking" on the horizontal face-plate, permitting the work to be laid upon it and moved about until centred and then clamped, is an important feature.

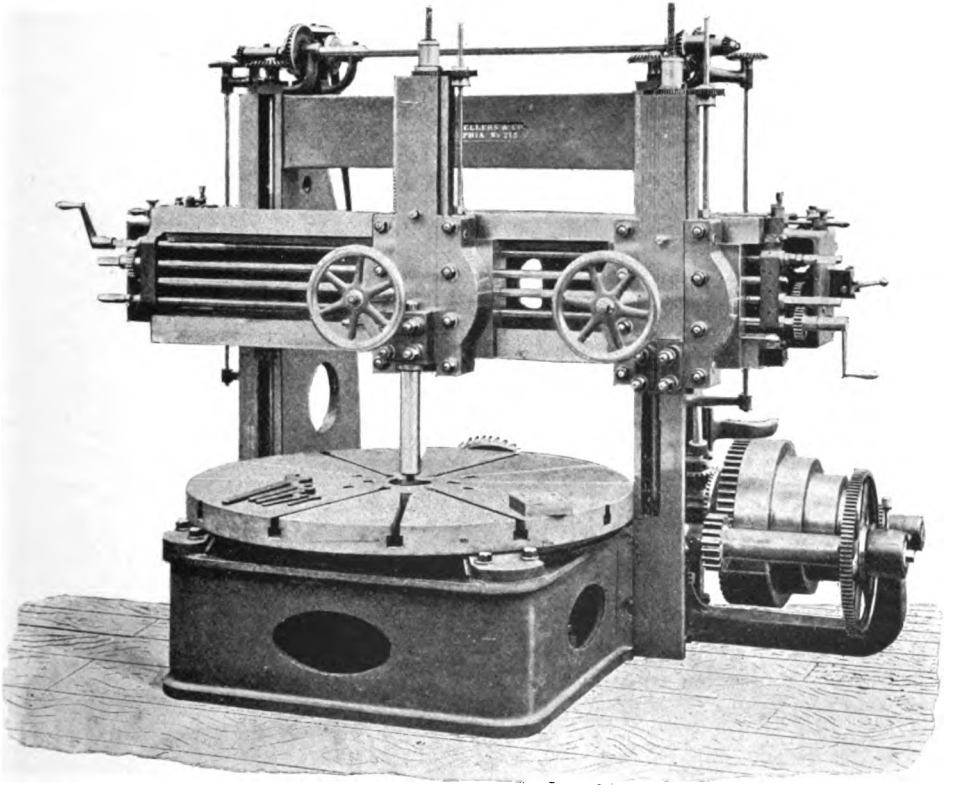
The weight of the revolving face-plate carrying the work is distributed over large bearings directly beneath the table; a more favorable condition for permanent stability than obtains in a lathe where the work, attached to a face-plate, overhangs the front bearing and depends upon the stiffness of the spindle for the character of its support.

Besides the ordinary operations of boring and turning of wheels, tires, pulleys, etc., mills of this type may be used advantageously and economically for a variety of other work, as, for example, in locomotive shops, where numbers of driving-boxes are placed in a circle on the face-plate and faced off at one operation.

The great usefulness and range of application of these mills are now so well known to all engineering establishments, in this country at least, as to make general commendation superfluous. We have given the subject special attention for many years; in fact, we practically made this machine known to American shops, and

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PLATE NO. 47.



5-FOOT BORING- AND TURNING-MILL.—WITH TWO SADDLES.

Independent feeds, operated by friction discs at each end of cross-head. Power lifting device for cross-head, by means of bevel friction gearing. Table, 60″ in diameter. Height under cross-head, 33″. Table driven by powerful bevel gear. Revolutions of cone-pulley per revolutions of table with cone locked, 20 to 1; with back-gear in, 147 to 1. Feeds variable from about .01″ to about $\frac{9}{16}$″ per turn of table. Complete with countershaft, sample boring-bar, 3″ in diameter, and full set of wrought-iron wrenches. Largest lift of cone, 24″ for 4″-belt. Fast and loose pulleys on countershaft, 20″ diameter, 5″ face. Should make 150 revolutions per minute.

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features which we introduced long ago have now generally been adopted by other builders. We refer particularly to the form of the uprights, the box-like bed with projecting corners, and the use of the sides as well as the top of the bed as bearing and clamping surfaces for the uprights. The projecting corners of the bed are to permit the use of a spider to carry large cylinders, etc., over the table, while the latter is employed in driving a boring-bar (see Plate 43) with travelling cutter-head fed by a screw from gearing connected with a top spider fastened to the upper end of the cylinder. In all our constructions of this machine, however, it has been self-contained, that is, not dependent for its stability upon supplemental devices below the shop-floor, and this is still maintained, as its advantage is confirmed by all our experience. We have increased the proportions of the parts from time to time, to meet the demands due to the general use of steel castings, steel forgings, etc., and we now guide the table laterally by a large centre spindle revolving in a bushed bearing in the bed. In the majority of our mills the table has also a centre step, very conveniently adjusted from one side of the bed, so that any desired amount of the vertical strain may be relieved from the outer annular bearing. The lever for this step is the only portion of the machine extending below the floor line, and is accommodated by a trough about six inches wide and of same depth.

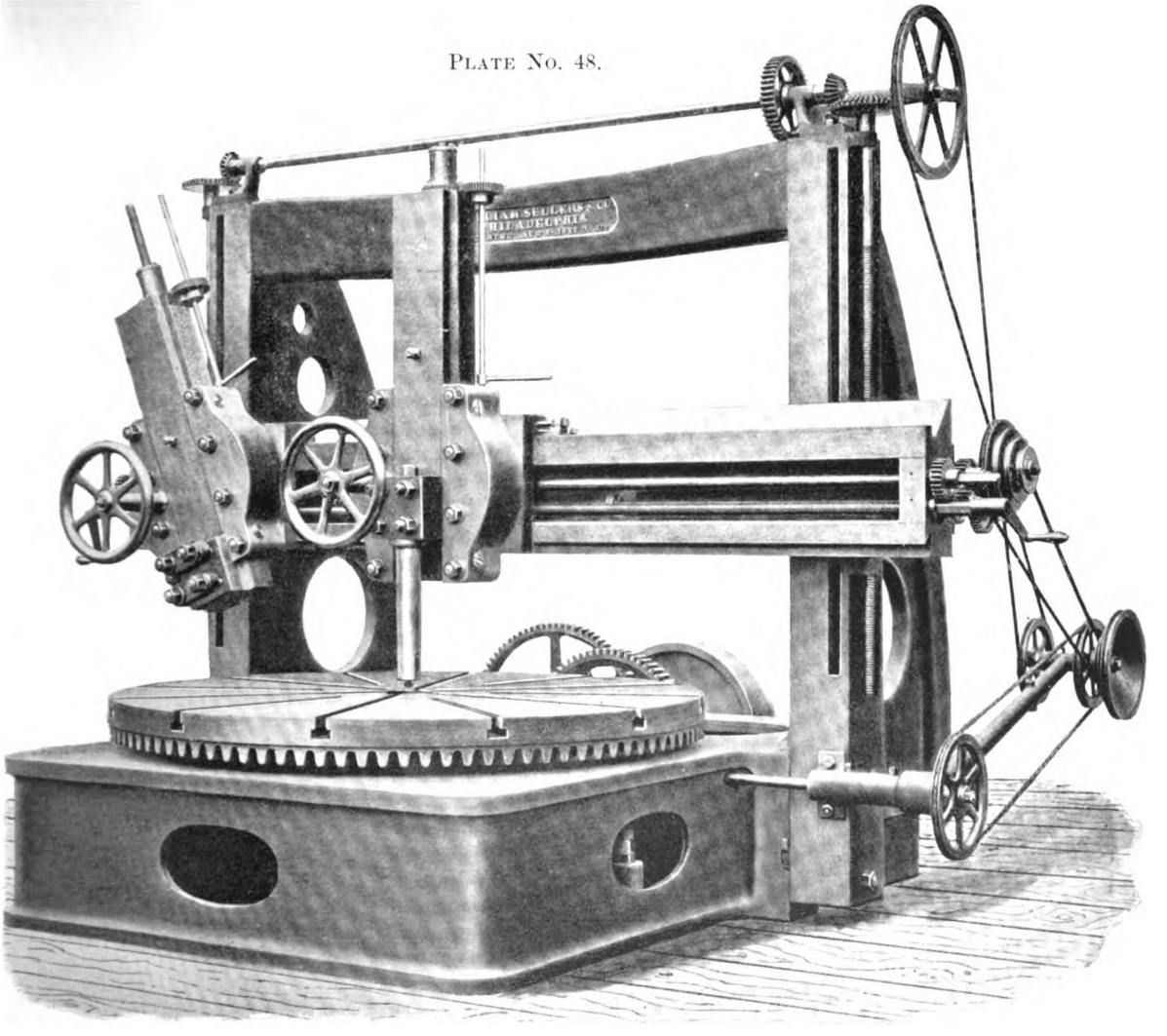
The machine may be set upon a solid floor by raising it to clear the step-lever, or, if a foundation is prepared for it, a pit should be left under the centre of the table to collect the chips which fall through. The step does not prevent the free passage of the chips into the pit. The cross-head is raised and lowered by power.

Feeds.

The feeds have a wide range, and when two slide-rests are used (which is now almost universal) the feeds to each are separate.

The feeds are so arranged as to enable the roughing-cut to be made with fine feed and the finishing-cut with broad feed, thus minimizing the wear of the finishing tool, an important item of economy.

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7-FOOT BORING- AND TURNING-MILL.—WITH EXTRA SADDLE, BEVELLED-GEARED TABLE.

Diameter of table, 5′ 6″. Greatest height under cross-head, 43″. Greatest height under projecting saddle, 39¾″. Vertical slides with 22″ stroke. Only one saddle will go to centre of table. Feeds operated by cord-cone and swing-frame. Cross-head lifted by power. Cone-pulley, 24″ in diameter on largest lift, by 3⅞″. Complete with counterbalancing arrangements for vertical slides. Overhead countershaft and hangers; full set of wrought-iron wrenches and sample boring-bar. Countershaft should make 90 revolutions per minute. Fast and loose pulleys, 22″ diameter, 5″ face. Table also made 80″ diameter.

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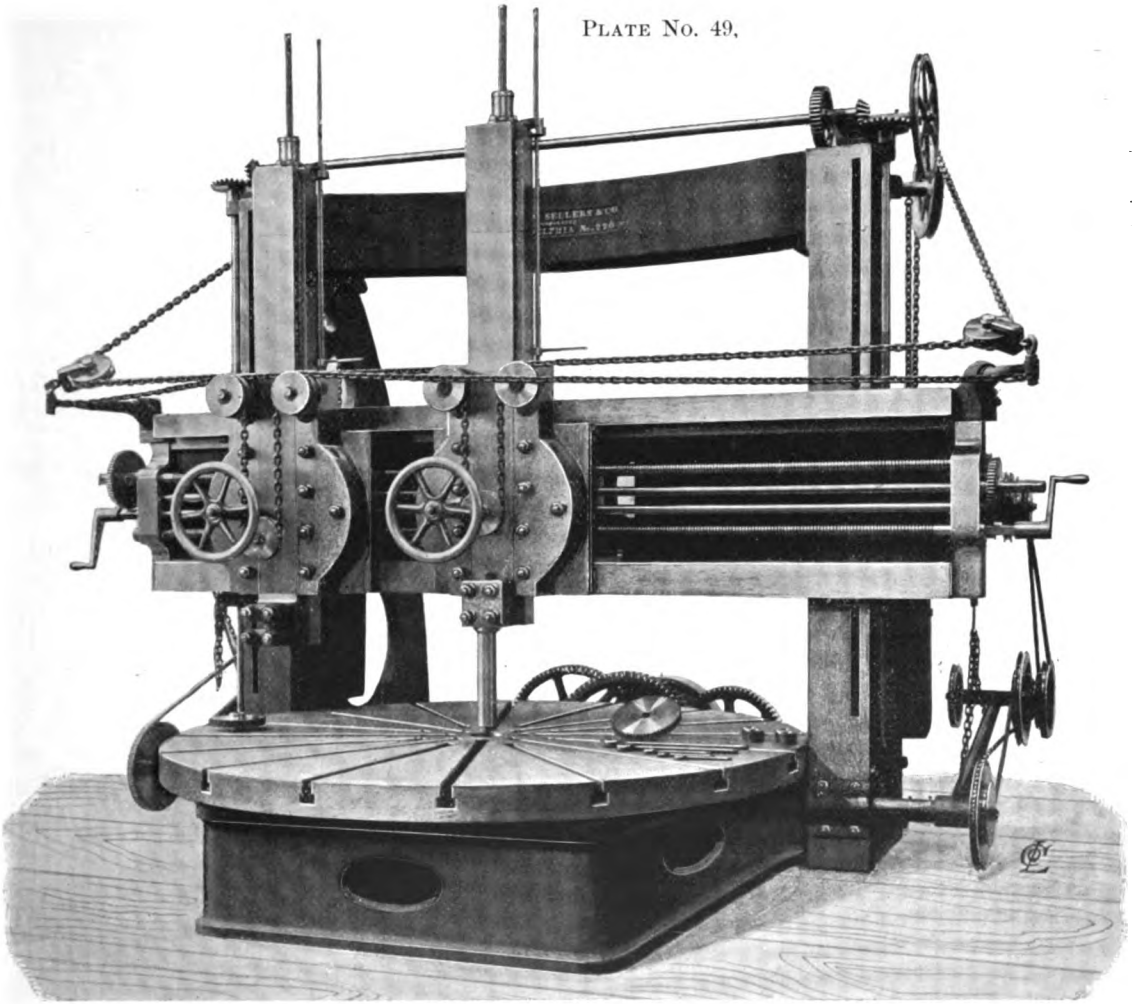
The vertical power-feed in the saddles is produced by a screw of quick pitch, which is operated through bevel gears by a splined rod in the cross-head, and as the nut is made in two parts, arranged to open easily, the feed may be engaged or disengaged at will by the operator standing at the saddle, without the necessity of going to the end of the cross-head. Quick hand adjustments of the slide in the saddle are made by rack and pinion. The hand-feed pinion is of forged steel and gears into a steel rack on the long vertical slide; this makes a convenient arrangement for occasional use in key-seating large work before it is removed from the mill, as the tool-slide can be moved up and down by the rack-pinion and the tool fed into the work from end of the cross-head. We make the pinion for this special purpose of a coarser pitch, and provide a hand-wheel with radial handles in the rim.

Counterbalance.

The slides of all our machines are counterbalanced either by the looped chain with counterweight sustained from upright, or by hook and wire rope passing over sheaves attached to the roof beams or to bracket from the wall. Of these, the former arrangement is self-contained, and does not interfere with the use of cranes in putting work on a mill; but the arrangement last described allows a greater range of angular adjustment in the vertical slides, and the slides of these mills are made so that they will assume any position from the vertical to the horizontal on either side of the centre. The slides are rectangular in form and are in the best shape to take the wear of torsional or other strains. Suitable adjusting shoes are provided. All the bearing surfaces are ample to insure stability and long wear.

Our most common sizes of mills will bore and turn the following diameters: 5, 7, 8, 10, 12, and 16 feet; but we are prepared to build these machines to the largest dimensions, and with uprights fixed or movable, with one, two, or three slide-rests, and with hand- or power-slotting attachments. Our power-slotting arrangement is not illustrated, but consists of a frame carried upon the top of the

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8-FOOT BORING- AND TURNING-MILL.

With centre spindle, bevel-geared table, with triple driving-gear. Extra heavy cross-head with two saddles; independent feed for each saddle. Table, 96″ diameter. Maximum height under cross-head, 55″. Steel vertical slides with 48″ stroke. Complete with full set of wrought-iron wrenches, countershaft, and sample boring-bar. Feeds variable from .02″ to .42″ per revolution of table. Speed of 22″ by 5″, fast and loose pulleys on countershaft, 100 rotations per minute.

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saddle and supported by the gross-girt of the machine. At the upper end of this frame is a gear-wheel provided with the Whitworth quick-return motion, driven by a pinion operated by a belt from a separate countershaft, through a swing frame arranged to compensate for the movements of the pulley either vertically or horizontally to suit the character of the work. The crank-wheel is coupled by a connecting rod with the vertical slide on the machine, which becomes, when disconnected from the screw and pinion, an excellent slotting bar, and can be used for quite a variety of work besides key-seating.

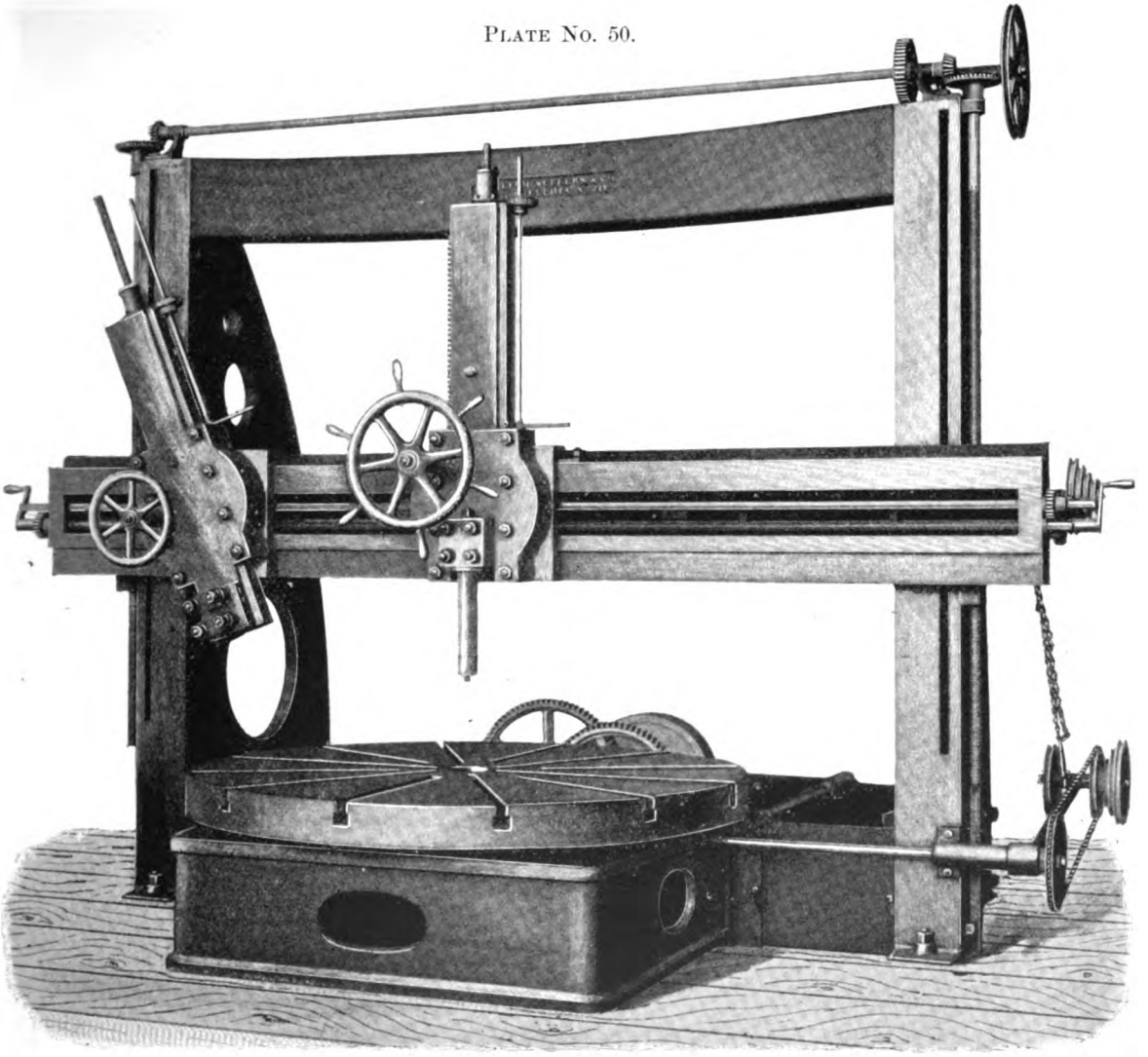
The tables of our boring-mills are provided with radial slots for holding work. They are stiff and massive. Where we use bevel gearing, the gears are made with strong teeth of coarse pitch, amply sufficient for their work, while the central bearing insures against any tendency to tip or rise.

Special Mills.

We build a series of extra heavy mills, especially designed for steel tires, gun rings, and similar work. Of these our five feet and seven feet sizes are shown in Plates 51 and 52.

These are very powerful machines, with entirely independent feeds, both horizontal and vertical, operated through our improved friction discs. The feeds are arranged in two series, and are provided with a counterweighted releasing device which opens if the feed mechanism be from any cause unduly overloaded. The cross-head used on these mills is of very massive construction, and embraces the saddle by its top and bottom edges, so that the saddle slides entirely within the cross-head and the wearing surfaces are made perpendicular to the direction of the pull or thrust. The cross-head is of great depth and is stiffened by an arch in the back, while the main tie between the top and bottom flanges extends throughout the length of the cross-head, thus making it extremely stiff both vertically and horizontally.

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10-FOOT BORING- AND TURNING-MILL.—WITH TWO SADDLES AND SPLINING ARRANGEMENT.

Diameter of table, 80″. Height under cross-head, 78″. Steel vertical slides, 36″ stroke. Cross-head lifted by power. Separate screw and feed-rod for each saddle. One saddle with coarse rack on vertical slide, and enlarged hand-wheel for cutting key-seats. Counterbalances for slides. Countershaft, set of wrought-iron wrenches, and sample boring-bar. Fast and loose pulleys on countershaft, 22″ diameter by 5″ face. Speed, 90 revolutions per minute.

NOTE.—Also made with additional change of gearing in driving arrangement, giving 15 speeds.

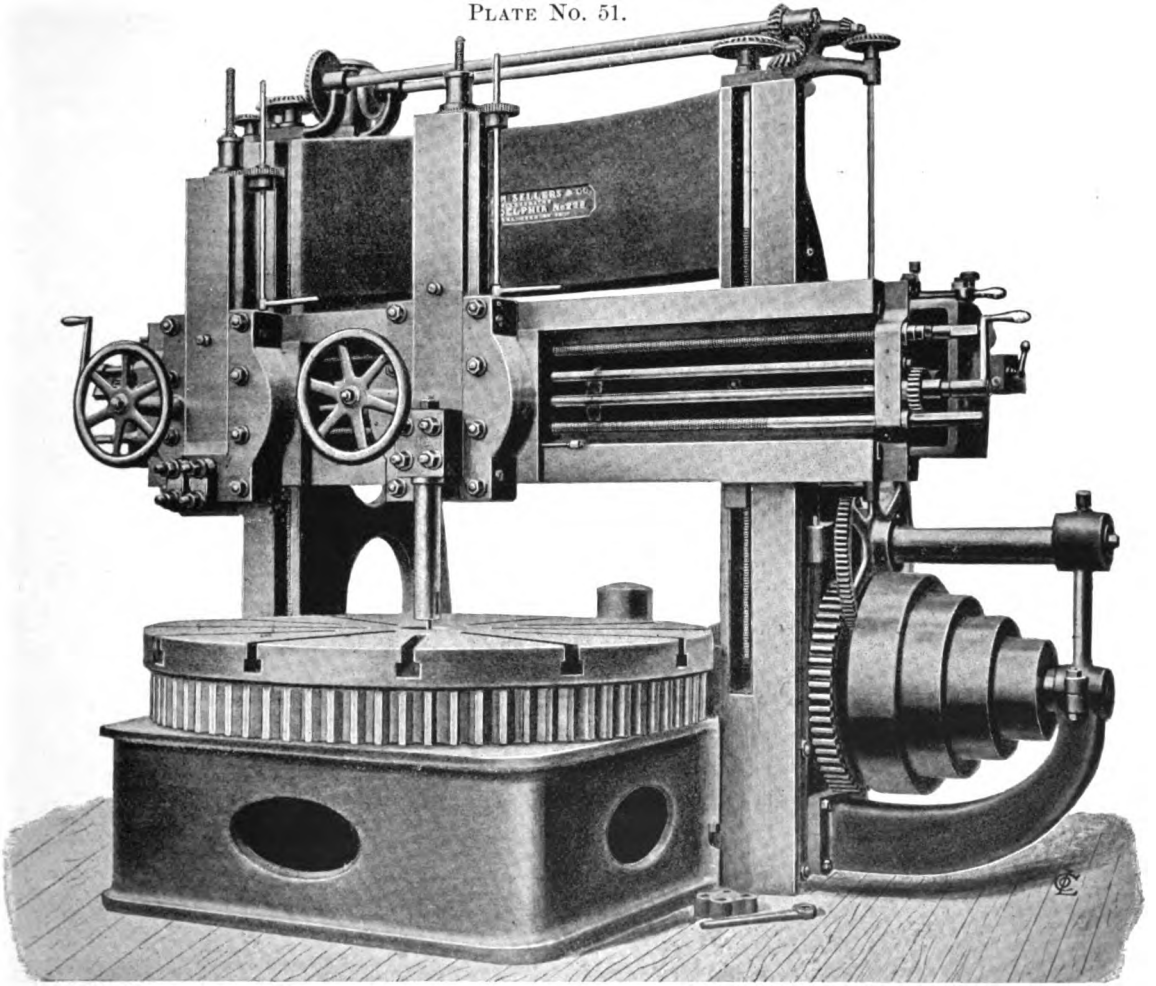
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The cross-head is lifted by our improved bevel friction arrangement. The table has cut-spur teeth near its circumference, driven by a steel pinion on a vertical shaft, connected by bevels with the driving arrangement. To prevent breaking of gearing, a short pin of hard steel is provided in the driving-train, which will shear in case of excessive overload. Arrangements are made for quickly replacing the pin. The table may be provided with a drip-lip to prevent soda water from getting into the gears, and when required we stop up the ends of the bolt slots and arrange for draining into the centre hole. We illustrate in Plate 53 a boring- and turning-mill capable of taking work twelve feet in diameter, which is a good type of our larger machines. The cross-head is of our improved form, having the saddles carried within the cross-head, and independent feeds to both saddles, operated through friction discs and provided with weighted releasing devices, which will throw out in case the feeding pressure becomes excessive. The feeds are independent in direction and amount, there being a feed-box at each end of the cross-head. Cross-head is raised and lowered by power through our bevel friction gearing. The slides of the saddles are of steel, provided with screw-feed and rapid hand adjustment by rack. They are counterbalanced. The table is carried upon a flat, annular bearing, and has also a central spindle which centres and guides the table. This spindle rotates in a removable bushing in the bed, and the lower end of the spindle is carried upon an adjustable step-bearing which can be arranged to take any portion of the load desired. This step-bearing is supported by a regulating bar from the under side of the bed, so that the machine is entirely self-contained and no separate foundations are required for any portion of it. The table is large in diameter, is provided with spur gearing having cut teeth, driven by a steel pinion on a vertical shaft, and the teeth of the pinion are protected by carefully arranged guards from any danger of falling chips or dirt.

The machine is triple-geared, with fifteen changes of speed, and a shearing-pin in hardened bushings is introduced which will yield in case of excessive overload. The feeds are in two series, varying from .01″ to .32″ in the slow series, and from

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PLATE NO. 51.



EXTRA HEAVY 5-FOOT MILL.—DESIGNED FOR STEEL WORK.

Diameter of table, 61″. Height under cross-head in highest position, 36″. Steel vertical slides, having 22″ stroke. Two saddles on cross-head with independent feed-motions, operated by feeding mechanism at each end of the cross-head. Feed mechanism and driving-gear provided with safety devices. Cross-head lifted by power. Spur driving-gear for table, all cut teeth. Feeds adjustable from .01″ to 1″ per turn of table. Largest lift of cone-pulley, 24″ and 4″ face. Full set of wrought-iron wrenches, sample boring-bar, overhead countershaft, and counterbalances for vertical slides. 20″ by 5¼″ fast and loose pulleys on countershaft. Should make 110 revolutions per minute.

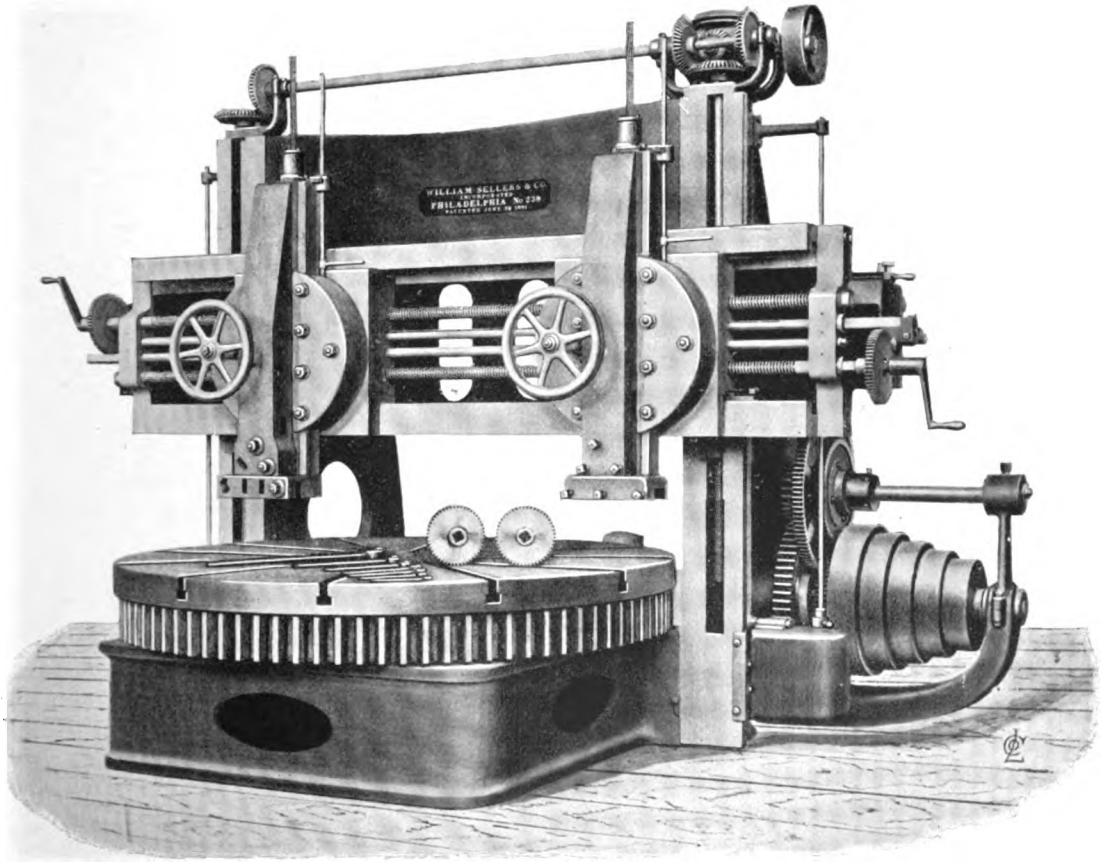
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.05″ to 1¼″ per turn of table in the fast series. This machine is in every respect massive and strong, and is designed for heavy work.

The boring and turning mill illustrated in Plate 54 is similar to that just described, but is arranged with uprights to slide back on the bed, thus increasing the capacity of the mill to sixteen feet in diameter. The bed is extended back to support the uprights when they are moved out of normal position, and the uprights are carried upon ribs raised on the edges of the bed, to which they are secured by short bolts of large diameter, by the fit of which we insure absolute alignment of the uprights at various points, especially when in their initial position. We desire to call particular attention to the fact that this construction makes the movable uprights as stable as those in a machine with fixed uprights, which is a very important consideration, and one that is not always properly provided for. The uprights are moved back and forth by power, the mechanism for the purpose being operated by bevel friction wheels, driving from a separate countershaft. This machine is made with either two or three saddles, the third being designed only for certain kinds of work, where it is desired to bore out the centre at the same time that the two other saddles are turning other portions of the work. For rapid hand adjustment of the saddles along the cross-head a chain is provided, passing over sprocket wheels at the ends, and means are provided for coupling this chain to either saddle as desired, the nut on the feed-screw being at the same time opened to permit the saddle to move freely; the same motion which connects the chain opens the nut. When it is required to move either saddle a considerable distance, it is simply connected to the chain, and a revolution of the spider at the end of the cross-head brings the saddle promptly to the required point, when the chain is disengaged and the nut closed around the screw ready for the power-feed.

Both mills just described have tables 10′ diameter and a maximum clear height under the cross-head of 9′ 6¾″. The stroke of the steel vertical slides is 48″. Largest lift of cone-pulley is 24″ diameter by 4″ face, and maximum ratio of gearing is 451 to 1. Fast and loose pulleys on countershaft are 22″ diameter, 5″ face, and should make 250 revolutions per minute.

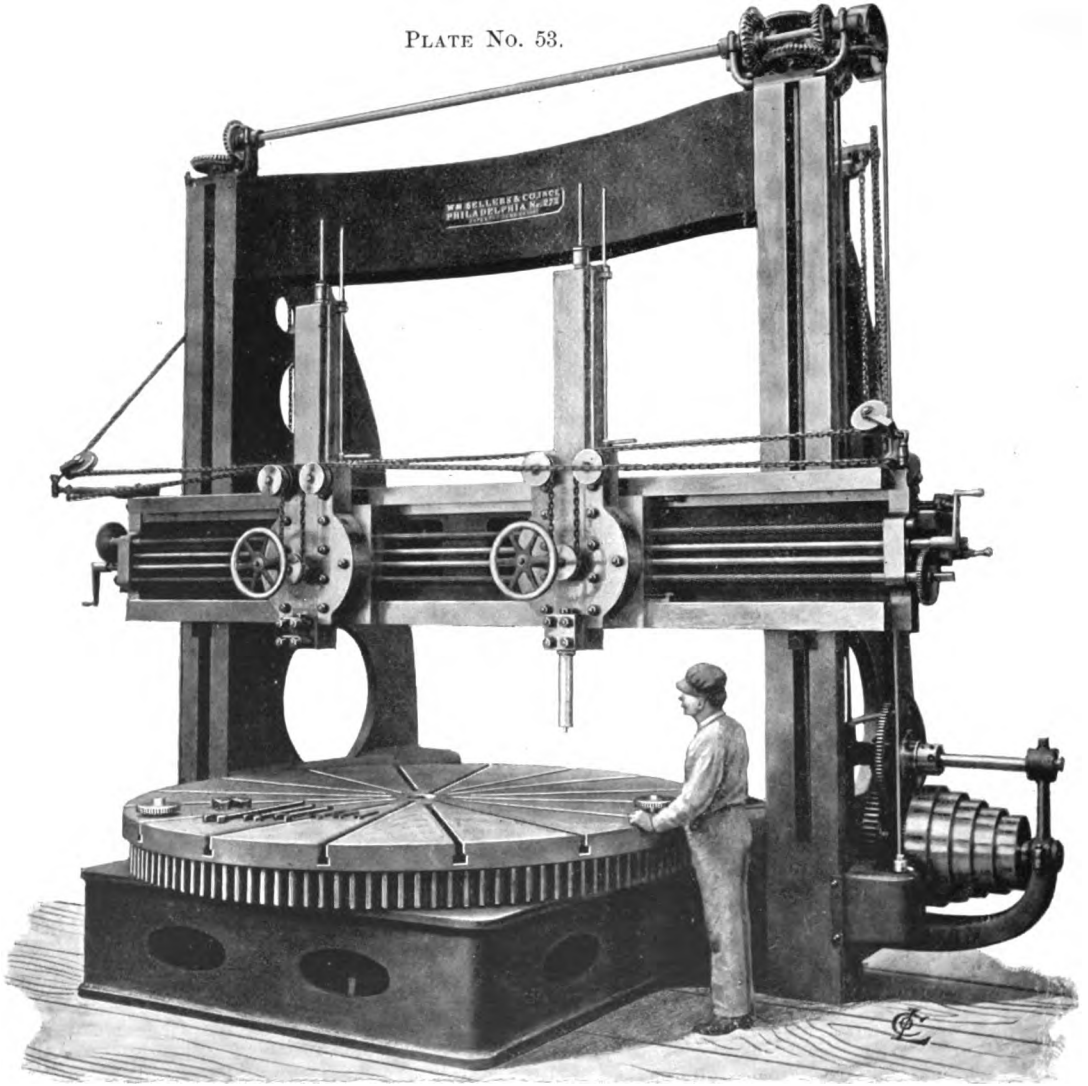
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EXTRA HEAVY 7-FOOT BORING-MILL.—WITH TRIPLE GEARING, SPUR-GEARED TABLE.

This machine is designed especially for very heavy work in steel, such as locomotive tires. Table, 84″ diameter. Height under cross-head in highest position, 39″. Depth of cross-head bar, 30⅜″. Steel vertical slides of stroke of 26½″, with special detachable tool-holders, designed for tire and ring work. Cross-head raised and lowered by power. Two saddles, having independent feed-motions, operated from mechanism at both ends of cross-head. Feed mechanism and driving-gear provided with safety devices to prevent breakage by overloading gearing. Cone-pulley has five lifts, and there are two changes of gearing, making 15 distinct speeds. Spur-gearing for table is all cut. Full set of wrought-iron wrenches, complete overhead countershaft and hangers. Speed of countershaft should be 280 revolutions per minute. Fast and loose pulleys on countershaft, 22″ diameter, 5″ face.

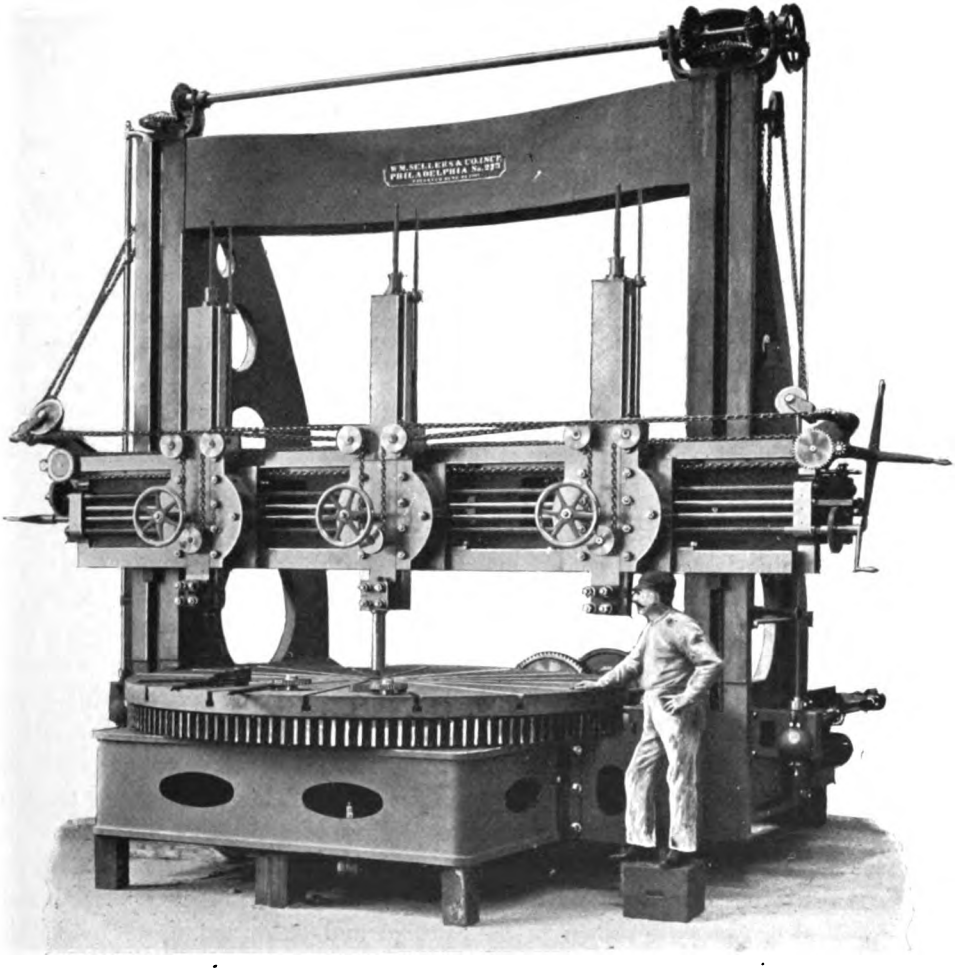
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12-FOOT BORING- AND TURNING-MILL.—WITH TWO SADDLES.

Table, 10′ diameter, 9′ 6¾″ under cross-head. Steel vertical slides, 4′ stroke. Independent feeds of great range. Safety devices in feed- and driving-gear. Power lifting device for cross-head. Spur-geared table, steel pinions. Adjustable centre step. Fast and loose pulleys, 22″ by 5″. 250 revolutions per minute.

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12-FOOT BORING- AND TURNING-MILL.—WITH THREE SADDLES.

Uprights arranged to slide back by power, to turn 16′ diameter. Table, 10′ diameter. Height under cross-head, 9′ 6¾″. Steel vertical slides, 4′ stroke. Independent feeds of great range. Safety devices in feed- and driving-gear. Power lifting gear for cross-head. Pulleys, 22″ by 5″. 250 revolutions per minute.

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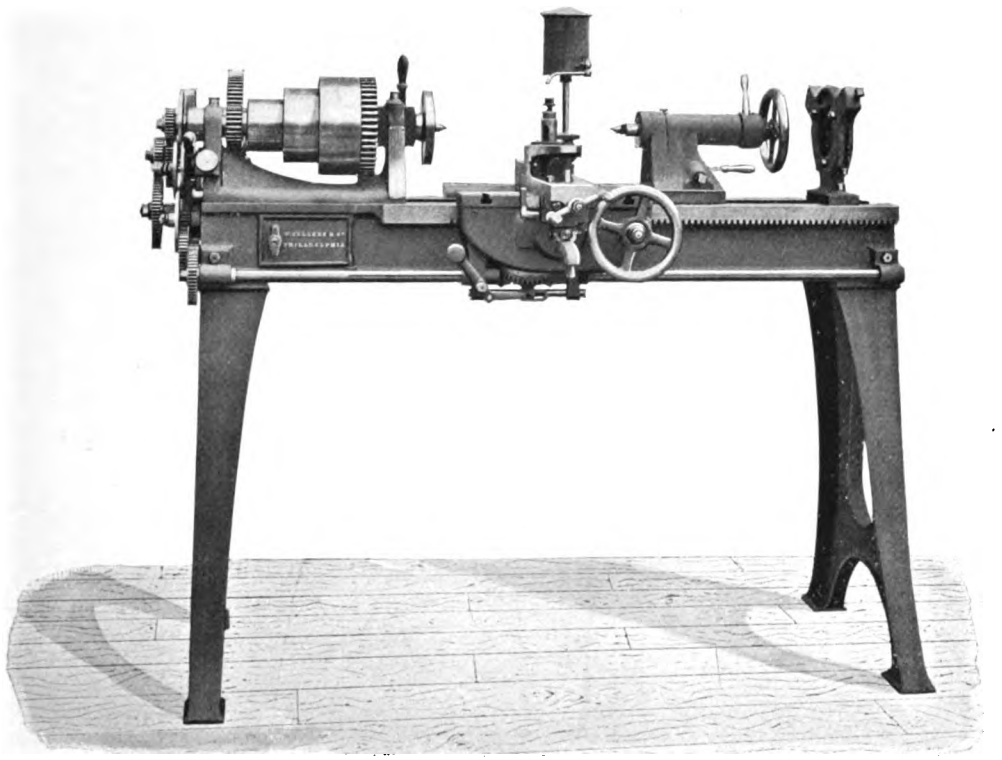
Self-Acting and Screw-Cutting Lathes.

"RECOMMENDED for general excellence and extreme mechanical refinement in all the details that determine accuracy of production in regard to true circles, true cylinders, and true planes. For originality in the method adopted for fixing the shifting head, the introduction of an under V within the bed, whereby the head is always drawn up to the same straight line in the mathematical sense, and thus avoiding the necessity of a tight fit, and its attendant disadvantages. For the adoption of a method which insures the retention of truth in spindles, and more especially in their relation to their centres. For originality both in the conception and design of an admirable system of feed motion, consisting of a simple combination of discs, whereby the feed rate may be altered from one extreme to another, or to any intermediate point, by a momentary touch of the attendant, thus affording the skilful and zealous workman an opportunity of developing the produce of the lathe to its utmost capacity, and along with that the reduction of cost."—*See Introduction*, pages 6 to 12.

ONE of the most important of all machine tools, as it is the oldest, is the turning-lathe, and a vast amount of thought and ingenuity has been expended upon its improvement. It is a long step from the little hand-tool of the ancient worker in metals to the gigantic gun-lathe one hundred and thirty-three feet in length, weighing two hundred and fifty tons, shown in the illustration on pages 136 and 137. Yet the connection between this great machine,—having all the improvements contributed by past experience and embodying many entirely new features,—and its diminutive ancient prototype may be clearly traced; such a history, though beyond the scope of this work, would present an epitome of the united skill and practical experience of generations of mechanics.

The fundamental principles of the turning-lathe are extremely simple, while the modern accessories are complex, and the difference in merit between "lathes and lathes" is due to the skill shown in their design and construction, whereby it is possible to combine the greatest accuracy of work with the largest output and the smallest wear upon the machine; the accomplishment of these results has been our constant aim, believing that such desirable attainments will more than offset in the

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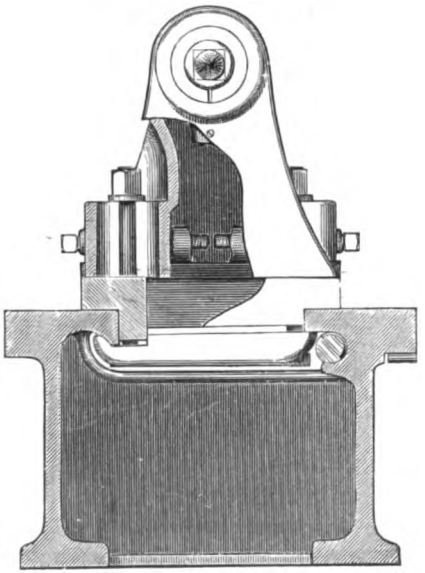
12″ PATENT SELF-ACTING SLIDE-LATHE.—TURNING AND SCREW-CUTTING FEEDS.

Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp; concentric hold-fast for poppet spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch; direction of turning-feed controlled by lever on saddle. Lead screw, used for screw cutting only, supported throughout its entire length and protected from chips. Maximum swing over bed, 12″; over slide-rest, $8\frac{5}{8}$″ diameter. Improved friction discs giving instantly any feed required, between limits. Largest lift of cone-pulley, 8″. Width of belt, $2\frac{1}{2}$″. Ratio of back-gears about 7 to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Countershaft pulleys, 8″ diameter for 3″ open and cross belts, should make 160 and 320 turns per minute. Follow-rest and taper attachments extra, if required.

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increased product of the machines, any arguments in favor of cheaper lathes; these are, in fact, cardinal principles of long standing in our establishment, and applied to all our machines, to which we partly attribute the favorable reputation they have won, both at home and abroad, not only among our customers, but also as shown by our imitators.

Recent important improvements in our self-acting slide-lathes call for a description of the changes made and a statement of the advantages gained thereby.

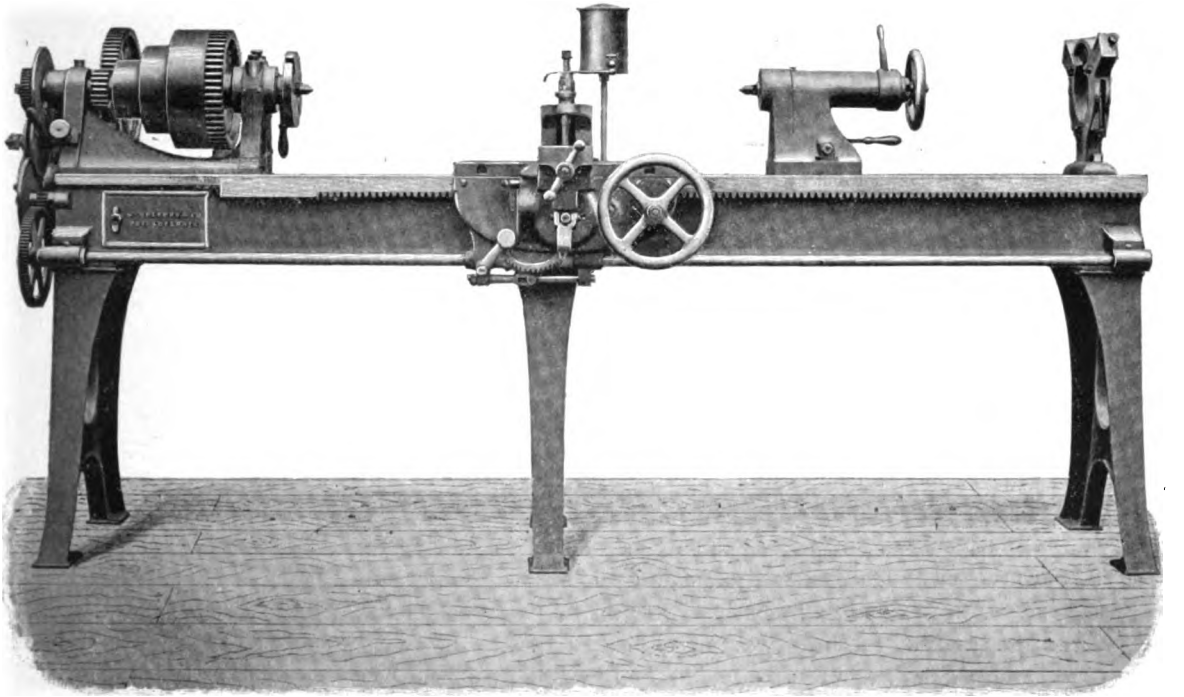


Bed or Shear.

In reference to the bed or shear, we uniformly make what is known as the flat-top shear, not the V shear. We changed to this form of lathe-bed believing it to possess many advantages, not the least of which is, that by its use we are

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PLATE NO. 56.



16″ SELF-ACTING SLIDE-LATHE.—TURNING AND SCREW-CUTTING FEEDS.

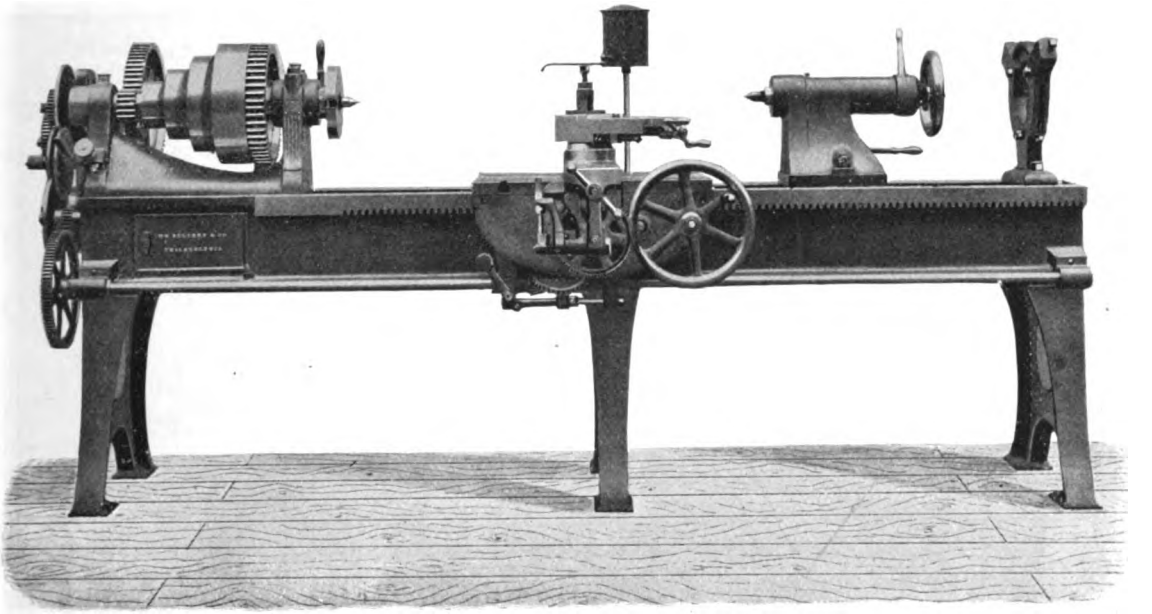
Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest with power cross-feed. Lead-screw, used for screw-cutting only, supported throughout its entire length, and protected from chips. Maximum swing over bed, 16″. Over slide-rest, 11¾″ diameter. Improved friction discs giving instantly any feed required between limits. Largest lift of cone-pulley, 11″. Width of belt, 2½″. Ratio of back-gears about 9 to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Countershaft pulleys, 9″ diameter for 3″ open and cross belts, and should make 145 and 290 revolutions per minute. Follow-rest and taper attachments extra, if required.

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enabled to obtain a greater capacity of swing over the slide-rest than is possible with the ordinary V shear. Recognizing the difficulty of insuring accuracy of alignment of the fixed and the movable heads, when the latter is guided by the inner edges of the opening in the centre of the shear surface only, we added a V to the under side of one of these edges. This V is made use of to hold the poppet-head up to one of the straight sides of the opening in the centre of the lathe-shear, when the head is clamped fast, and yet permits absolute freedom of motion when it is loosened for adjustment to place. When the outside guiding edges of the flat-top shear are bevelled at an angle inclining inwards from the face of the shear as is customary, and these angular faces made to receive the holding-down shoes or gibs of the slide-rest, there arise complications which it is desirable to avoid. In the first place, the wearing down of the top surface of the shear not only loosens the fit of the slide-rest at the worn part (even if there is no wear on the guiding edges), but permits the movement of the slide-rest sideways to the extent of this looseness; thus producing a greater disturbance of the tool line than is due to the mere change of position vertically, at the circumference of the work being turned. It also necessitates the entire readjustment of all the surfaces as soon as the lathe shows deviation from truth in turning, no matter whether the wear be on the horizontal surface or on the edges of the bed; wear on either part producing the same effect on the work done in the lathe. By making the guiding edges of the top of the shear at right angles to the horizontal plane of the shear top, that is to say, by making them vertical and not inclined, we separate the components of the adjustment, and cause each to be independent of the other. It has been demonstrated to our entire satisfaction, that in the case of the flat-top shear, the wear from long use occurs on the flat upper surface to a much greater extent than on the guiding edges of the bed against which the gibs press, this to such an extent as to warrant us in saying that the wear on the edges is practically of little moment, and is not perceptible after years of use. By making the edges of the shear vertical, the pressure to produce wear is diminished, and any wear of the upper flat surface does not loosen the slide-rest sidewise, so that

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PLATE NO. 57.



20″ SELF-ACTING SLIDE-LATHE.—TURNING AND SCREW-CUTTING FEEDS.

Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest with power cross-feed. Lead screw used for screw-cutting only, supported throughout its entire length, and protected from chips. Maximum swing over bed, 20″; over slide-rest, 15¼″ diameter. Improved friction discs, giving instantly any feed required between limits. Largest lift of cone-pulley, 13″. Width of belt, 2½″. Ratio of back-gears about 12 to 1. Complete with countershaft, wrought-iron wrenches, full set of change-gears, water-can, and steady-rest. Countershaft pulleys, 10″ diameter, for 3″ open and cross-belts, and should make 112 and 224 revolutions per minute. Follow-rest and taper attachments extra, if required.

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the error in the truth of the turned work, due to the wear of the flat-top surface of the shear, is confined to the almost imperceptible effect of the slight difference in the vertical height of the tool while under cut, and is not complicated with any side movement of the cutting tool. A very considerable wear on the flat surface must occur before its influence can be felt on the work; while on the other hand, when the guiding edges are made inclined, a very slight wear of the top surface produces an immediate effect on the truth of the work as detrimental, as if the guiding surfaces had worn out of truth. The substitution of the vertical guiding surfaces for the usual inclined surfaces is as important to the correct working of the lathe and to its durability as was the introduction of the under V to the holding of the movable head in adjustment with the live spindle.

The combination of the two improvements in the flat-top system, viz., the under V and the vertical guiding surfaces, gives us a theoretically perfect lathe bed.

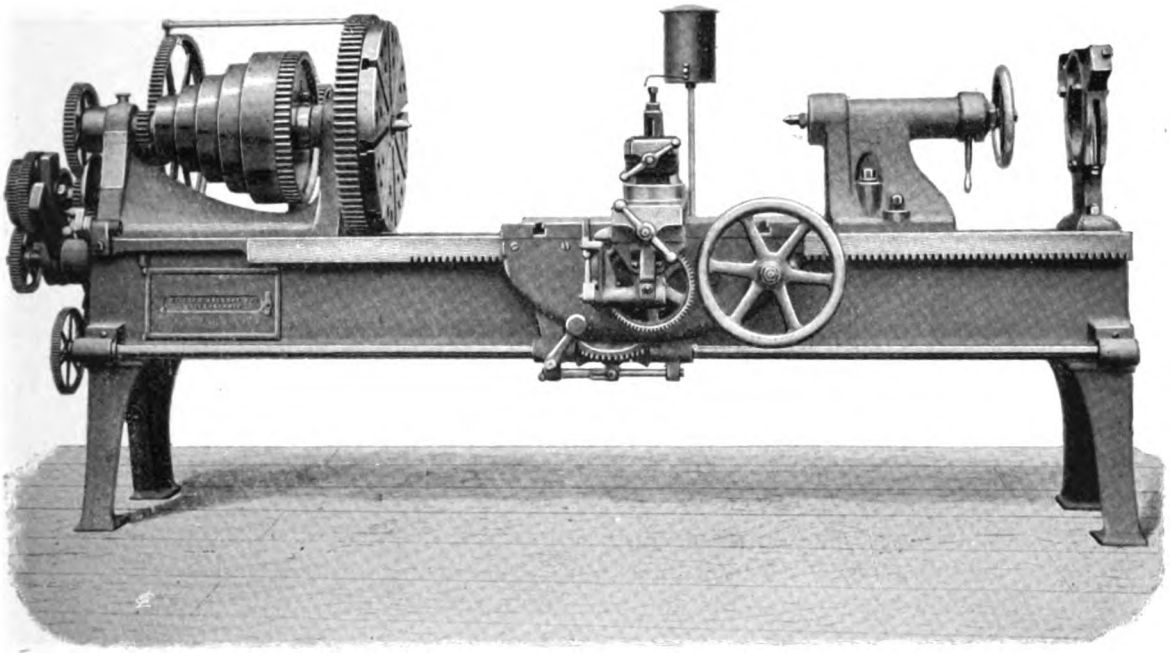
Inasmuch as the important improvements we have made in the lathe beds have removed the objections raised against the flat-top shear by those who have known the system only as in use without these improvements, we dwell upon it the more fully to explain some of its advantages.

In view of the well-known fact that durability of machinery is largely dependent upon extended surface, where surfaces move or slide one on another, it is rather surprising that the flat-top shear should have met with so little favor in this country up to quite a recent period. Theoretically, it presents the largest wearing surface, and is the most easily made.

The saddle of the slide-rest, bearing over its whole under surface, may find a support up to the edges of the centre opening of the shear. Having less distance to span unsupported than on the V shear, the saddle can be made thinner and yet of sufficient strength, thus increasing the capacity of the lathe-swing over the slide-rest. On lathes with V guides there are usually four of these guides, the two outer ones serving as guides for the saddle, and the saddle must, of necessity, span the entire space unsupported from one V to the other; hence it must be thicker and heavier

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PLATE NO. 58.



25″ LATHE.—TRIPLE-GEARED, TURNING AND SCREW-CUTTING FEEDS.

Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest, with power cross-feed. Lead screw, used for screw-cutting only, supported throughout its entire length, and protected from chips. Maximum swing over bed, 25″; over slide-rest, 19½″ diameter. Improved friction discs, giving instantly any feed required between limits. Largest lift of cone-pulley, 17″. Width of belt, 2½″. Ratio of back-gear about 9 to 1. Ratio of triple gear, 50 to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Countershaft pulleys, 14″ diameter, for 3½″ open and cross-belts, and should make 135 and 270 revolutions per minute. Follow-rest and taper attachments extra, if required.

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than if resting on a plane surface. The nominal capacity of any lathe is what it will swing over the shear. The actual capacity in relation to cylindrical work is what it will swing over the slide-rest; hence the advantage of less thickness in the saddle, if of sufficient strength.

Those workmen who have not used lathes with flat-top shears are apt to think that the extended surface in contact with the shear may make it hard to move. If it be allowed to stick fast with gummy oil, this may be so; but with such care as any machine tool should receive at the hand of the workman, it is really easier to move. Friction being dependent upon weight, not surface, the flat-top shear, owing to the extended bearing surface, will permit the use of much lighter saddle, and the dust and dirt are no more apt to catch upon the flat shear surface than on the V shear, and are as effectually pushed off by the saddle. Lightness in the slide-rest becomes of great moment on lathes of large capacity, and is worth considering in all lathes, when it can be obtained without loss of strength.

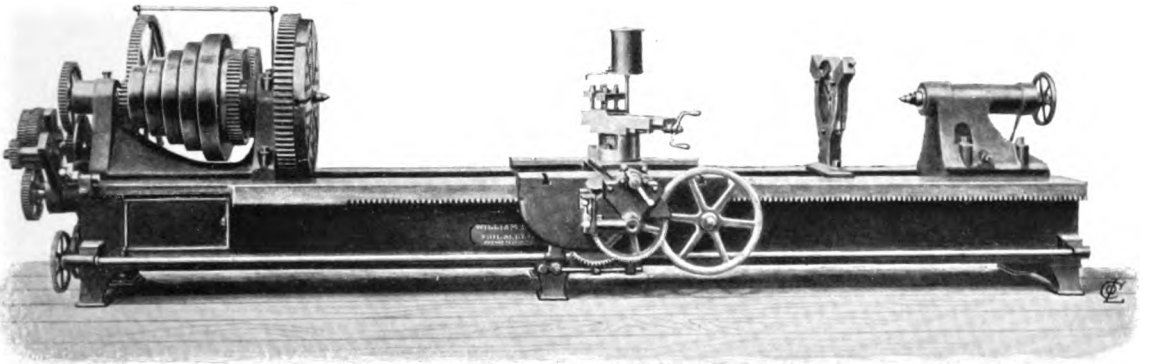
Makers of engine lathes, who still adhere to and recommend the V shear, build their lathes for turning car-axles with a flat-top shear. The axle-lathe, but for the extended surface on the flat-top shear, would soon wear hollow at the place where most work is done. The advantages to be derived from the use of the flat-top on the axle-lathe should recommend its adoption on other styles of lathes.

The flat-top shear can be readily planed true on its upper face, on its outer edges and on its inner edges. The outer edges guide the saddle, lost motions being taken up by shoes or gibs. The lathe heads are guided by the inner edges. The parallelism of all these edges can be readily insured.

The function to be performed by the lathe-shears or bed is to maintain the driving head or live-head spindle in line with the poppet-head spindle, and to carry the cutting tool parallel with this centre line. It must do this under various conditions of strain. Screwing up the centre to hold the work tends to bend the shear in one direction. The strain of the cut tends to bend it in another, in fact, in several directions.

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PLATE NO. 59.



36″ LATHE.—TRIPLE-GEARED, TURNING AND SCREW-CUTTING FEEDS.

Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet-spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest, with power cross-feed. Lead screw used for screw-cutting only, supported throughout its length and protected from chips. Maximum swing over bed, 36″; over slide-rest, 28¼″ diameter. Improved friction discs, giving instantly any feed required between limits. Largest lift of cone-pulley, 28″. Width of belt, 3½″. Ratio of back-gear about 6¼ to 1. Ratio of triple-gear about 39 to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Countershaft pulleys, 26″ diameter, for 4″ open and cross-belts, and should make 80 and 160 revolutions per minute. Follow-rest and taper attachments extra, if required.

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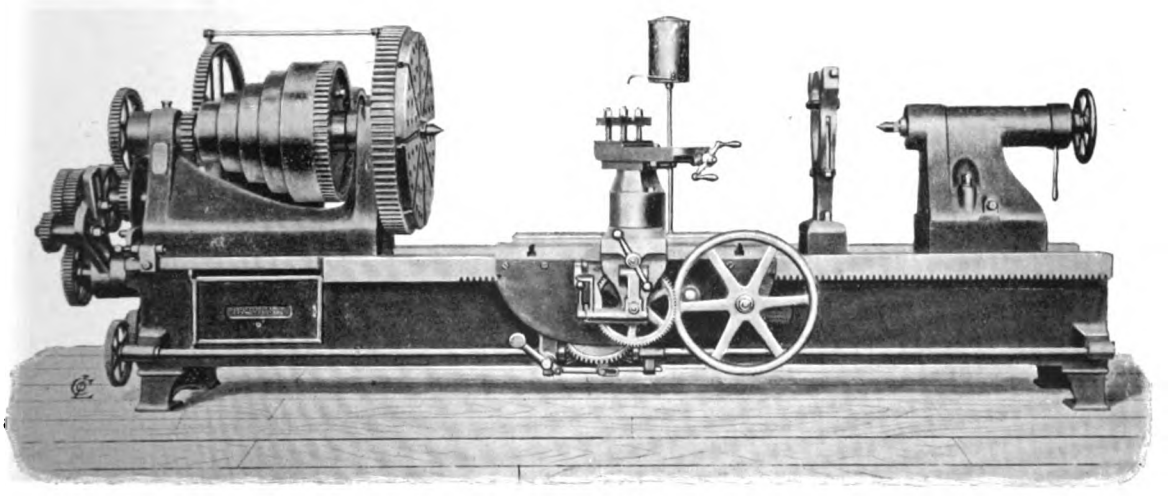
It must be borne in mind that the lathe centres, being above the shear, and dependent entirely on the stiffness of the shear for their rigidity, are placed at some disadvantage in regard to leverage. A clear idea can be obtained of resultant strains, if thought be directed to a lathe with a rigidly fixed live head and a very flexible shear. The work, being also rigid, will be driven around its axis by the rotation of the live-head spindle, and will therefore tend to turn the slide-rest, the shear and the poppet-head around the axis of rotation, thus producing a severe torsional strain on the bed. Hence the bed must resist strain in all directions; the longer the bed the more elastic it would be in regard to torsion, an evil to be corrected only by the system adopted by us of introducing cross girts in all our lathe beds. These cross girts, from the peculiar construction of our lathes, extend near to the top of shear, and form inflexible ties between the two I beams, which represent the sides of the shear. The lead screw in screw-cutting lathes is placed within the bed, and, supported over its entire length by resting in a trough planed out to receive it, it is not subject to deflection; maintaining its right line will produce a truer thread, than if unsupported, except by the nut and end-bearings. By being placed under the shear top, it is entirely protected from falling chips and dirt.

Slide-Rest with Improved Turning-Feed.

The next important improvement in our lathes to which we call especial attention relates to the slide-rest and the peculiar turning-feed, both as regards construction and operation. In all lathes of all capacities we arrange a turning-feed, quite independent of the screw-cutting feed, and we use the lead screw, which operates the screw-cutting feed for screw-cutting only. The turning-feed is driven by a rotating feed-rod or shaft running the entire length of and in front of the bed. This feed-rod gives motion to the slide-rest by means of a rack and gearing, the rack being on the under side of the overhanging edge of the top of the shear on its front side, while the gearing is carried by the apron dependent from the front side of the slide-rest. In place of the shifting right and left hand worms on the feed-

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PLATE NO. 60.



42″ LATHE.—TRIPLE-GEARED, TURNING AND SCREW-CUTTING FEEDS.

Flat-top shear, with vertical guiding surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet-spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest, with power cross-feed. Lead screw, used for screw-cutting only, supported throughout its entire length and protected from chips. Maximum swing over bed, 42″; over slide-rest, 34″ diameter. Improved friction discs, giving instantly any feed required between limits. Largest lift of cone pulley, 28″. Width of belt, 3½″. Ratio of back-gear about 6¼ to 1. Ratio of triple-gear about 39 to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Countershaft pulleys, 26″ diameter, for 4″ open and cross-belts, and should make 80 and 160 revolutions per minute. Follow-rest and taper attachments extra, if required.

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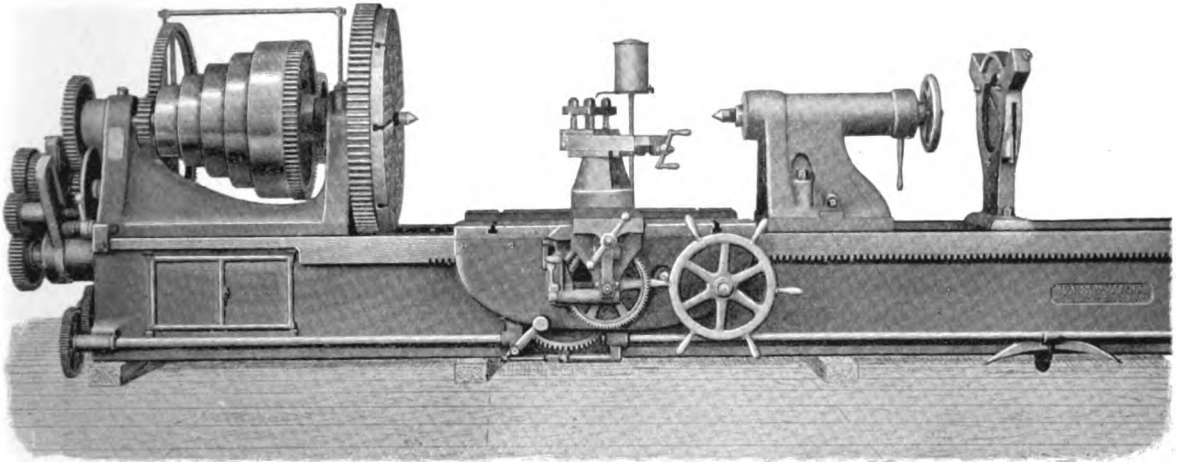
rod, gearing into one worm-wheel, to operate both directions of feed, as usually employed in American lathes, we introduce a novel motion obtained from bevel wheels on the feed-rod, and carried through a system of gears, one of which is our spiral pinion motion to the pinions which work the feeds; either to that one which operates the longitudinal feed and gears into the rack, or to the pinion on the screw of the cross-slide to operate the cross-feed. A weighted lever near to the lower edge of the apron of the slide-rest can be tumbled over by the slightest touch, carrying with it the clutch which gives motion in the required direction, and the motion of this lever is such as to coincide with the direction of the feed; thus, if the lever be thrown over to the right the lathe will feed in that direction, and if to the left it feeds to the left. In lathes provided with a cross-feed in addition to the regular feed, a lever, limited in its motion by a shifting-stop, controls the starting and the stopping of the feed in use. The position of this stop determining the character of the feed to be used.

The feed-rod on our lathes is driven by our well-known friction feed-discs, and these have been improved both in their range and in the method of clamping to position, and yet permitting quick and easy adjustment. We also indicate at the point of adjustment the approximate feed obtainable at any fixed position of the movable discs. This is quite important, as it enables the workman to set the feed coarse or fine with certainty without any trial.

Lathes of 16-inch swing and over have two slides to the rest, the upper one being swivelled to set at any required angle in boring or the like work, and the stand below the upper rest is graduated to facilitate this setting. Our 12-inch lathes have an adjustable device for setting the point of the tool high or low after it is clamped to position. This is a very important feature and greatly increases the efficiency of the lathe, inasmuch as such lathes are used on work of smaller diameter, and the smaller the piece being turned the more care must be exercised in setting the tool as to height of the cutting point. As these smaller lathes have no cross-feed worked automatically, we arrange a lever and latch in a convenient position below

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PLATE NO. 61.



48″ LATHE.—TRIPLE-GEARED.

Flat-top shear, with vertical bearing surfaces. Poppet-head lined by under V clamp. Concentric hold-fast for poppet spindle, clamping spindle at both ends of bearing. Independent screw-cutting and turning-feeds, instantly changeable from one to the other, when both are in gear with spindle. Longitudinal feed and screw-cutting feed cannot be engaged at the same time. Turning-feed stopped and started instantly by positive clutch. Direction of turning-feed controlled by lever on saddle. Compound swivelling slide-rest with power cross-feed. Lead screw, used for screw-cutting only, supported throughout its entire length and protected from chips. Maximum swing over bed, 48″. Over slide-rest, 38½″ diameter. Improved friction discs, giving instantly any feed required between limits. Largest lift of cone-pulley, 32″, and width of belt, 5″. Ratio of back-gear, 7¾ to 1. Ratio of triple-gear, 45½ to 1. Complete with countershaft, wrought-iron wrenches, full set of change gears, water-can, and steady-rest. Fast and loose pulleys on countershaft, 26″ diameter for 6″ open and cross belts, and should make 90 and 180 revolutions per minute. Follow-rest and taper attachments extra, if required.

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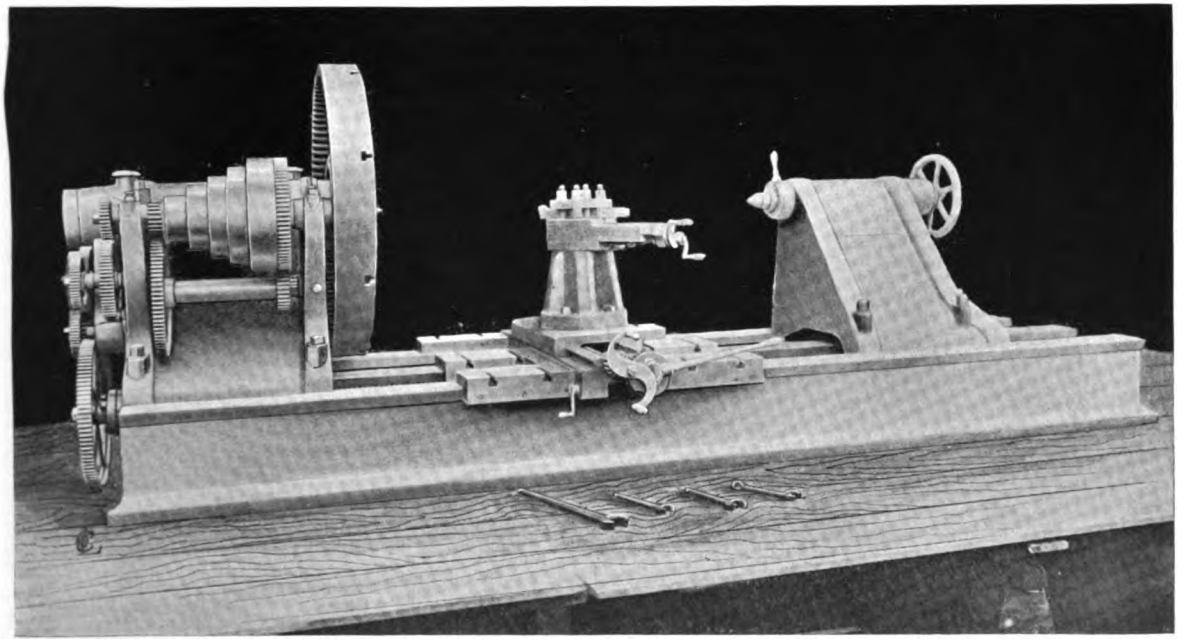
the cross-slide to stop and start the feed. Our aim has been to arrange all the operating handles of the slide-rests in such position as to be very convenient to the workmen, and to be so readily operated as to consume neither time nor attention. For all lathes of 30 inches swing and under we use the single-screw tool-post, but on lathes of greater size we place on the top rest four standing bolts, and with these hold clamp-plates or bars, admitting of great firmness of holdfast and permitting a wide range in tool position.

Movable or Poppet Head.

In regard to the movable or poppet head of the lathe, we have already mentioned its insured alignment by means of the V on the under side of one of the inner edges of the flat top of the shear. When the head is loosened for adjustment back and forth on the bed it is free to move, but the moment an attempt is made to tighten it to place, this under V, acted on by the clamping-down shoe, draws the head over to one side of the centre opening in the shear and holds it firmly against this surface, which surface is subjected to no wear whatever. The practical utility of this important feature of our lathes has been demonstrated through many years of constant use. Our more recent improvements in the poppet head relate to the concentric clamping of the sliding spindle at both ends of the bearing in which it slides. We arrange a lever convenient to the wheel, which works the screw in the spindle; a simple motion of this lever clamps the spindle concentrically at both ends of its bearing, and with a uniform pressure at each end. The concentric clamping device at the nose of the poppet-head bearing, which has been in use for some time, while being an improvement over the old clamping set screw, does not hold the spindle with sufficient rigidity, inasmuch as it leaves it free to move out of line to the extent of any looseness in its bearing back of the clamping device. By clamping at front and back of the bearing we obtain great rigidity of alignment, and yet permit freedom of motion when the spindle is loosened. We also thereby render the spindles of our poppet heads interchangeable, thus adding

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PLATE NO. 62.

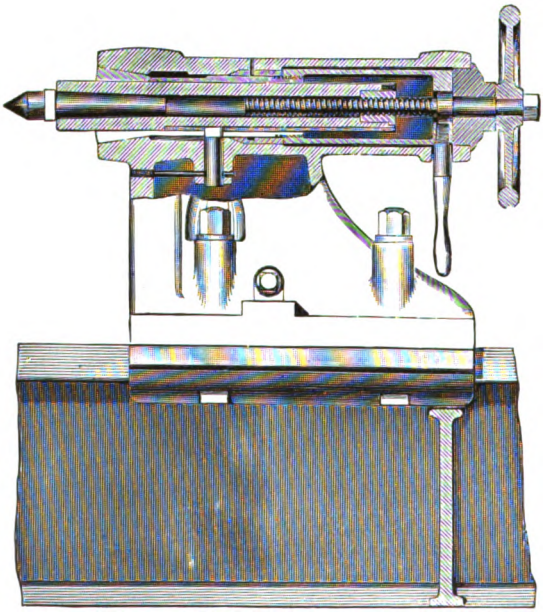


60″ LATHE.—SCREW-CUTTING AND TURNING, WITH SCREW-FEED.

Flat-top shear, with three bearings. Head set over to bring thrust of cut within bed at all times. Heavy cast-iron spindle; the cone pulley and back-shaft drive through face-plate only. 15 changes of speed. Will swing over bed, 60″; will swing over slide-rest, 49″. Diameter of largest lift of cone-pulley, 20″ for 3″ belt. Ratio of back-gearing, 53 to 1. Ratio of triple-gearing, 300 to 1. Feeds variable by change gear from 1″ per turn of spindle to $\frac{1}{36}$″. Ratchet lever for moving poppet-head and saddle. Compound slide-rest, power cross-feed. Complete with countershaft, full set of wrought-iron wrenches, and ratchet lever. Countershaft pulleys, 16″ diameter for 3½″ open and cross belts. Speeds, 140 and 280 revolutions per minute. This is a strong but simple lathe, useful for general work. We also make a 72″ lathe of the same design.

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another item to the list of interchangeable parts to the system. It has been our constant aim to render all parts of our machine-tools interchangeable, but in the case of the spindles of the poppet heads of lathes, so long as their rigidity depended upon accuracy of fit to any considerable degree this was impossible. The introduction of the double concentric clamping device above alluded to accomplishes the

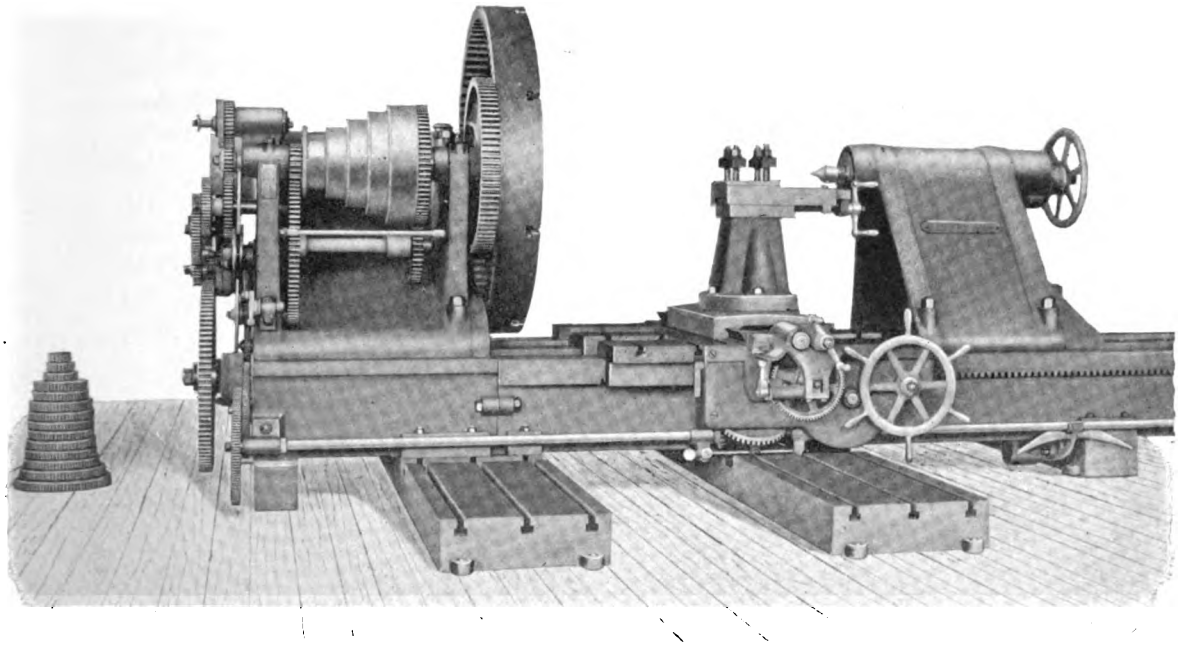


much desired possibility of interchange in the parts, and it also gives more freedom of motion when the spindle is freed from its clamps.

If lathes were not required to turn tapers as well as cylinders, there can be no doubt that the poppet head, made in one piece, resting on the shears over a sufficiently

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PLATE NO. 63.



72″ SELF-ACTING LATHE.—FOR SCREW-CUTTING AND TURNING.

Independent shaft for turning-feeds operated through improved friction discs. Compound swivelling slide-rest, with automatic cross, longitudinal, and angular feeds. All feeds engaged, disengaged, or reversed at the saddle within convenient reach of the operator. Easy hand adjustment of saddle by rack and pinion. Swing over bed, 72″; swing over slide-rest, 64¾″ diameter. Ratio of back-gearing about 50 to 1; ratio of triple-gearing, 300 to 1. Largest lift of cone-pulley, 24″ diameter for 3½″ belt. Complete with countershaft, wrenches, full set of change gear, and ratchet lever for moving poppet head. Fast and loose pulleys on countershaft, 20″ diameter for 4″ open and cross belts, and should make 122 and 244 revolutions per minute. As shown in illustration, lathe is arranged with bed in two parts, so as to form gap-lathe when required, bed being supported on shoe-plates at intervals, and arranged so that the long end may be moved to form a gap for large work. See also Plate No. 64.

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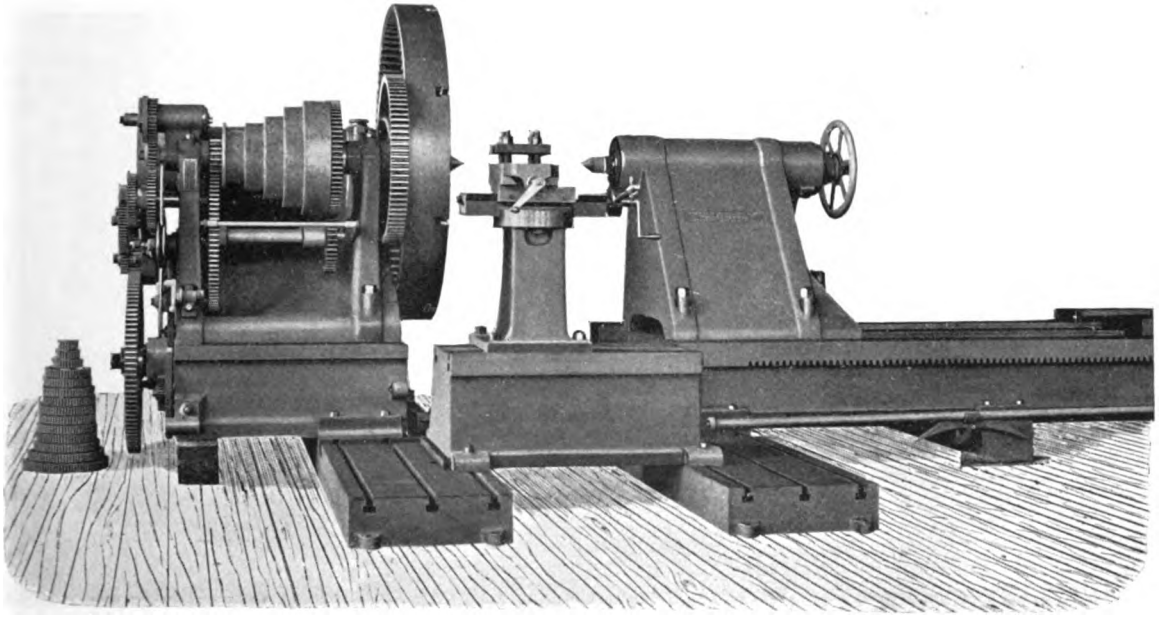
broad surface and capable of adjustment sideways only to the extent of practical alignment, would be the simplest and the best. In our own practice we prefer this system, and, while we make our poppet heads in two pieces so as to be capable of being set over to turn tapers, we adapt to lathes requiring it, a device which enables the turning-tool to be guided by former bars, and thus to produce tapers or irregular shapes, such as the curves of handles, etc. This device, called technically "a former attachment," does much better conical or tapered work than with the centre set over out of line, for reasons obvious to all mechanics familiar with the use of the machine, and gives a greater range to its capacity. We may be pardoned for mentioning in this relation what we consider the readiest method of bringing the centre in line after the head has been set over, in adjusting the centres in the first place or in testing the correctness of a new lathe. A bar of round iron carefully centered, is turned up a short distance on one end. This turned end being placed next to the live-head centre, a turning-tool clamped in the slide-rest is made to just touch the turned part. Taking out the bar the tool is then moved over to the poppet-head spindle, and the bar reversed with its turned end next to poppet-head centre, when, if the tool just touches the turned part as before, the lathe may be considered in adjustment.

Live Head.

Especial attention has been bestowed on the design of the live head, and the greatest care is taken in the perfection of the workmanship on all its parts. The possibility of turning a true circle depends on the accuracy of the spindle, for its shape is reproduced in turning, and truly cylindrical work can only be produced when the spindle is truly round. To do good facing work the spindle must be insured against end motion, and the cross-slide of the slide-rest must be at right angles to the spindle. Theoretically, a hardened steel spindle running in hardened steel bearings, the spindle and its bearings having been made true after they are hardened, would seem to present the most reliable conditions of correctness and durability. Such spindles, however, are expensive, and, unless well looked after, are liable to cut

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PLATE NO. 64.

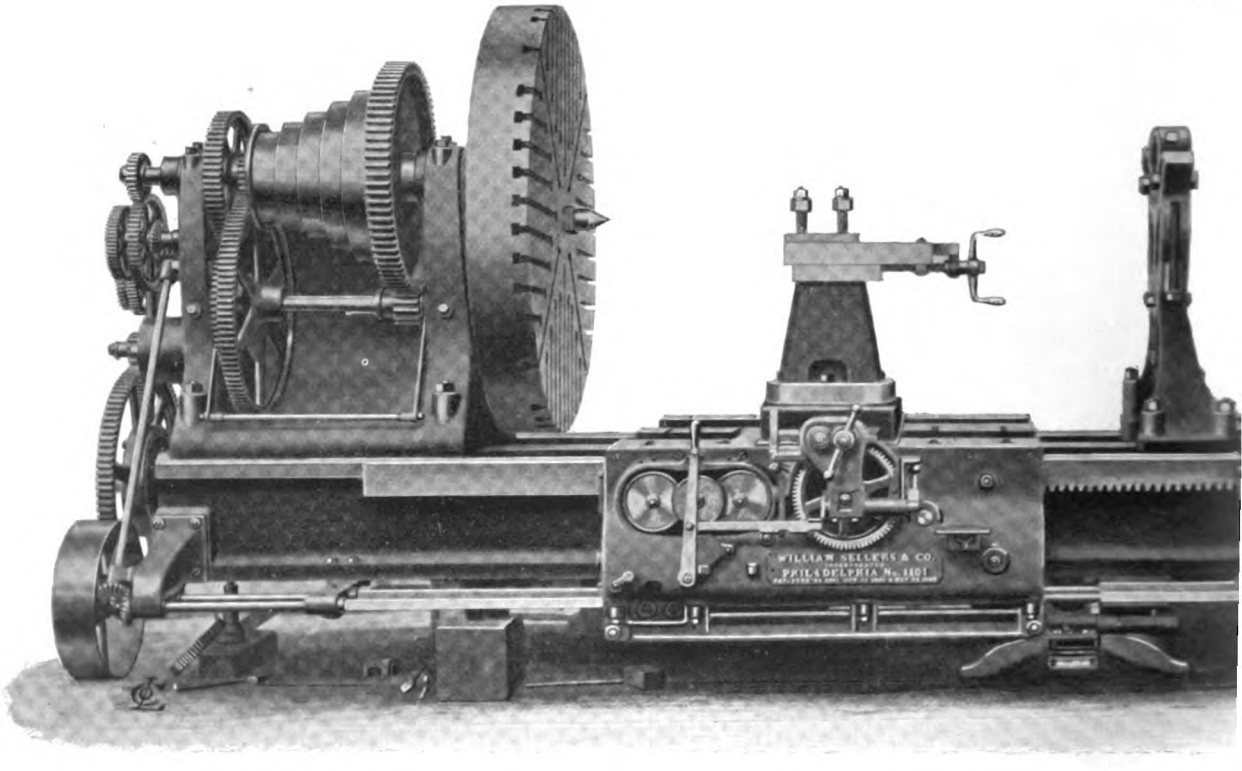


72″ SELF-ACTING SLIDE-LATHE.—FOR SCREW-CUTTING AND TURNING.

Arranged as gap lathe to take work 16′ diameter by 3″ face. Bed is parted and auxiliary bed, carried upon two of the shoe-plates (which are extended for the purpose), supports special rest for turning the large diameters. This rest is provided with ratchet feed, operated from a rock shaft, which is vibrated by a crank on the live head.

For further particulars of lathe, see specification under Plate No. 63.

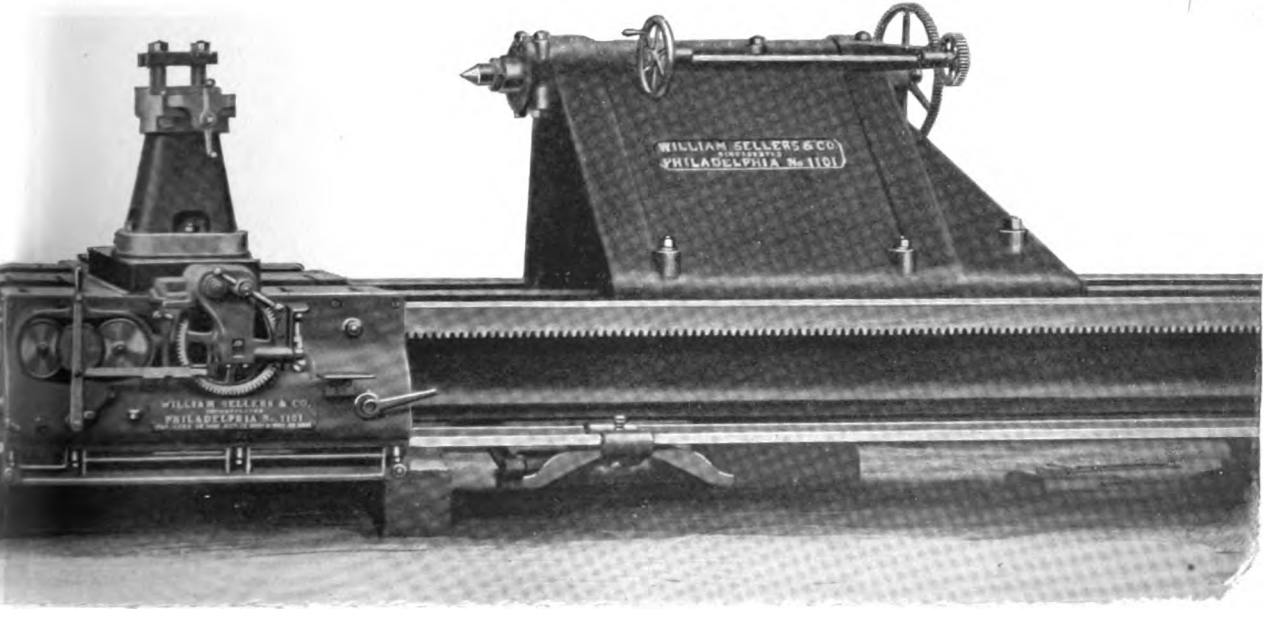
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72″

With independent screw-cutting and turning-feeds and rapid power traverse to carriage. With one or two carriages, as required. Will swing 72″ over bed and 63¾″ over slide-rest. 12″ cast-iron spindle driving through gears on face-plate. Fifteen changes of speed. Ratio of back-gear, 43 to 1; ratio of triple-gear, 270 to 1. Internal teeth in face-plate; steel driving pinion. Poppet head capped to permit use of boring-bar, 6¾″ diameter. Longitudinal, cross, and angular feeds, varied by improved friction discs in the apron of the carriage. Rapid-power traverse of carriage along bed for adjustment. Traversing and screw-cutting feeds interlocked so that no two feeds can be thrown in at the same time. Operator at either saddle can throw in

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LATHE.

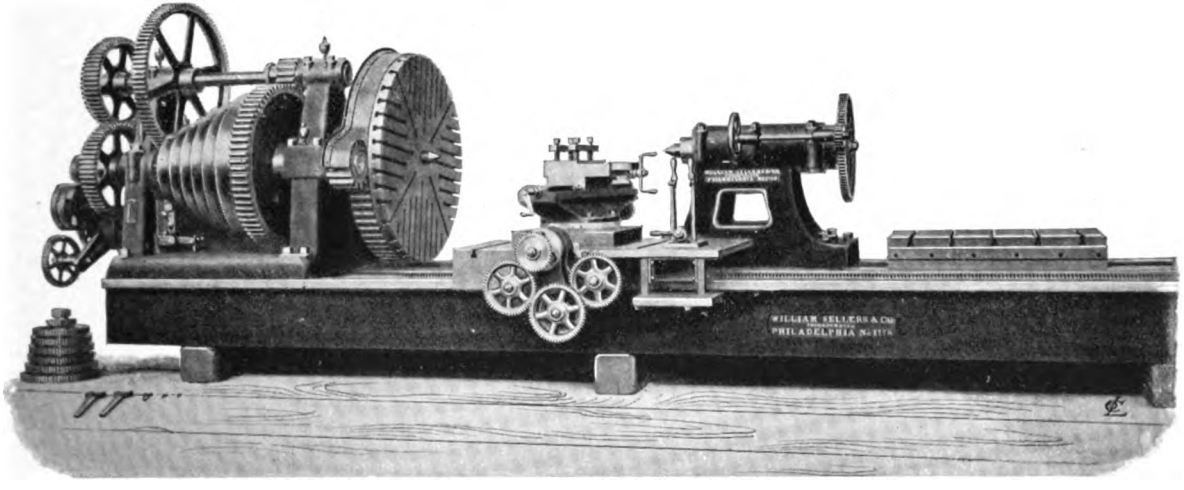
or out any feed motion, change the amount of turning-feed and shift the saddle backward and forward by power without leaving his position. If made with two carriages, they can be run at different turning-feeds at the same time, being entirely independent of one another, but both engage with same screw. Screw used for screw-cutting only, supported in bearing throughout its entire length. Massive steady-rest for turning long work. Complete with countershaft, wrenches, and one steady-rest. Fast and loose pulleys on countershaft for open and cross belts, 26″ diameter for 4″ belt, and should make 100 and 200 revolutions per minute.

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and stick fast, so that carefully-made spindles of the best cast-steel forging, not hardened, running in special bronze bearings, are preferred. We do not collar the front end of the spindle, but we make the journal of good diameter and length, taking care to have it truly cylindrical, and we support it over its entire length in a truly cylindrical bearing of a carefully prepared bronze. The back-bearing is slightly conical, carried in a solid bearing of bronze. To prevent end motion of the spindle, we secure to the spindle back of the back-bearing a carefully-made ring or collar of hardened steel. This collar is confined between a hardened steel thrust collar back of it and the back end of the back-bearing in front of it, and all these parts are enclosed in a tight cast-iron tail-block, which serves as an oil well to insure constant and perfect lubrication. The surfaces which confine the revolving collar front and back of it are so adjusted as to allow perfect freedom of rotary motion, but no perceptible end motion. The securing of the spindle endways is confined to the thickness of one collar only, and this is enclosed in so large a mass of cast-iron as to insure a uniform temperature in all its parts; thus there is no liability to stick or jam, while the expansion of the spindle endways from this collar, if there is any expansion in excess of the head, is allowed for in freedom of end motion in the front journal, which is a little longer than the front bearing in which it runs. In turning work between centres the thrust is taken against the thrust collar back of the fixed collar on the spindle, while in turning chucked work the spindle is held in place endways by the confinement of the one fixed collar on the spindle between the fixed back-thrust and the back end of the back-bearing. With this arrangement of the spindle the change from one kind of turning to another requires no thought to be given to any adjustment of the spindle, to be ready for the changed condition of pressure, as is the case with lathes of ordinary construction. When the spindle of a lathe has collars at its front end, and is provided with an adjustable tail-screw to take up the back-thrust, constant attention is required in the adjustment of these parts, and any neglect or error in the adjustment is soon shown in the worn condition of the collars; and it is seldom that any lathe, even in the hands

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PLATE NO. 66.



72″ LATHE.—SCREW-CUTTING AND TURNING, WITH SCREW-FEED.

Very massive lathe for heaviest class of work. Three bearings to bed and head set over to bring strains of cut always within the bed. Very heavy poppet-head, with capped bearing for boring-bar, 8½″ diameter. Cast-iron spindle, 12½″ diameter. Spindle always driven through face-plate. Ratio of back-gear, 25 to 1; ratio of triple-gear, 125 to 1. Largest lift of cone-pulley, 46″ diameter for 5″ belt. Carriage arranged to run past poppet-head. Slotted extension to carriage for use when boring large work. All movements of slide-rest and carriage have rapid power adjustments to position; poppet-head movable to place rapidly by power. Compound swivelling rest of massive proportions, with angular feed operated by power. Swing-frame and change gear for changing ratio of turning-feeds carried on saddle. Tapers turned by combination of gearing on carriage. Turning-feeds variable from $\frac{1}{20}$″ to 2″ per turn of spindle. In screw cutting, lathe is not reversed; but carriage is moved to place by power rapidly, and clutch for screw cutting is so arranged as to insure starting in the right place on the screw.

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of the most careful workman, long escapes this worn condition. A spindle held at one end by a collar and at the other end by a tail-screw, set up to take up lost motion, may heat, and a very slight amount of expansion over that of the head itself will serve to produce an injurious amount of end binding, as is seen in the worn condition of such collars on lathes of the old style.

Our form of back-thrust does away entirely with the tail-screw, and in its place presents a large and very durable wearing surface. It also permits the extension of the spindle through the tail-block to receive change wheels of any size for screw-cutting or for feed. The form of the live head is such as to hold the front-bearing rigid against the side strains, and the back-bearing against the strain of the spindle pressed endways.

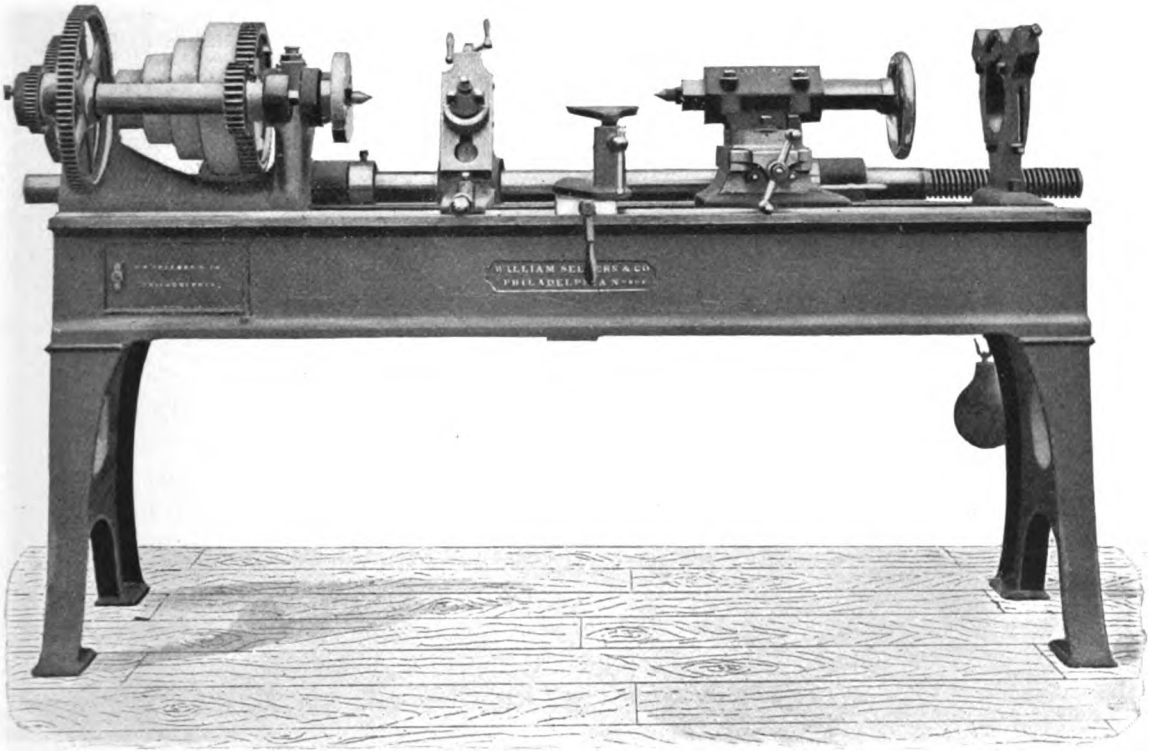
The spindles of all lathes, up to and including 48 inches swing, are made of the best steel forgings in the manner above described, but in lathes of greater swing we generally use cast-iron spindles of much greater diameter as compared to the size of the lathe. In all lathes of all kinds the taper-hole in the live spindle, in which the live centre is carried, is made true, after the head is finished, with the spindle revolving in its own bearings. The truth of this hole is as important as the truth of the outside of the spindle, as upon its absolute concentricity with the outside of the spindle depends the possibility of the centre being made to run true, no matter how it is replaced after it has been taken out. We make all centres of the same size lathes interchangeable, so that any centre will fit and run true in any lathe of the same size, provided the centre has been ground true to its own axis.

Spindles made as described above have been tested during many years of constant use, and have been found to show no perceptible wear; this is particularly the case with the peculiar back-thrust described. Possible adjustment to compensate for wear has been provided for, but the adjustment of these parts has been removed from the control of the workman using the lathe.

Our double-geared lathes, say those of 12, 16, and 20 inches swing, are provided with face plates to unscrew for convenience of changing from one size of face plate

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PLATE NO. 67.



20″ DOUBLE-GEARED CHASING LATHE.

Specially designed for brass work. Arranged with chasing attachment. Spindles for holding the chasing hobs are so arranged as to accommodate two different pitches at the same time. Also, to cut with single pointed tool, either single, double, triple, or quadruple threads. Slide-rest for chasing attachment carried by counter-weighted bar at back of lathe. Poppet head with square spindle to carry boring and turning-tools, when required, provided with swivel-post and mounted on cross-slide to act as slide-rest when desired. Provided also with hand-tool rests, steady-rest, and countershaft. Fast and loose pulleys on countershaft for open and cross belts, 10″ diameter for 2½″ belt, and should make 225 revolutions either way. Also made with turret-head in place of compound slide-rest shown. Ratio of back-gear, 12 to 1. Largest lift of cone-pulley, 13″ diameter, 2½″ belt.

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to another, and for the ready placing of chucking devices. All such lathes have their front journal made large enough to serve as a shoulder for the face plate to abut against, the nose of the spindle being the same diameter as the body of the spindle. This nose is not screwed over its entire length, but a portion of its length, next to the shoulder, is made cylindrical without any screw thread on that part. The face plate is made to fit the cylindrical part of the nose, and a short and rather loosely fitted screwed portion serves to draw the face plate to place on the cylindrical part and hard up against the squared face of the journal, which acts as the squaring surface. Face plates arranged in this way may be taken off and replaced as often as need be without any danger of their being other than true when in place, unless the surfaces have been abused in their fitting parts.

The cone-pulley on the live head is turned true outside and inside to balance, and is provided with an inner sleeve presenting an extended surface on the spindle to insure proper lubrication when running loose on the spindle. The various speeds to be obtained from the cone in combination with the gearing have been so proportioned as to insure an exact ratio from the fastest to the slowest speed between each and every change.

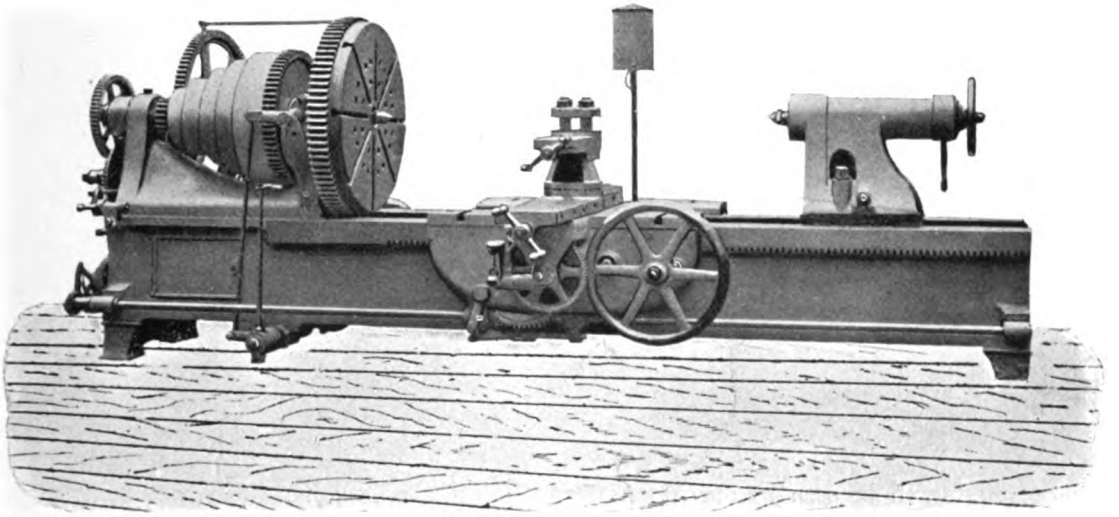
To Determine the Length of Lathe Beds.

We have already mentioned the manner of forming our lathe beds by the connection of the two sides of the bed by means of cross girts, which extend nearly to the top of the bed. The following table gives the name or size of the lathe and its capacity of swing over the slide-rest. This table also names the distance at which the cross girts are placed in the various sizes of lathes.

In this table the number of girts beyond the live head, in connection with the columns indicating the "Distance between centres" and the "Total length of the bed," show the shortest length of each size of lathe we make. Beds for lathes can of

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PLATE NO. 68.



36″ SELF-ACTING SLIDE-LATHE.—WITH ROCK-SHAFT TURNING ATTACHMENT. FRONT VIEW.

Specially arranged with vibrating movement to spindle for facing the arms of locomotive rock-shafts and similar work. Lathe, with all turning-feeds complete in every respect. See Plate No. 59. Rock-shaft attachment quickly and easily thrown in or out of action. Arc of vibration variable by stops on back of face-plate, from a few degrees to almost a complete circle. Face-plate reversed at about four times the cutting speed. Vibratory motion operated by friction clutches, as in our improved planer motion, and reversal takes place without jar or shock. Hand-shifting lever on front of the lathe permits face-plate to be vibrated as required. A ratchet-feed operated by a variable crank gives the adjustable feed-motion. Machine complete with countershaft, wrenches, water-can, and rock-shaft attachment. Fast and loose pulleys on countershaft, 18″ for 4″-belt, and should make 100 revolutions per minute.

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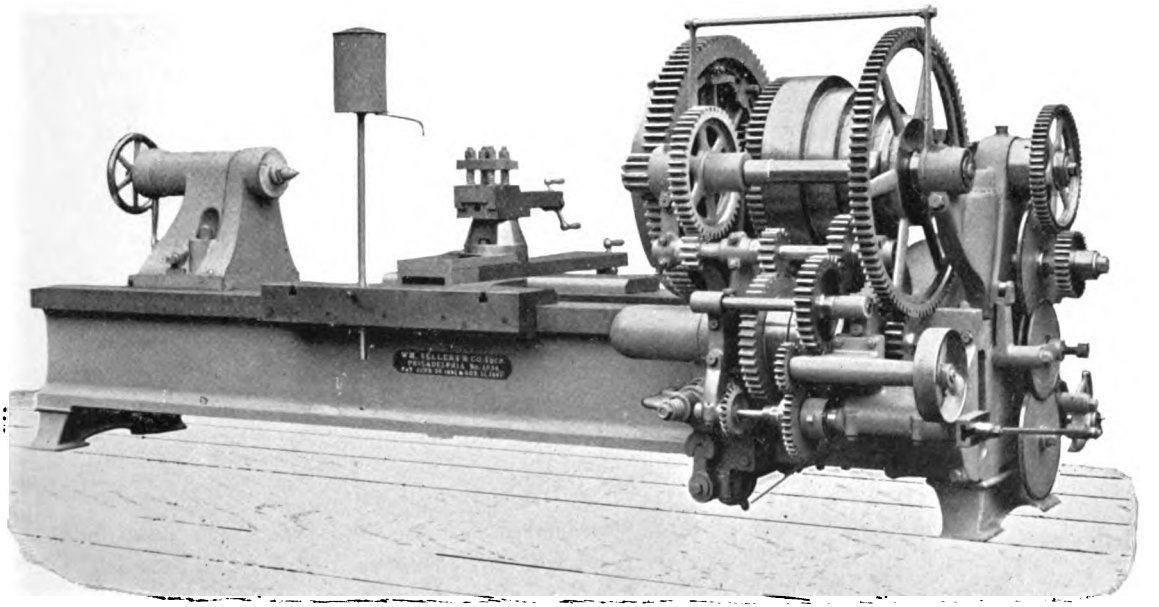
course be cast of any required length, but inasmuch as the distance between the girts is made or determined by cores of definite length, we increase the length of our beds not by any increments of feet and inches, regardless of the length of our core boxes, but by the distance between the girts controlled by the core lengths.

Name of Lathe; that is, Diam. of Piece will swing clear of Bed.	Diam. will swing over Rest.	Distance from Centre to Centre of Girts.	No. of Girts beyond Live Head.	Distance between Centres.	Total Length of Bed.
12″	8⅝″	10″	4	2′ 4″	4′ 7¾″
16″	11¾″	13″	4	3′ 0″	5′ 10¼″
20″	15¼″	16¼″	4	3′ 8½″	7′ 4″
25″	19¼″	20¼″	4	4′ 6¾″	9′ 0⅛″
30″	23¼″	24¼″	4	5′ 5¼″	10′ 8⅞″
36″	28⅝″	29″	4	6′ 7½″	12′ 10½″
42″	34½″	33¾″	4	8′ 6¾″	14′ 11¾″
48″	38½″	38½″	4	8′ 10″	17′ 0¾″
60″	49″	28″	6	9′ 1½″	17′ 3⅛″
72″	57½″	31⅛″	8	10′ 0½″	19′ 9¾″

Lathes Over 48 Inches Swing.

As will be seen by our illustrations and the specifications which accompany them, our large lathes differ in many respects from those of 48″ swing and less. Whatever may be the variations in details, however, there are certain general principles which we consider essential, and which we endeavor to incorporate in all our lathes. Among these may be mentioned the flat shear with vertical guiding surfaces for saddle and heads, and the location of the screw, so that its pull on the saddle is as near as possible in the plane of the cutting tool. This latter is an essential feature in our lathes, and one which enables them to cut screws of greater pitch and to take heavier cuts than is possible with most lathes in the market. Our larger lathes are provided with three bearing ways in the bed; the centre one affording additional support for the saddle, and thus permitting a greater swing over the slide-rest than is possible where it has to span across a wide opening, and at the

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36″ SELF-ACTING SLIDE-LATHE.—WITH ROCK-SHAFT TURNING ATTACHMENT. BACK VIEW.

Specially arranged with vibrating movement to spindle for facing the arms of locomotive rock-shafts and similar work. Lathe with all turning-feeds complete in every respect. See Plate No. 59. Rock-shaft attachment quickly and easily thrown in or out of action. Arc of vibration variable by stops on back of face-plate from a few degrees to almost a complete circle. Face-plate reversed at about four times the cutting speed. Vibratory motion operated by friction clutches, as in our improved planer motion, and reversal takes place without jar or shock. Hand-shifting lever on front of the lathe permits face-plate to be vibrated as required. A ratchet-feed operated by a variable crank gives the adjustable feed-motion required. Machine complete with countershaft, wrenches, water-can, and rock-shaft attachment. Fast and loose pulleys on countershaft, 18″ for 4″-belt, and should make 100 revolutions per minute.

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same time it allows us to bring our cross ribs very close to the top flanges of the bed. Our heads are set over so that the line of centres falls between the centre bearing on the bed and the outer bearing at the back of the bed, thus permitting all cutting strains to fall within the bed. The bed is symmetrical, so that we can fit up a long shear with two sets of heads and rests, one at each end of the bed, so placed that the workmen stand on opposite sides of the bed, and each has the live head to the left of the slide-rest. This construction enables one long shear to be used on long and short work at the same time, with manifest economy in first cost and in shop-room. We are prepared to build lathes of any size and for any character of work.

Roll Turning.

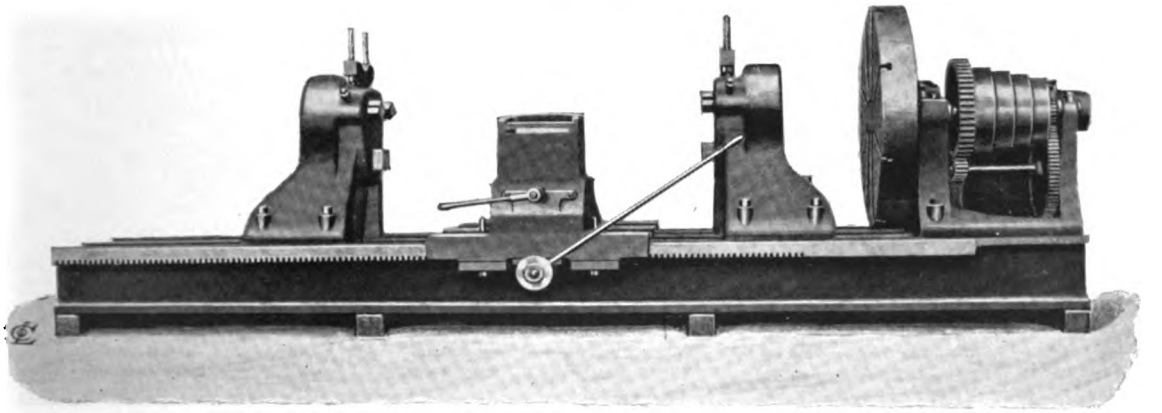
These lathes are heavily geared, and are well adapted to doing very heavy work, such as turning rolls for rolling-mills. The peculiar construction of the bed giving more room over the saddle than usual, and permitting a convenient arrangement of housings for holding rolls to be turned on their own bearings. See Plate No. 70.

Gap Lathe.

The very great power of these lathes enables us to extend their usefulness, by dividing the bed near to the live head when a gap lathe is required. We thus are enabled to furnish say a 72-inch lathe capable of turning pieces 16 feet in diameter. When fitted as a gap lathe the bed is carried on cast-iron shoes, and the lead screw of the lathe is made to actuate the parting of the bed to the required width of gap. A supplementary short shear carries a tool-post and compound slide-rest, such as we use on our driving-wheel lathes, the feed of which is obtained from a rock-shaft overhead by means of chains to the ratchet-feed lever. The short shear above mentioned rests on extensions of two of the shoes carrying the bed, and on these extensions it can be placed in such position as to command the entire range of work possible on such a swing of lathe, say within the limit of the pit, which, in the case of the 72-inch lathe shown, is 36 inches wide. See Plates Nos. 63 and 64.

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PLATE NO. 70.



60″ ROLL LATHE.

Three bearings on bed, very heavy face-plate, with internal gearing. Four speeds on cone. Ratio of gear reduction, 200 to 1. Extra heavy housings for rolls, with adjustable bearings to suit diameter of work, and cradles for matching roll. Heavy Scotch slide-rest with ratchet cross-feed. Rack-feed by hand for carriage along bed, with clamps for locking carriage to place when required. Countershaft pulleys, 24″ diameter for 5″-belt. Should make 150 revolutions per minute. Height from centre of spindle to top of lathe shear, 31½″. Largest lift of cone-pulley, 24″ diameter for 4″-belt.

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Countershafts and Speeds.

We make all the countershafts of our screw-cutting and turning lathes with one fast and two loose pulleys, so as to permit the use of open and crossed belts in screw-cutting, and the driving pulleys on the line shaft should be arranged to run the lathe backward at double the speed that it runs forward. To enable the proper driving pulleys to be prepared, we give in the following table the size of the fast and loose pulleys on the countershafts of our standard lathes from 12″ to 48″ swing, as well as the speed at which they should be made to run.

Table of the Speed of Countershaft of Lathes for Turning and Screw-Cutting.

Name of Lathe; that is, Diam. of Piece will swing clear of Bed.	Revolutions under Cut.	Revolutions Running Back.	FAST AND LOOSE PULLEYS.			
			Diameter.	Face.		
				Loose.	Fast.	Loose.
12″	200 Rev's.	320 Rev's.	8″	6″	6″	6″
16″	143 "	286 "	9″	6″	6″	6″
20″	112 "	224 "	10″	6″	6″	6″
25″	135 "	270 "	14″	7″	7″	7″
30″	110 "	220 "	16″	7″	7″	7″
36″	100 "	200 "	20″	4″	7″	4″
48″	90 "	180 "	26″	6″	12″	6″

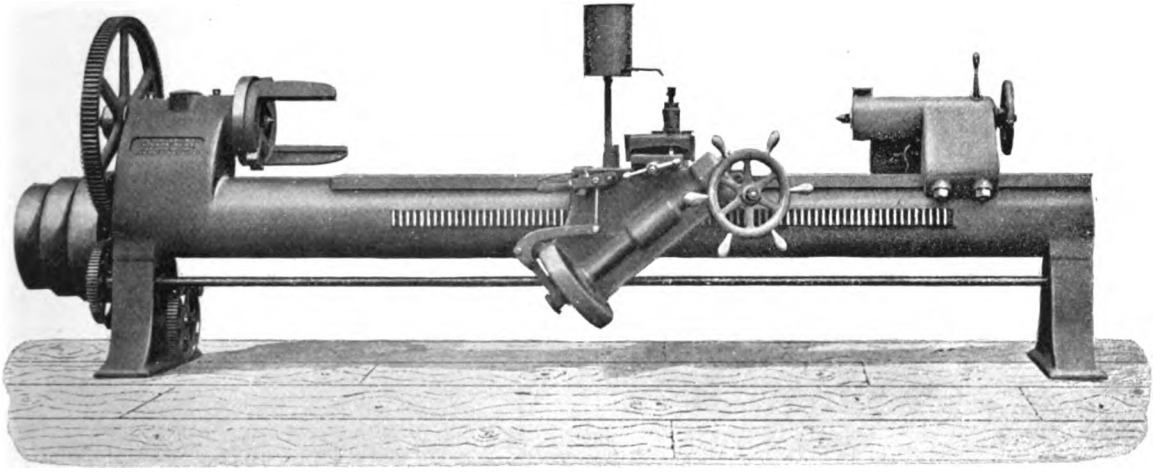
Improved Friction Feed.

Since the first application of our friction feed-discs to our tools, we have improved their construction, and extended their application to all tools to which a constantly acting feed is applicable, and where the feed is variable in amount.

These feed-discs consist of one driving disc, one driven disc, and two clamping discs. The driving and the driven discs are usually made of the same diameter,

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PLATE NO. 71.



AXLE LATHE.

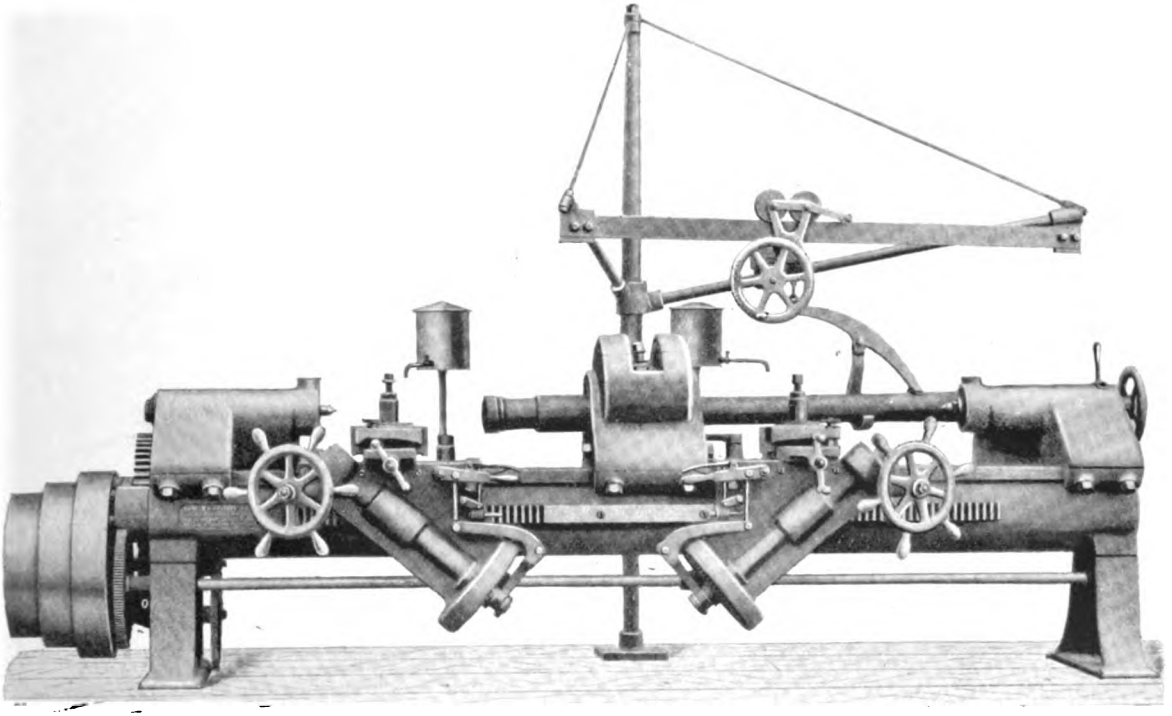
For turning railroad axles. Strongly geared for very heavy cut. Clement's driver on face-plate to equalize strains. Spiral pinion and rack-feed, with quick hand traverse for carriage. Improved adjustable tool-holder. Automatic feed-motion which can be started instantly by positive clutch. All working parts protected from chips and water. Height of centres above bed, 8″. Feed, 12½ to the inch. Largest lift of cone-pulley, 20″ diameter, 4″-belt. Gear ratio, 7.3 to 1. Machine complete with water-can, countershaft, Clement's driver for face-plate, sample dog for M. C. B. axles, two sets of fast and loose pulleys on countershaft, 24″ diameter, 4″ face, 135 revolutions per minute; and 14″ diameter, 4″ face, 225 revolutions per minute. "Former" attachment for shaping centres of axles, extra.

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and these discs are each edged with a rim on each side of the central plate, this rim being about from one-quarter of an inch to three-eighths of an inch wide, and the surfaces of their edges are made to conform to the shape of the clamping discs, which pinch these edges on either side, and the clamping discs are made convex on their biting surfaces. The clamping discs are carried on a shaft that is provided with ball-joints fitting corresponding depressions in the centres of the discs, and there is provided a spring-pressure forcing the plates into contact with the driver and the driven discs, while at the same time there is no binding of the shaft which carries the clamping discs. This mechanism drives by friction, and the variation in feed is obtained by shifting the position of the clamping discs relatively to the stationary ones, so that the one or the other shall act nearer to or farther from the centre of the clamping discs, producing the effect of wheels of fixed size being geared together by two wheels of the same diameter, or of different diameters, as the case may be. In using this system we gear down from the feed-discs, and from a light pressure and considerable speed obtain any amount of feed power at a slow rate of operation. It will be found that these discs are in operation like a belt or any other means of frictional driving, and their durability depends upon the lightness of the work they are required to do. They should not be tightened up more severely than is required to do the work. Under these conditions their wear will not be appreciable, and the discs will furnish a convenient slip in case of accidental overwork, and so save the driven mechanism.

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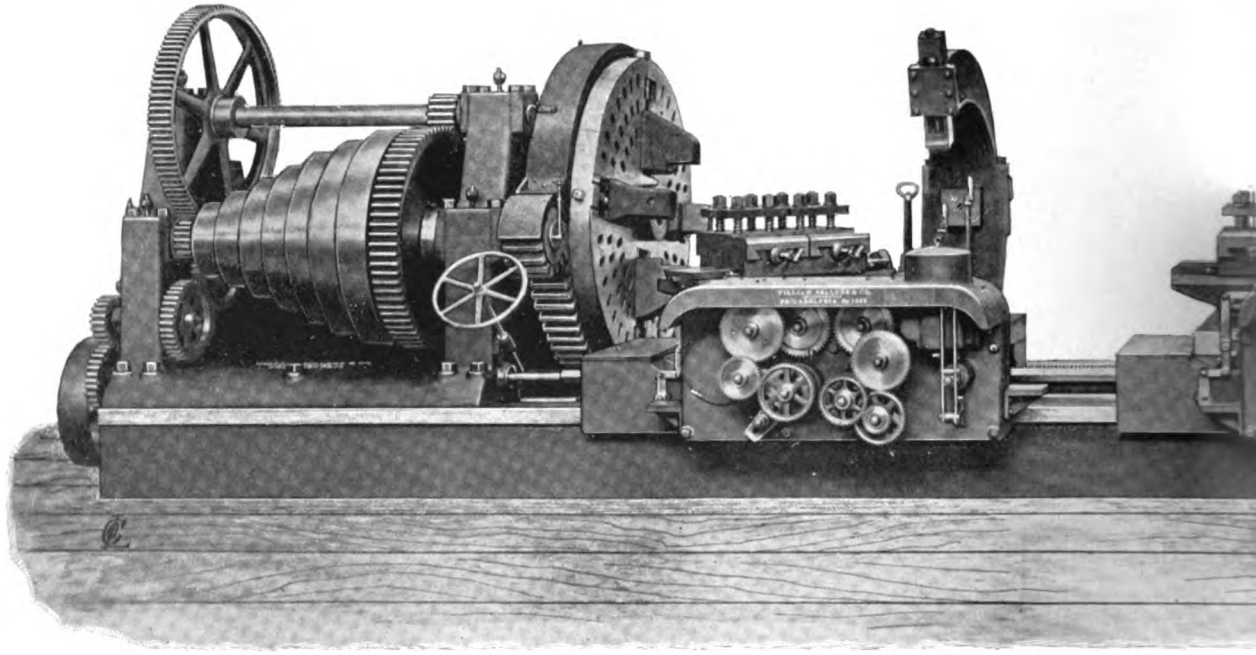
PLATE NO. 72.



DOUBLE AXLE LATHE.—WITH CRANE.

Axle held by the centre in equalizing driver to prevent undue strain. Two carriages with improved tool-holders, quick rack-feed, and automatic "knock-out" to limit motion. Very convenient crane, with hoist and lifting hook for putting axles into lathe. Complete with countershaft, wrenches, crane, hoist, water drip-cans, etc. Height of centres above shear, 8″. Largest lift of cone-pulley, 26″, 4½″-belt. Ratio gearing, 8.78 to 1. Fast and loose pulleys on countershaft, 26″ by 4½″, 160 revolutions per minute, and 15″ by 4½″-belt, 278 revolutions per minute for finishing cut.

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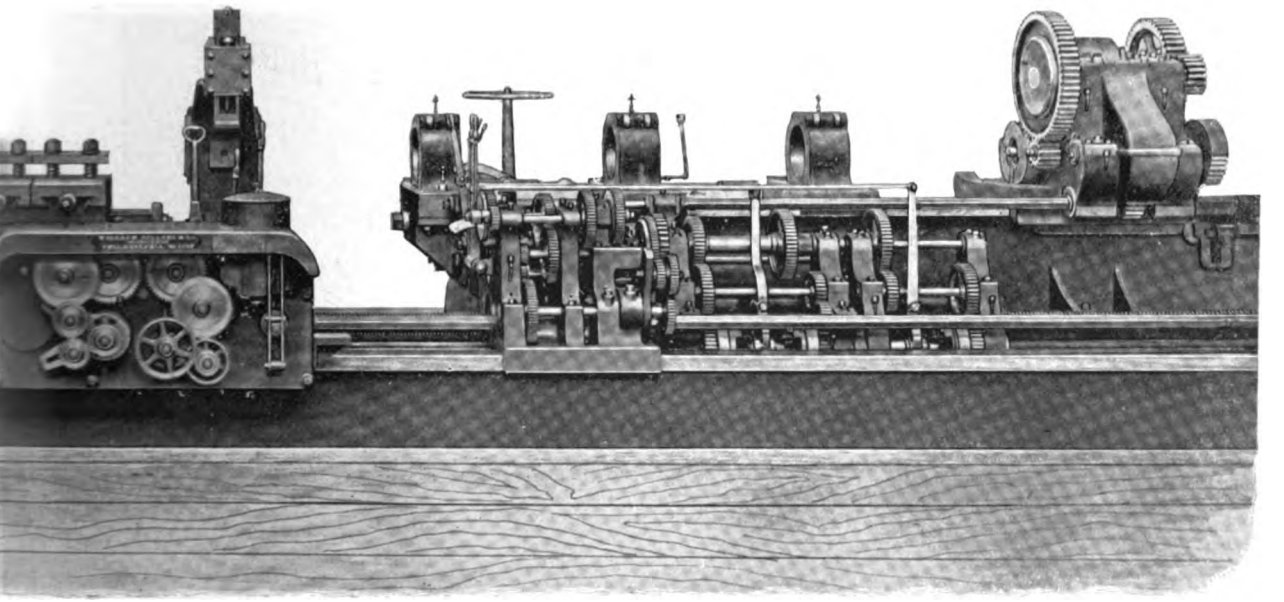


8-FOOT TURNING AND BORIN

Designed especially to permit the use of broad, flat turning tools fed at right angles to the axis of the gun, which involves very powerful feeding gear, and means of quickly moving the tool carriages and slide-rests by power. **Main Bed**, 73′ 10¾″ long, 9′ wide. **Extension Bed** for carrying the boring arrangement, 54′ 5″ long, 5′ 2″ wide. Main bed has four ways,—two for tool carriage and two for steady rests, and poppet-head so arranged that tool carriages may pass by poppet-head and steady-rests. Massive and powerful **Live Head** about 9′ long, with 20″ oil-tempered steel spindle and cast-steel face-plate, with 75 cut teeth, 4″ pitch, 10½″ face. Face-plate provided with four powerful clamping jaws, with bronze shoes. Largest lift of cone-pulley, 60″ diameter for 8″ double belt. Two speeds on countershaft, making 14 turning speeds, arranged in geometrical progression. Breaking pin in driving-gear prevents possible overstrain. The **Tool Carriages** are two in number, each consisting of a saddle sliding directly on the bed, and provided with a swivelling slide-rest, which carries two tool-rests having independent cross adjustment. Length of guide for carriage on bed, 9′. Carriage is moved by long nut revolving on a stationary 6″ steel screw. This nut receives its feed-motion from a square shaft within the bed, driven at constant speed by gears in the live head, while its quick traverse, 20′ per minute, is obtained from a second square shaft, also of constant speed, driven by a separate pulley. The quick traversing mechanism of one carriage can be instantly operated in either direction without disturbing the other carriage, whether it be screw-cutting or turning. All changes for feeds or screw-cutting are made on the saddle, thus making the two tool carriages entirely independent of each other in all their movements. Cross-slide in each saddle is operated by a 3″ steel screw, rotated by the square feed-shaft in bed. By feeding cross-slide and saddle simultaneously and in various relative amounts, taper surfaces may be turned.

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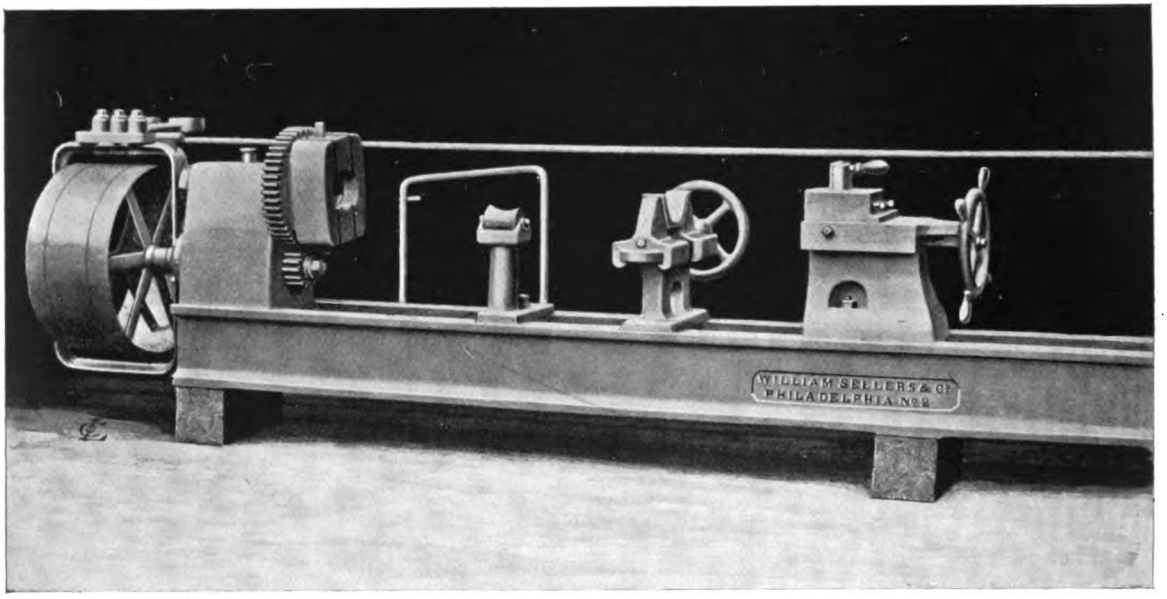
No. 73.



G LATHE.—For 16″ Steel Cannon.

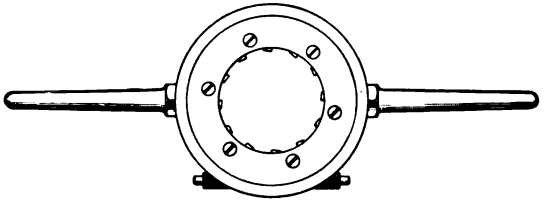
When screw-cutting carriage is run back to starting-point after each cut by quick traversing mechanism, an indicator is provided for spacing threads and to show proper time for throwing screw-cutting clutch into gear. Levers for rapid traverse and longitudinal feed are interlocked so that they cannot be thrown in together. **Four steady-rests** are provided, taking respectively, 61″, 54″, 40″, and 27″ diameter. They have adjustable jaws and embrace an arc of over 220 degrees, but are open in front to permit the carriages to run by. **Poppet-Head,** supported like the steady-rests upon the two back-bearings of the bed, is provided with a 14″ steel spindle and 8″ centre. By removing this spindle and thrust block the poppet-head may be used, if desired, as a boring-bar support. It may be moved along the bed like the steady-rests, by the nearest carriage; a coupling bar being provided to join them. **Boring Bench** carried upon the extension bed and operated from a revolving nut on the 6″ screw in the main bed. All mechanism required for moving the boring bench, for boring-feeds and for quick traverse of the boring-bar, is bolted to the front side of the boring bench, its frame-work being also supported by the end of the main bed, upon which it slides as the bench is moved. This mechanism is driven by the feed and quick traverse shafts in the main bed. The boring-bar is supported by a fixed rest at the front end of the bench by a sliding-head in which it is held and rotated at the rear end, and by two intermediate supports, travelling with the sliding-head at proportional rates of speed. The boring-bar can be rotated at any speed that may be desired, whereby the rate of boring is rendered independent of the turning-speed. The sliding-head on the end of the boring-bar is moved by a 5″ steel screw in the boring bench. This screw receives both slow-motion for feed and quick-motion for rapid bar traverse. Boring-bar supports have side extensions, upon which the bar can be rolled when it is desired to examine the bore of the gun.

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AXLE CENTRING AND SIZING MACHINE.

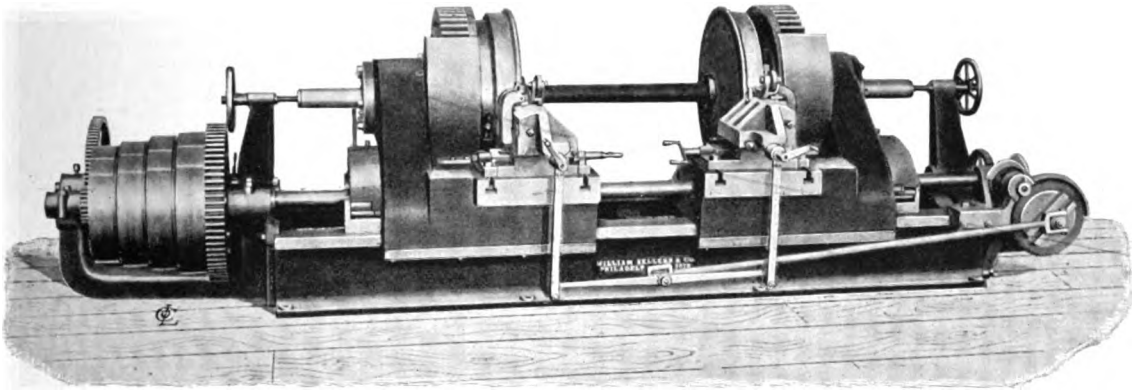
For squaring up and recentring railroad axles and sizing wheel-fit. Has powerful bronze-lined chuck to clamp axle by outer collar at one end, while other end rests in adjustable bronze-lined "V" bearings, and a squaring tool finishes the end of the axle and recentres it at the same time. The "wheel-fit" is brought to size by a hollow reamer provided with adjustable cutting blades. Complete with countershaft, sizing reamer, and sample tools. Fast and loose pulleys, 20″ diameter for 2¼″-belts, in two sets, one making 84 and the other 268 rotations per minute.



HOLLOW REAMER.

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PLATE No. 75.



LATHE FOR STEEL-TIRED CAR-WHEELS.—UP TO 42″ DIAMETER.

This lathe is intended for turning car-wheels with steel tires up to 42″ diameter on the tread, and is especially designed for those forms of wheel in which the tread projects beyond the plate on the outside of the wheel. Such wheels are held by expanding a continuous chuck against the inside of the tires, and are supported without any strain on the axles. They are centred rollers running on any unworn part of the tire, as top of flange, for example, and then bolted fast. There are two driving-heads, each provided with its own slide-rest, arranged to move to and from one another by power upon the bed; the axle of the wheels being supported upon adjustable centres. Face-plates, 43″ diameter. Driving-cone, 32″ diameter on the largest lift, for 5″-belt; and the ratio of the gears in the driving train is 276 to 1. Feeds are provided in both directions, operated by an adjustable crank and ratchet boxes. Height of centres above bed, 26″; capable of turning full width of tire in one broad cut, but arranged for successive narrow feeds also. Complete with countershaft, wrenches, two sample expanding rings for 42″ tires. Fast and loose pulleys, 26″ diameter, 6″ face. Should make 168 rotations per minute.

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Wheel-Turning Lathe.

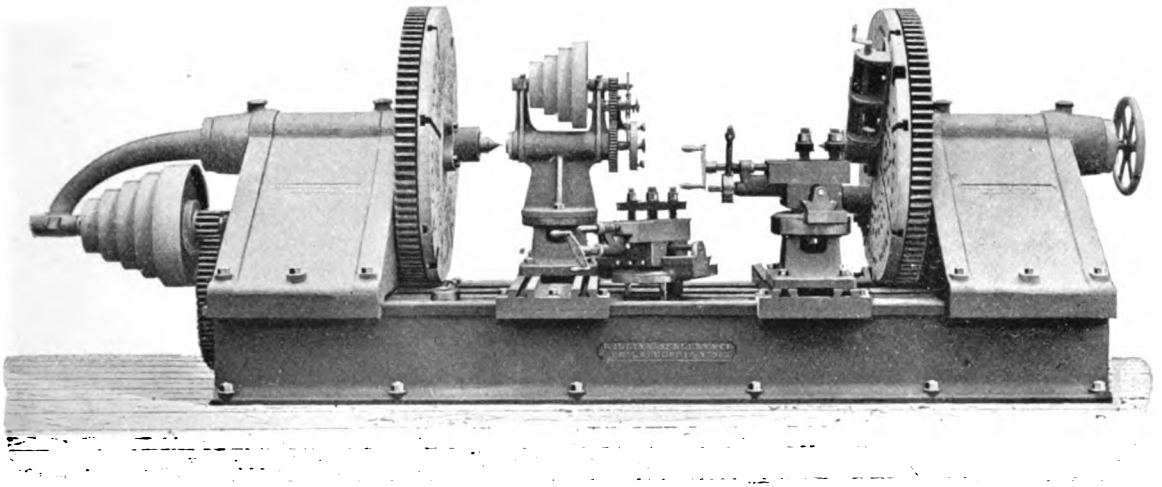
"RECOMMENDED for its great stability and general excellence of construction as a machine tool, and for the convenient adaptation of various devices to a special purpose of great importance, namely, for turning the driving-wheels of a locomotive correctly, and at the minimum of cost, with such arrangements as will enable both wheels to be acted upon at the same time. The beautiful outlines and grandeur of this tool are worthy of highest commendation."—*See Introduction*, pages 6 to 12.

THIS is believed to be the most efficient tool for turning driving-wheels for locomotives that has been built. Its principle admits of unusual stability. The pressure of cut always falls within the bed-surface, and its exceeding simplicity recommends it for the work it is designed to do. The feed is obtained from a rock-shaft, placed overhead, from arms on which chains are carried to ratchet-feeds on the compound slide rests. This enables the feeds to be operated to equal advantage in all directions by power, and to be entirely under the control of the workman.

For wheel quartering, we furnish a portable horizontal boring-machine, which can be put in place of one of the slide-rests upon its post, and when so placed its spindle is on a level with the centres of the lathe. This boring-machine is provided with the most improved self-acting feed-motion, of wide range, either forward or back, and quick return by hand. When lathes are ordered with the quartering attachment, the face-plate furthest away from the driving-cone has four of its T-slots planed truly at right angles, and these slots, one pair horizontal and the other vertical, are made to serve the purpose of quartering the crank-holes. The face-plate is clamped to place by means of a block, which fastens the bottom end of the vertical slot to the bed-plate or shear. The horizontal slot is provided with adjustable plugs, which set to one or the other side of the centre, serve to fix the position of the crank-hole to be bored either for right- or left-hand crank-lead. The boring is done from between the wheels toward the live-head face-plate, the

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PLATE NO. 76.



54″ WHEEL-TURNING LATHE.—WITH TWO GEARED HEADS, WITH FACE-PLATE 54½″ DIAMETER, DRIVEN INDEPENDENTLY.

Two compound slide-rests, self-acting feeds in all directions; will swing 49″ over the saddle. Height of centre above top of bed, 27″. Head set over to bring cutting strains all within bed. 8½″ cast-iron spindle. Maximum distance between face-plate, 9′ 11″. Ratio of gearing in face-plate, 6 to 1; ratio of back-gearing, 48 to 1. Largest lift of cone-pulley, 26½″ diameter for 3¾″-belt. Complete with countershaft, wrenches, ratchet-boxes, and rock-shaft for feed. Fast and loose pulleys, 20″ diameter, 5″ face, and should make 50 revolutions per minute. Wheel-quartering and hub-facing attachment, extra. Splining attachment for hubs of wheels, extra. Patent hoisting attachment for lifting wheels into lathes, extra.

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finishing cut being made from outside of wheel. The face-plate slide-rest is bolted to the horizontal slot in the first named face-plate and serves to turn up the whole of the outside of the wheel-crank, boss, and centre, the slide-rest being stationary and the wheels being driven by the face-plate on the live head.

We provide in both face-plates circular pockets near to the rim, which pockets are for the purpose of sustaining the ends of a small I-beam adapted to the gauge of the road. On this I-beam are sling-chains and screw-swivels to attach to the axle between the wheels. By means of this very simple and not cumbersome device the wheels on their axles are swung up to the centre by the rotation of the two face-plates through say one-quarter of a revolution. Wheels rolled up to the back of the lathe are thus lifted in with great ease, and they are set down again on the floor in the same manner.

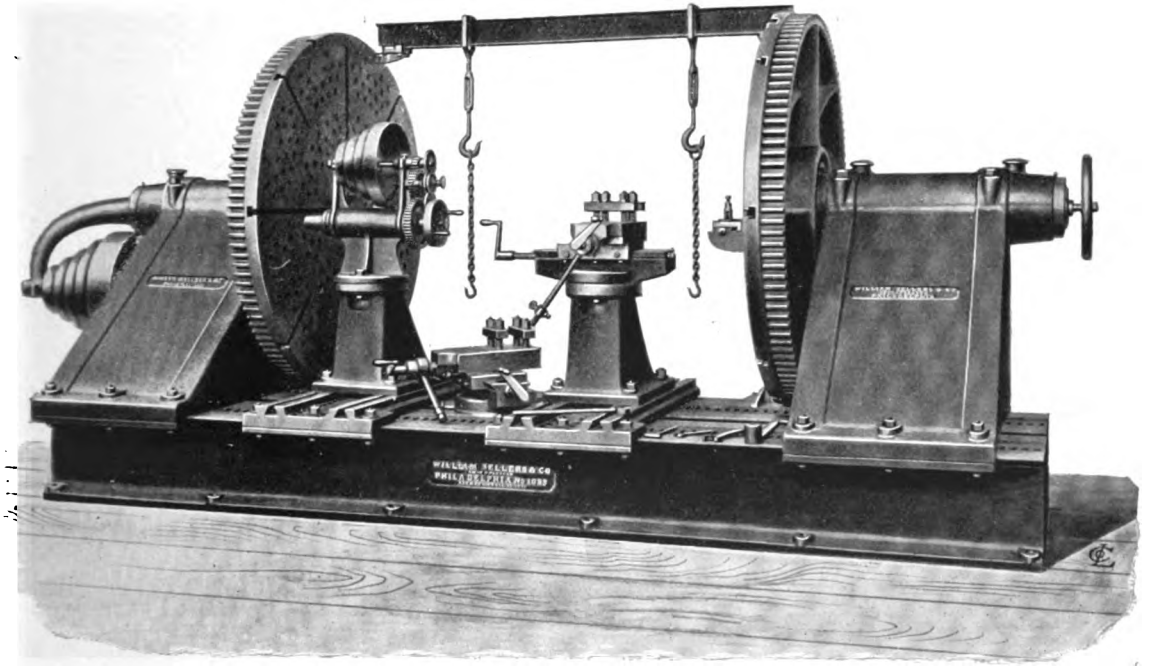
The machines noted in the following table cover the entire range of sizes of wheels used in modern railroad practice up to 6 feet 6 inches diameter on tread. Our 54-inch lathe has been especially designed to meet the requirements of the narrow gauges, and its slide-rests are so made as to permit the entrance of at least one of them between the driving-wheels of the narrowest gauge, close to the axle, for the purpose of returning the journals when they need such attention.

Size of Lathe.	Diameter of Face-Plate.	From Centres to Top of the Shear.	Distance between Face-Plates.	Total Length of Shear.	Diameter of Pulleys on Countershaft.	Speed of Countershaft.
90 ins.	7 ft. 6½ ins.	3 ft. 9 7/16 ins.	8 ft. 7½ ins.	16 ft. 11¾ ins.	24 ins. x 7 ins.	50 Rev's.
79 "	6 " 6½ "	3 " 3½ "	8 " 10 "	15 " 11¼ "	24 " x 7 "	50 "
66 "	5 " 6½ "	2 " 9½ "	8 " 6 "	14 " 10¼ "	24 " x 7 "	50 "
54 "	4 " 6½ "	2 " 3½ "	7 " 3¼ "	13 " 6 "	20 " x 5 "	50 "
54 "	4 " 6½ "	2 " 3½ "	9 " 11 "	16 " 2¼ "	20 " x 5 "	50 "

Wheel-Quartering Attachment, extra. Face-Plate Slide-Rest, for facing the hubs of crank-pin holes, extra. Splining Attachment, extra. Patent Crane Attachment, for lifting the wheels into and out of place, extra.

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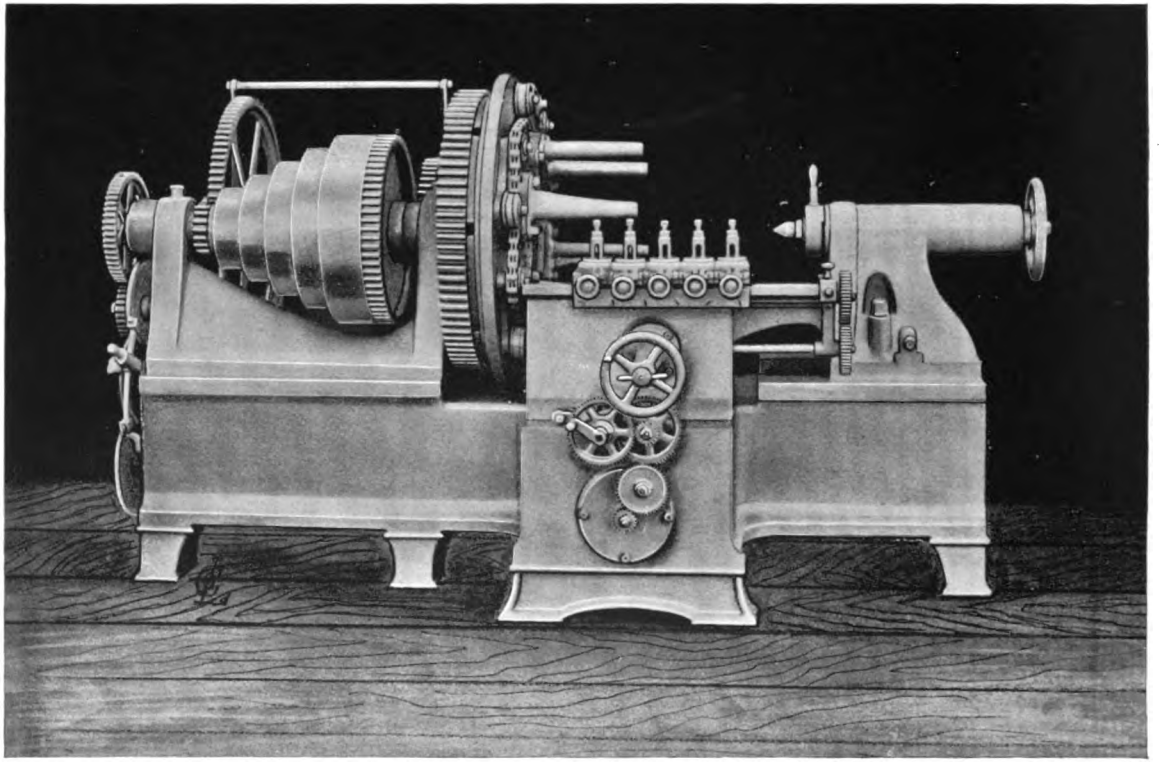
PLATE No. 77.



79″ WHEEL-TURNING LATHE.—WITH TWO GEARED HEADS, WITH FACE-PLATE, 6′ 6½″ DIAMETER, DRIVEN INDEPENDENTLY.

Two compound slide-rests, self-acting feeds in all directions; will swing six feet over the saddle. Height of centre above top of bed, 3′ 3½″. Head set over to bring cutting strains all within bed. 9″ cast-iron spindle. Maximum distance between face-plate, 8′ 9″. Ratio of gearing in face-plate, 10 to 1; ratio of back-gearing, 60 to 1. Largest lift of cone-pulley 29″, for 4½″-belt. Complete with countershaft, wrenches, ratchet-boxes, and rock-shaft for feed. Fast and loose pulleys on countershaft, 24″ by 7″. Should make 50 revolutions per minute. Wheel-quartering and hub-facing attachment, extra. Splining attachment for hubs of wheels, extra. Patent hoisting attachment for lifting wheels into lathe, extra.

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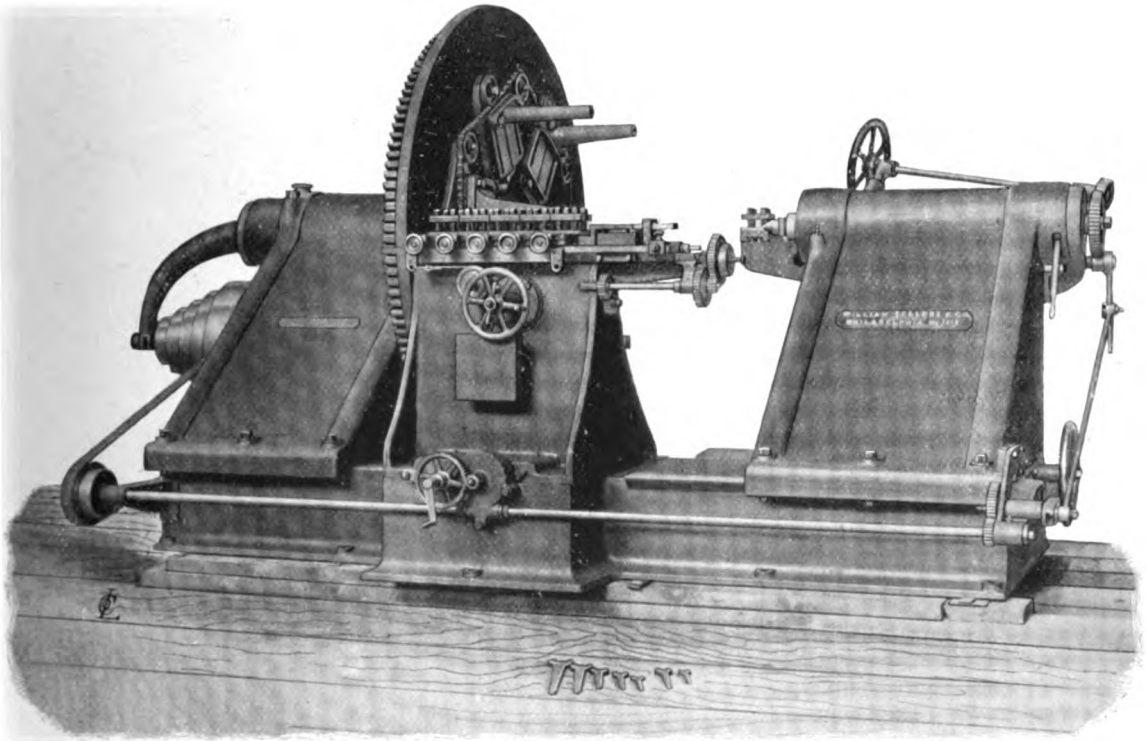


36″ PULLEY LATHE.

Special lathe for turning pulleys from 20″ diameter to 36″. Slide-rest with five independent tool-holders, and former bar to determine shape of pulley face. Frictional turning-feed through improved discs, equalizing drivers for face-plate, with six arms. Largest lift of cone-pulley, 28″ for 3½″-belt. Triple-geared head. Ratio of triple-gearing, 38 to 1. Ratio of back-gearing, 6 to 1. Height from centre to top of bed, 20″. Will turn and face up to 24″ width of face. Fast and loose pulleys on countershaft, 26″ diameter, 4″-belt, and should make 80 revolutions per minute.

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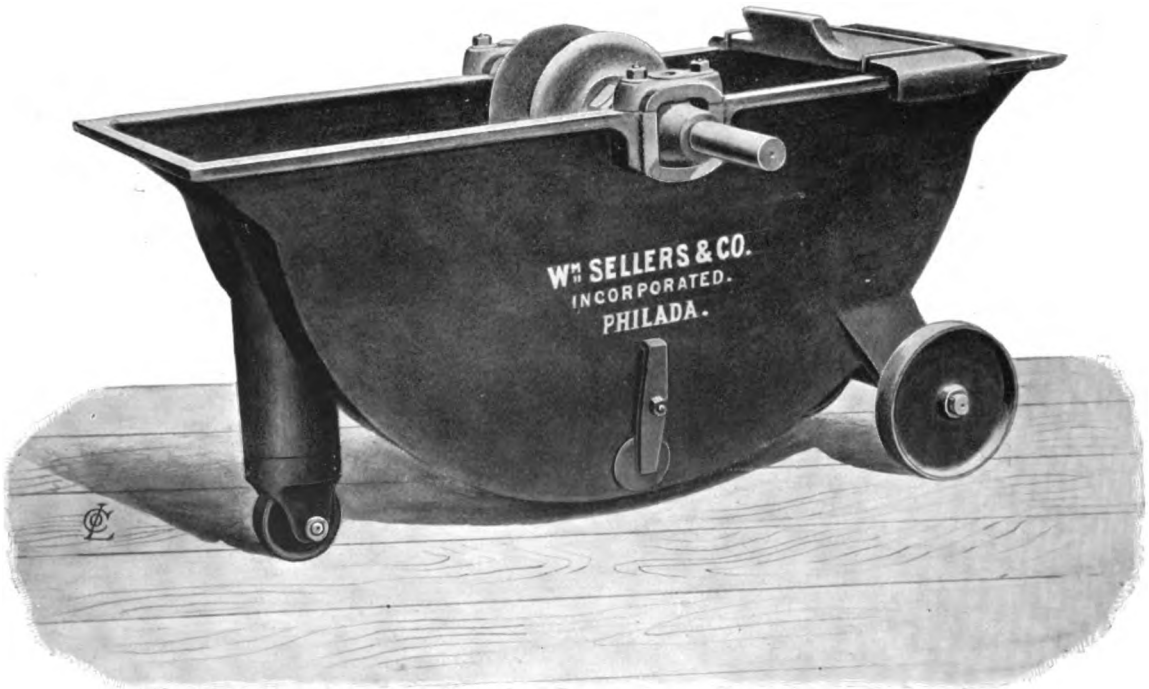
PLATE NO. 79.



96″ SPECIAL PULLEY LATHE.

Cast-iron spindle and live head, 11″ in diameter. Live head driven through face-plate giving ten speeds. Largest lift of cone-pulley, 29″ for 4½″-belt. Height from centre to top of shear, 45½″. Will turn and face pulleys from 36″ diameter up to 96″ diameter by 48″ face. Five independent slide-rests on carriage, with former bar to determine shape of pulley face. When required, provided with attachment for turning the outside of pulley-hubs, and with former attachment for turning grooves of rope wheels. Patent holdfast for poppet spindle and equalizing drivers on face-plate. Fast and loose pulleys on countershaft, 24″ by 7″, and should make 135 revolutions per minute.

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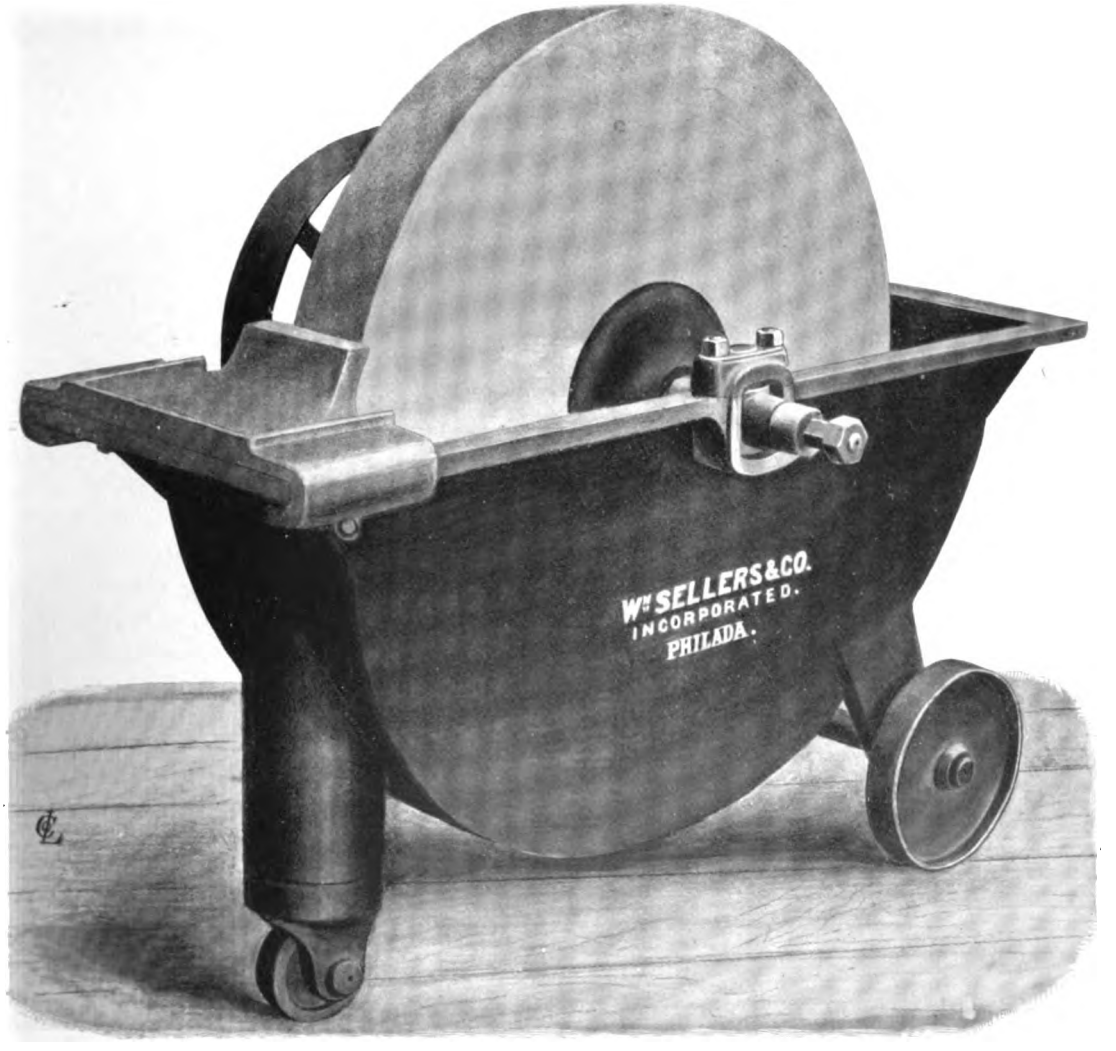


42″ GRINDSTONE BOX.

Box of cast iron in one piece, resting on three wheels, one of which is made to turn in a socket to permit easily moving the box, for adjusting to length of belt or for other purposes. 2″ arbor for grindstone, with washers 10½″ diameter, and nut. Adjustable rest for tool. 1¾″ ball and socket bearings for arbor. All complete except pulleys and stone, which are extra, to suit stone 42″ diameter, 6″ face.

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PLATE NO. 81.



48″ GRINDSTONE BOX.

Box of cast iron in one piece, resting on three wheels, one of which is made to turn in a socket to permit easily moving the box for adjusting the length of belt or for other purposes. 2½″ arbor for grindstone, with washers 12″ diameter, and nut. Adjustable rest for tool. 2½″ ball and socket bearings for arbor. All complete except pulleys and stone, which are extra, to suit stone 48″ diameter, 7½″ face.

We also have patterns for similar box for a stone 60″ diameter, 8″ face.

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Patent Drill-Grinding Machine.

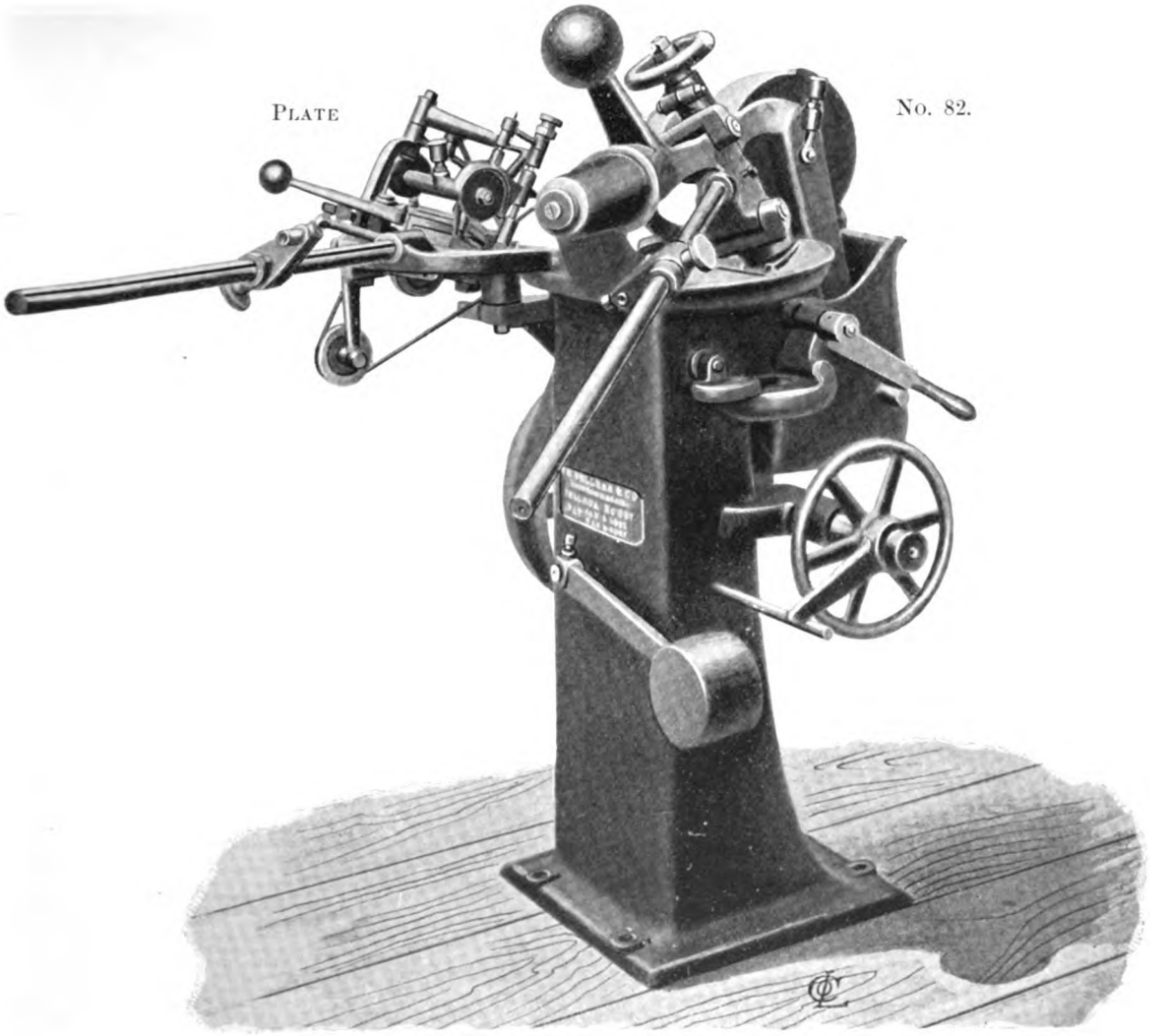
"RECOMMENDED for originality in the idea and excellence of the design of an apparatus for grinding the edge of drills in such a manner as will insure mathematical accuracy, both in the angle and the cutting edges, at the minimum of cost, by which means the drill instrument is rendered more efficient; it performs more and better work than is practically obtainable by the usual system, even in the hands of a skilled workman."—*See Introduction*, pages 6 to 12.



O drill true holes of uniform diameter and the closest approximation to the size of the drill, it is necessary that the two cutting edges of the lips of the drill should be of precisely the same length, and at the same angle with the axis; and to obtain the greatest drilling effect it is requisite that the backing or clearance of the two lips should conform as closely as possible, near to the cutting edges, to the shape of the bottom of the hole produced by the drill, so as to give the greatest strength and support to the cutting edges, yet insuring sufficient clearance to enable the drill to cut freely without binding. As the shape of the bottom of the hole is a cone with the apex truncated by the point of the drill, it is evident that the best shape for the end of the lips of the drill will be that of the surface of a similar cone having its axis sufficiently eccentric to the axis of the drill to give the proper clearance to the edge. Our drill-grinding machine is constructed on this principle, and produces the correct shape on every size, from $\frac{5}{16}''$ to 3″, of twist, fly, chuck, or any other kind of double-lip drill, without any alteration or adjustment of the holding device to suit the different sizes and kinds. The thickness of the web between the cutting-edges at the point of a drill has a marked effect upon its behavior, and should be as thin as possible, consistent with strength. We have attached to the machine a pointing device which grinds a groove on each side of the web at an angle to the cutting-edge, and also to the axis of the

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PLATE No. 82.



FRONT VIEW OF PATENT DRILL-GRINDING MACHINE.

Produces cutting edges of the correct shape on any kind of double-lip drill from $\frac{5}{16}''$ to 3″, without any alteration or adjustment of the holding devices to suit different sizes and kinds, and reduces the thickness of the web at the point symmetrically about the axis.

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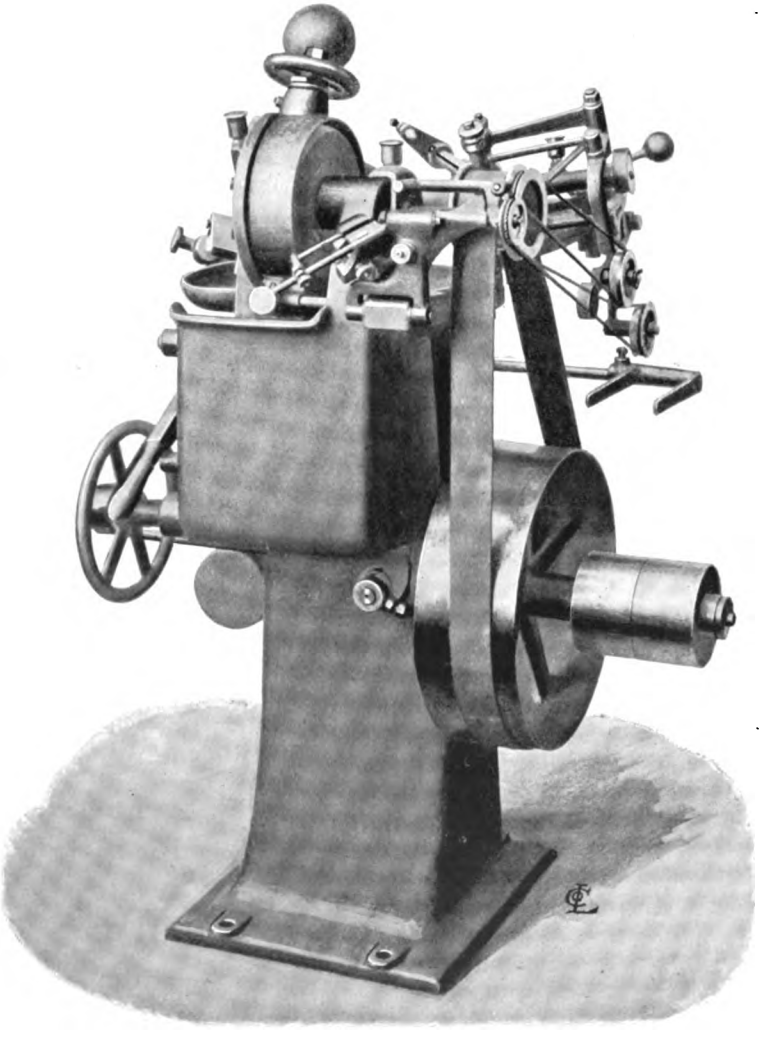
drill, deepest at the point and rapidly growing shallower as it extends up, the width being proportioned to the diameter of the drill, narrow in small drills and wider in large ones, and determined automatically by the size of the drill itself, without any adjustment.

A machine for grinding drills from $\frac{1}{16}''$ to $\frac{5}{16}''$ diameter has recently been added, which can be used either as an attachment to the large machine or as a separate apparatus. This is constructed on the same principles as the large machine, and will produce the same theoretically correct shapes, so that a complete drill-grinding machine, with all attachments, will accurately grind any kind of double-lip drill from $\frac{1}{16}''$ to $3''$ diameter, and will reduce the thickness of the point in such manner as not to diminish the strength, with the result that both cutting-edges will be of the same length and the point will be in the centre, regardless of the accuracy with which the drill has been forged or milled. The advantage of being able to grind drills which will make holes of uniform diameter is very great when the holes are to be reamed, as it permits the size of the drill to be so proportioned to that of the reamer as to leave the least amount of work to the latter compatible with securing a smooth and true hole. These advantages are obtained with very little skill on the part of the operator, the size of the drill itself in all cases automatically determining its position for correct grinding. In addition to which, the pump and water-supply nozzles enable the work to be done quickly and without risk of drawing the temper of the drills. The machine is simple in construction, is but little liable to wear, and takes up its own lost motion.

The benefit of having the lips and points of drills accurately ground is found not only in the superiority of the work which they do, but also in the diminished wear on the machines in which they are used, and the less power required to drive and feed them, and the system of having all drills ground by one man, which results from the use of these machines, tends to increase the output of the drilling machines, the uniformity of the product, and economy in drills.

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PLATE NO. 83.



REAR VIEW OF PATENT DRILL-GRINDING MACHINE.

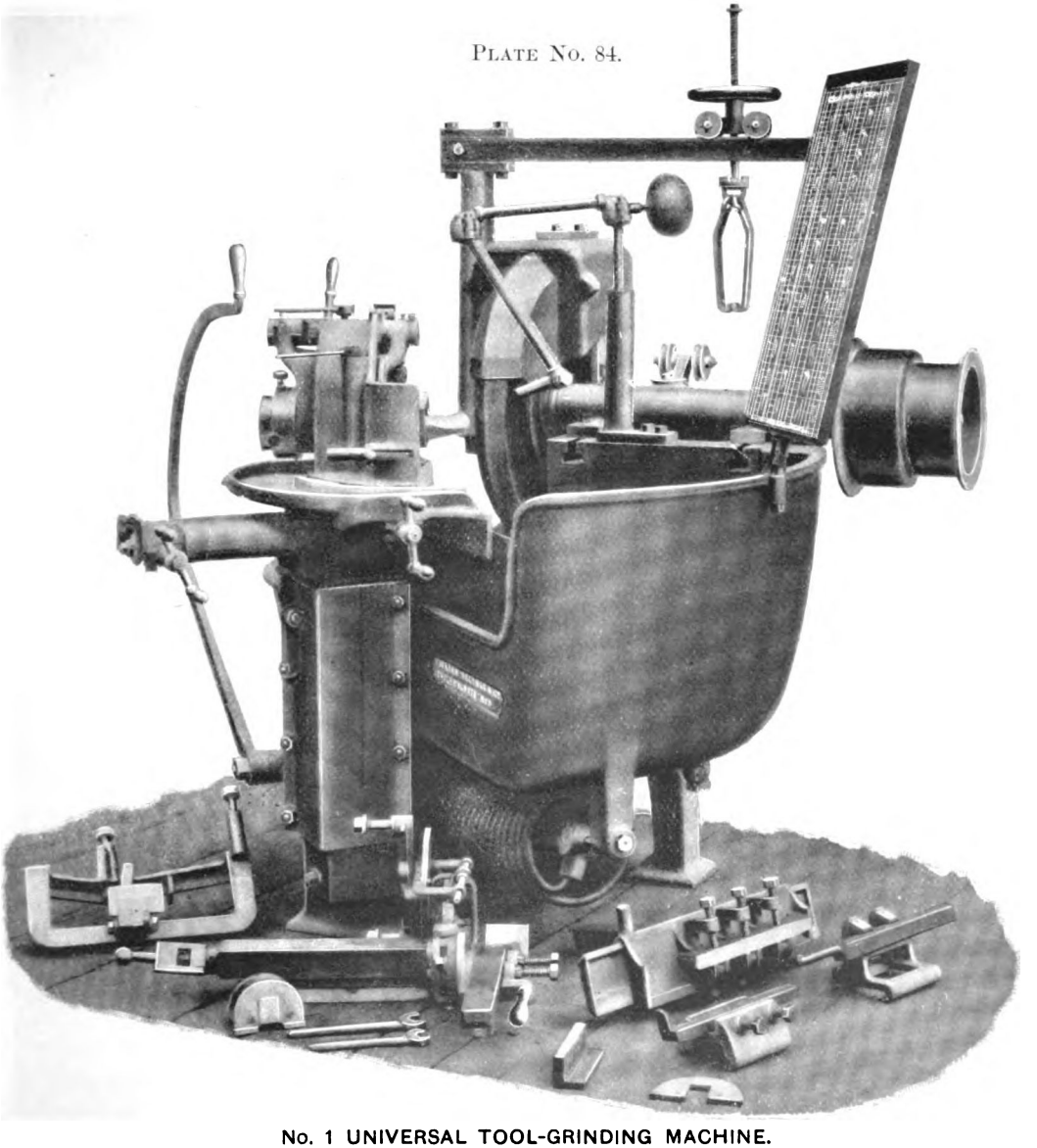
Carries, when so ordered, a supplemental machine for grinding drills from $\frac{1}{16}''$ to $\frac{5}{16}''$. The fast and loose pulleys on the machine are 5″ diameter, 3″ face, and must be made to run about 560 revolutions per minute.

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Patent Tool-Grinding Machines.

THE system of having a separate department for the manufacture, care, inspection, maintenance, and storage of small tools, from which they are delivered to the users only on checks, which serve as receipts to identify the person at fault in case of their loss, breakage, or misuse, has been of such pronounced benefit that it is almost universally adopted. Many years ago we started an effort to bring within this system the lathe and planer tools, and everything in the shape of a cutting-tool used on any of the machines in our works. This necessitated a thorough investigation of the shapes and merits of such tools as were at that time distributed among the various machines, and a long series of experiments to determine the best forms and cutting angles, so as to decide just what was the most efficient shape of tool for any definite operation upon any given material. When the desired forms were finally fixed upon, we designed and built a machine by which these forms could be quickly, reliably, and accurately ground by unskilled labor. This machine we placed in our tool department, and by it produced a set of tools such as we believed would answer every requirement of the works. These tools were systematically arranged so that they could be treated with as much consideration as reamers or taps, and when all was ready every machine in the place was relieved of its stock of good, bad, and indifferent tools, thus unearthing tons of the best tool steel, much of which had been absolutely useless for years. Although encountering, at the start, some opposition from men who had pronounced ideas as to the most desirable shapes, which did not coincide with the standards adopted, the system soon proved a great benefit in every respect. While at the beginning we had occasionally to fine a man who would return a tool showing evidence of his having touched it up on an ordinary grindstone, now we could not

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No. 1 UNIVERSAL TOOL-GRINDING MACHINE.

For tools with shanks not over two inches square. Complete with rotary pump and a chuck for circular and curved tools. A holder for grinding base of tool-shank. A chuck for grinding any bent tool on all faces without changing its position in the chuck. A chuck for holding splining or key-seating tools in same manner. A crane for changing the wheel on its spindle. Fast and loose pulleys 10″ by 6″, 400 revolutions per minute.

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induce him to waste the time required to do so. We are convinced that by the adoption of this system we have not only increased the daily output of our machine tools, but also have improved the average quality of the work from them, while at the same time reducing the cost of the cutting-tools and improving the appearance and *esprit* of the shops.

The results of this experience are embodied in our Patent Tool-Grinding Machines, which have been designed to produce and to duplicate with mathematical accuracy the angles and shapes which we have adopted as our standards, or any others that may be desired, and to do this reliably and expeditiously by means of unskilled labor.

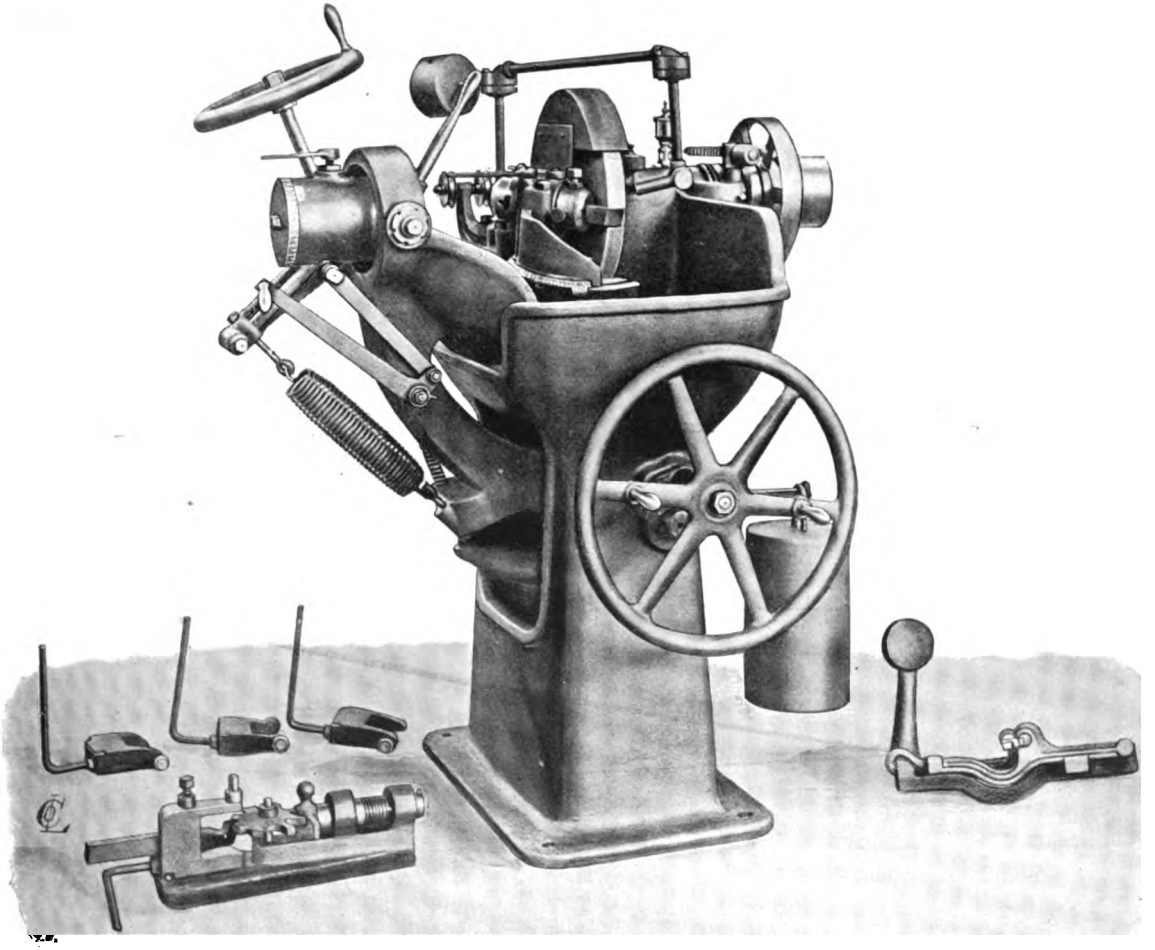
To efficiently grind steel tools by means of rapid cutting-wheels, it is absolutely necessary that the contact between the two should be a line and not a surface. Hence, if it is desired to grind a plane face of a tool, the wheel must have a cylindrical or conical surface, past which the surface to be ground must be moved in a plane. A plane face of the wheel cannot be used for this purpose, because it and the surface being ground would soon coincide, with the results of no cutting and much heating.

The tool should be clamped in the holder against its base, or the surface upon which it rests when in use, in order to avoid any errors due to want of parallelism of its sides, and to enable it to be reground with a minimum of loss. All of its plane faces should be ground without altering its position in the holder, to insure the accuracy of the angles and uniformity in results. This requirement is particularly important in thread tools, for the grinding of which these machines are of the utmost benefit. Indeed, if they were capable of nothing else, this one feature of the accurate grinding of thread tools and the consequent maintenance of standards, would make their use profitable.

The tool-holder should be capable of presenting the tool to the wheel in such manner that any face can be so ground as to have a definite, predetermined relation to the other faces and to the shank, and the adjustments necessary to accomplish this

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PLATE NO. 85.



NO. 2 UNIVERSAL TOOL-GRINDING MACHINE.

For tools with shanks not over 1½ inch by 1 inch. Grinding wheel of ordinary shape, 15″ diameter, with axial reciprocating motion which can be instantly stopped or started. Graduated arcs by which the clearance angles can be read direct. Complete with rotary pump and jointed pipe arrangement and the following attachments: Holders for curved face tools, one for straight right or left hand, one for bent right hand, one for bent left hand, and one for circular tools. A gauge for setting curved face tools in the holders. A chuck for grinding any bent tool on all its faces without changing its position in the chuck. Tables and diagrams giving cutting and clearance angles of all tools. Countershaft complete and all necessary wrenches. Fast and loose pulleys 10″ diameter, 5″ face, to make 360 revolutions per minute.

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must be easily understood and quickly manipulated. It must be so mounted as to enable the tool-face to be easily and quickly reciprocated past the line of cut of the wheel, and to be reliably fed against it and brought to any part of it. The cuts should be light, quick, and frequent, to produce the best results in the shortest time.

Our experiments demonstrated that for roughing-cuts a curved cutting-edge is more efficient than a straight one, and that different materials and different depths of cut require different degrees of curvature; also, that the cut should be a draw-cut and not a gouging-cut, so that the bulk of the metal would be removed ahead of the point of the tool. This adds greatly to its life, the point being the most delicate part. The machines are supplied with holders to be used when grinding their curved faces, and gauges for setting the tools in the holders so as to produce our standard shapes as given by the reference tables accompanying the machines, but means are provided for producing any other shapes that may be preferred to those adopted by us. Means are also provided for grinding circular cutting-edges with ease and accuracy, which is a great convenience in forming tools for planing or turning fillets and circular grooves.

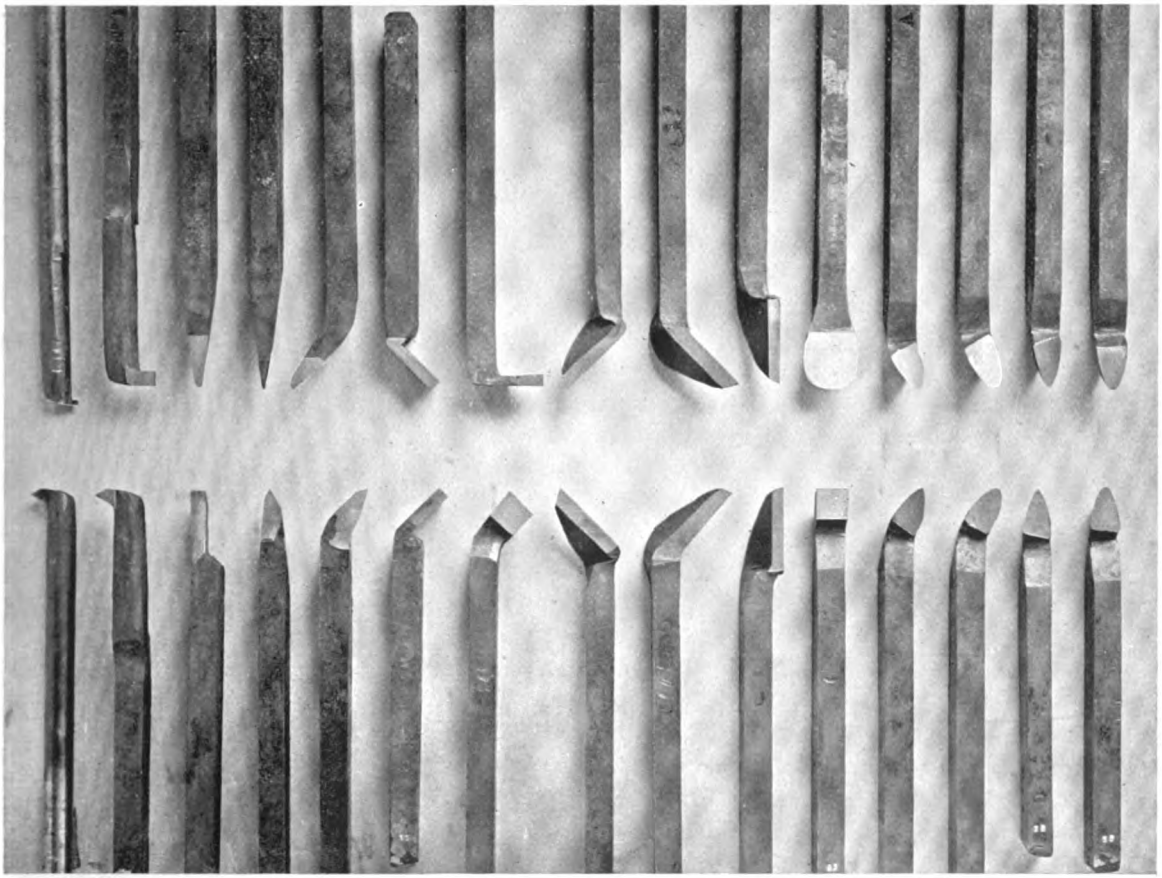
For boring or chasing tools, which are usually bent at right angles to the shank, a special holder is furnished which, when inserted in the regular holder, enables such tools to be ground in the same manner as the outside turning-tool. The advantage of being able to grind a chasing-tool which will make a female thread having absolutely the same shape and angles as its male mate which has been produced by a tool ground in the same manner, needs no comment.

The only shapes of cutting-edges which cannot be ground on these machines are concave curves and re-entrant angles less than ninety degrees.

A rotary pump forces water to the tool being ground through a system of jointed pipes, ending in an adjustable nozzle. This furnishes a large volume of water at low velocity, which can be regulated in amount and directed at will, thus enabling it to be applied in manner and quantity to suit the various conditions, and avoiding the necessity of applying it to the wheel at some distance above the tool,

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PLATE No. 86.



EXAMPLES OF LATHE TOOLS FINISHED TO SHAPE BY THE TOOL-GRINDING AND SHAPING MACHINE.

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whereby it would attain the velocity of the wheel on reaching the tool and cause an inadmissible amount of splashing. The function of the water is to carry off the heat generated by the grinding, and this arrangement accomplishes this in the most effectual manner and with the least splashing.

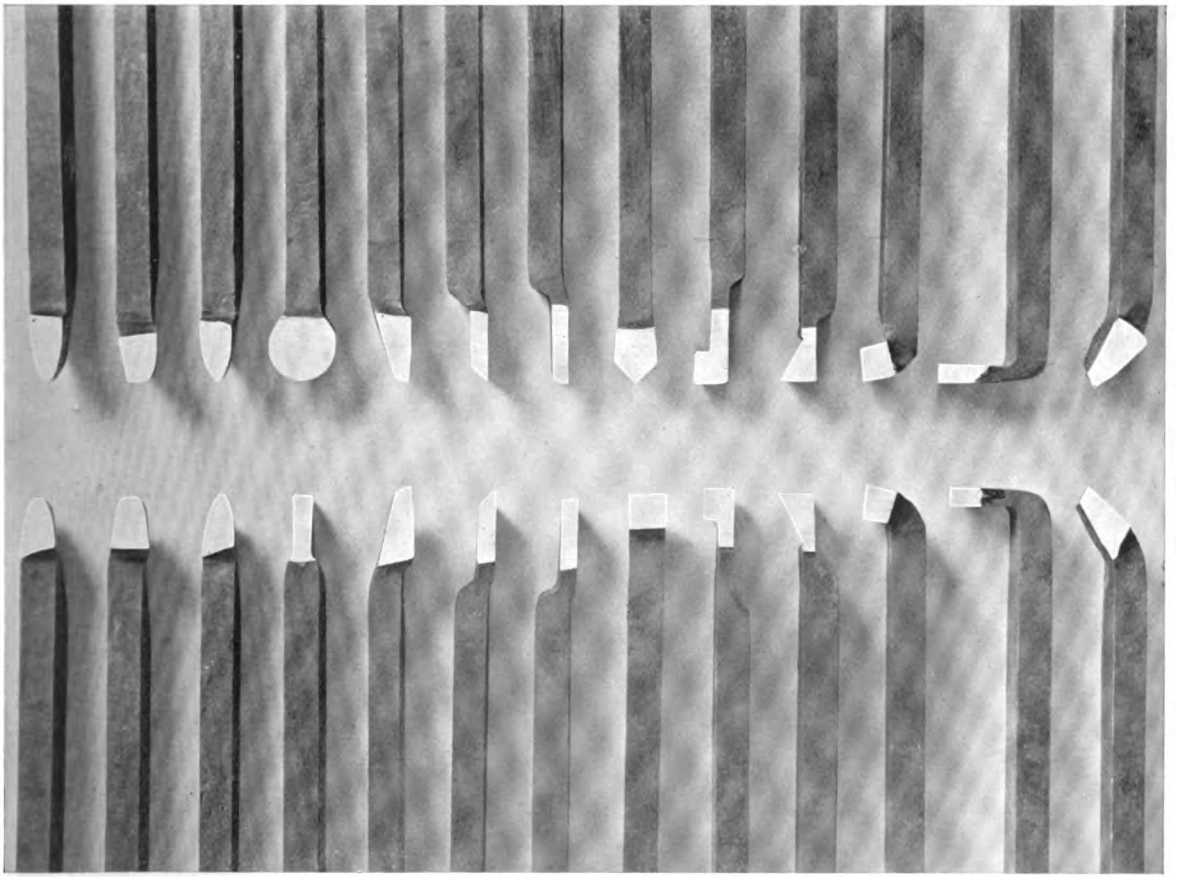
The use of such a large quantity of water demands that all working parts should be protected from it, on account of the grit carried along with it. This has been effectually done. In fact, every point about these machines has been carefully studied and thoroughly tried.

The daily product of the machine in our own shops averages something over four hundred tools, which includes new tools and those requiring only a slight retouching, or, in other words, the average requirements of a machine-shop.

The No. 1 machine will do all work, after forging, to finish to shape tools whose shanks are not over two inches square. The wheel has two conical grinding surfaces forming a V, for convenience in reading the different faces of tools, for increasing the available grinding surface, and to enable small and delicate splining tools to be ground. The tool-chuck can be rotated about a horizontal axis parallel with the shank of the tool, and can be readily set to any angle by means of a graduated circle and vernier reading to $\frac{1}{10}$ degree. This is carried in a frame which can be rotated about a vertical axis passing near the point of the tool, and can be set to $\frac{1}{10}$ degree. This is carried by two slide-rests at right angles to each other and moving parallel to the tangent planes of the two grinding surfaces. This is all carried by a vertical slide having a long square bearing accurately fitted, and the weight of the moving parts is counterbalanced by a spiral spring, so that, although massive and rigid, it can be reciprocated vertically with surprising ease. The chuck for grinding curved surfaces is inserted in the regular tool-chuck, and a frame carrying a gauge and a roller against which the former-plates work, is put in place in about half a minute. Means are provided by which any desired curved shape can be filed or ground by hand on a tool, and that tool used as a guide or templet from which a former-plate can be ground in the machine and afterwards used to

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PLATE No. 87.



EXAMPLES OF PLANER TOOLS FINISHED TO SHAPE BY THE TOOL-GRINDING AND SHAPING MACHINE.

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exactly reproduce the tool or a curve parallel to it. A chuck is provided for grinding the side or base of a tool shank. Also a chuck by which a tool bent at a right angle can be ground the same as a straight tool without changing its position in the chuck. The V shape of the wheels permits the use of a chuck for grinding delicate splining tools.

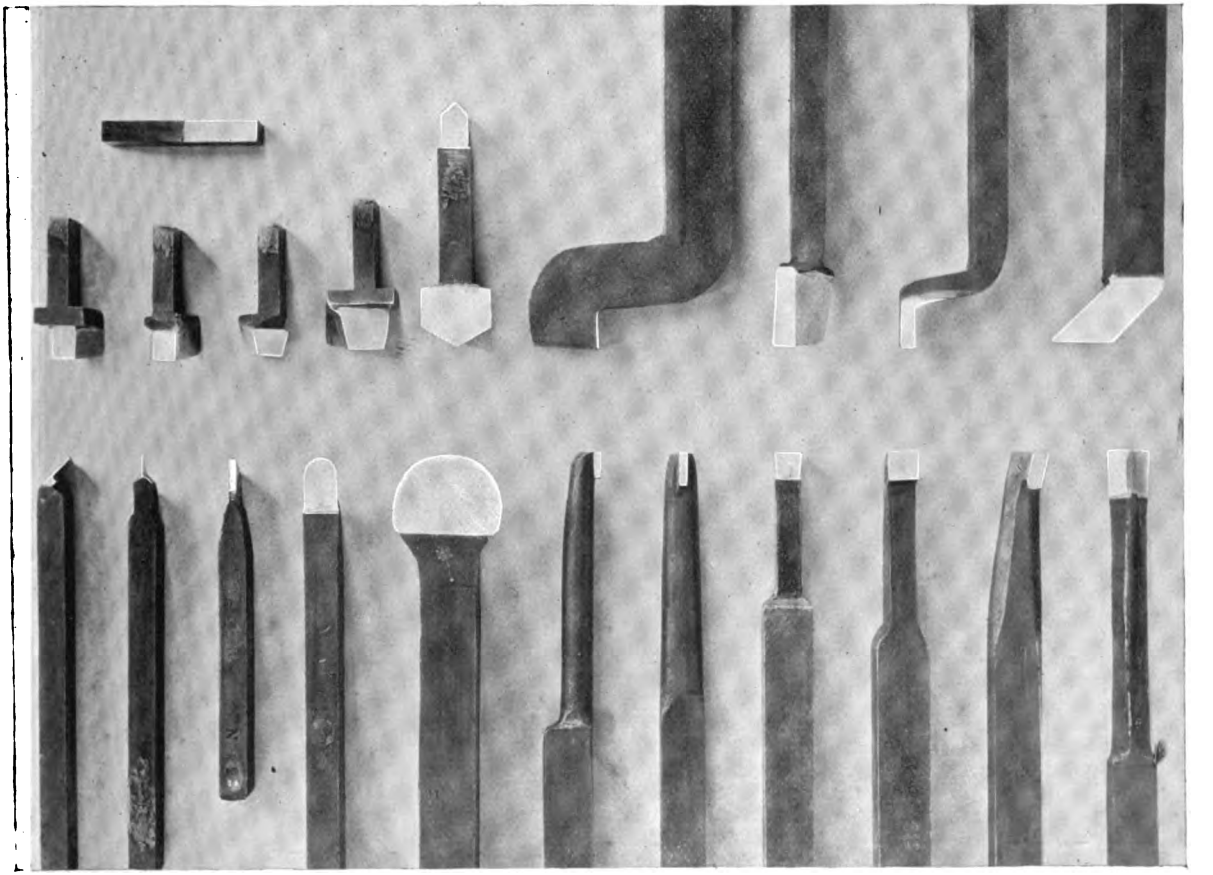
While the machine is massive and rigid, yet the facilities are such that all the operations can be easily and quickly performed, and its stiffness enables it to do very accurate work.

The No. 2 machine will do all work, after forging, to finish to shape tools whose shanks are not over 1½ inch by 1 inch, excepting those splining tools whose cutting shape is so small that it is made as a projection from a cylinder. Two such tools are illustrated in Plate No. 88. With this exception it will do all, within its limit as to size, that the large machine will do. Its movements are all convenient, light, and quick, while at the same time it is amply heavy to do excellent work on any tool which can be held in its chucks. Its design is less expensive in proportion to its capacity than the larger machine, but it will grind the large majority of the tools used in a machine shop.

The grinding wheel is of the ordinary shape, the cylindrical surface only being used. The axis has a reciprocating motion which can be instantly stopped or started. This makes smoother work with a coarser wheel, keeps the wheel surface true, and improves the lubrication of the spindle. The chuck for grinding plane faces is so mounted that any angular face can be properly presented to the wheel by reading the graduated circle direct for the required clearance angle.

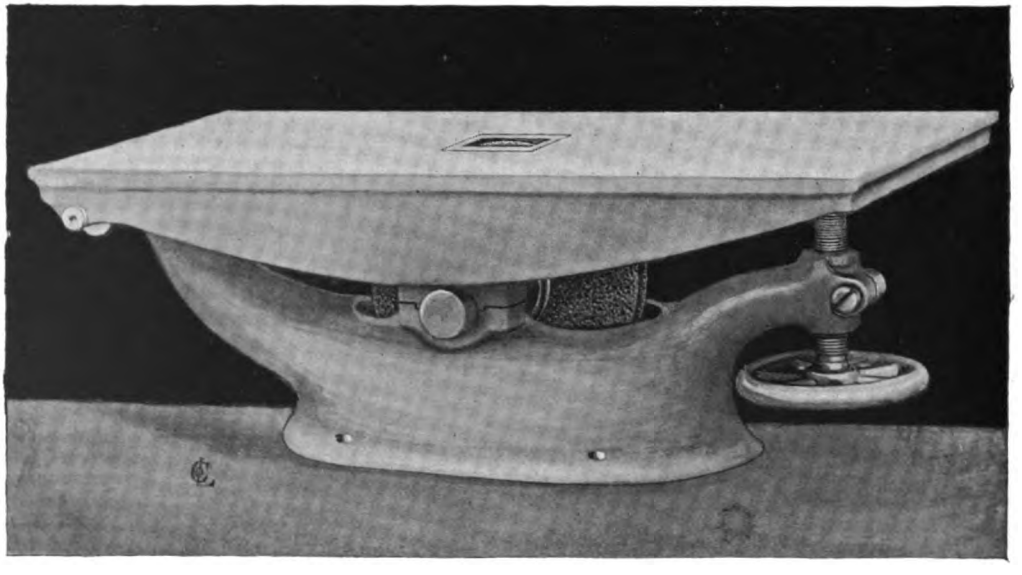
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PLATE NO. 88.



EXAMPLES OF MISCELLANEOUS THREAD, BORING, SLOTTING, AND OTHER TOOLS OF DIFFICULT SHAPES, FINISHED BY THE TOOL-GRINDING AND SHAPING MACHINE.

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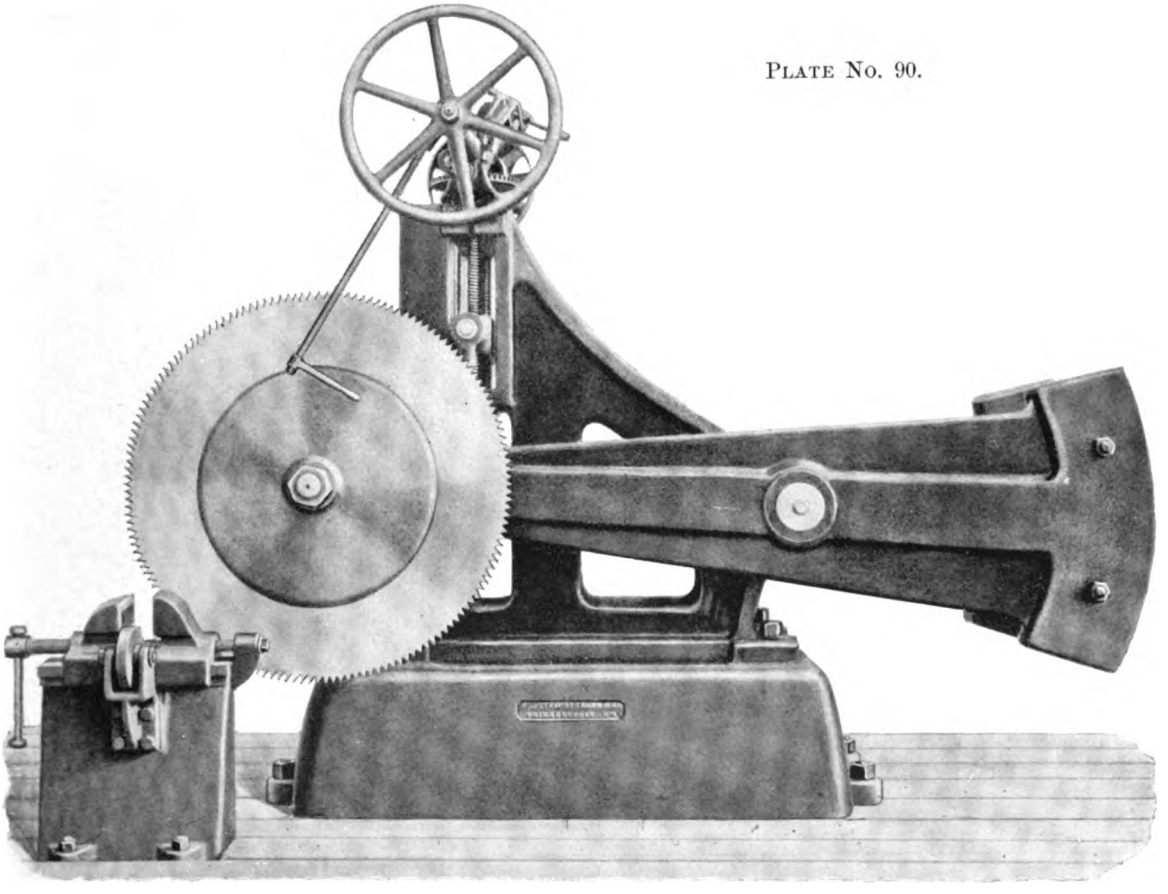
GRINDING MACHINE FOR FLAT SURFACES OF HARDENED STEEL.

"RECOMMENDED for originality both in regard to the idea or principles of this machine, and also for the design and development into a practical tool for the engineer, whereby a surface which is mathematically a true plane can be transferred to other surfaces, even of the most obdurate materials, either hardened steel or chilled cast-iron, the means employed being simple and inexpensive."—*See Introduction*, pages 6 to 12.

This is a very useful little machine, particularly in a tool-room, for finishing and straightening the bodies of boring cutters, the shanks of special lathe tools, and any flat surfaces which have become discolored and distorted by hardening. There are numerous hardened steel pieces, such as shoes, straight edges, reamer blades, gibs, and keys, whose surfaces can be made true, and at the same time handsome, by its use. It is simple in construction, but the essential parts are very carefully and accurately made, so as to insure good wearing qualities, and the maintenance of the truth and accuracy of the parts. It is a machine which would come into general use if its merits were more fully understood and appreciated. We would consider our tool-room very badly equipped without it.

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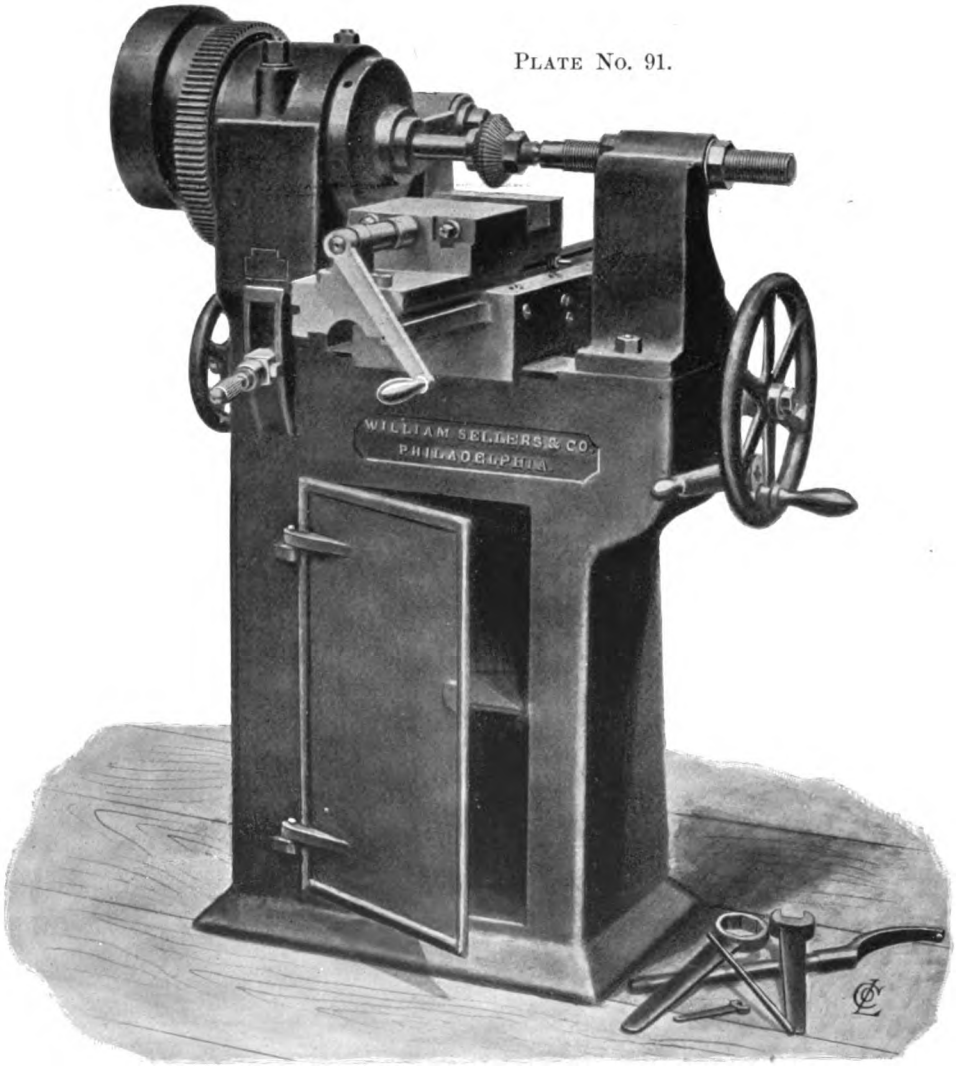
PLATE NO. 90.



COLD SAW.

Especially adapted for cutting with great rapidity rails, beams, etc., either hot or cold, by melting or burning the steel. The saw, 48″ diameter, is carried upon a heavy steel spindle by a balanced swing frame with lifting gears, operated by fast and loose pulleys, open and cross belts. Machine is driven from pulley situated behind it, either on a countershaft or an independent high-speed engine, the latter preferred. The centre of the pulley shaft should be at the same height as the fulcrum shaft carrying the frame of the saw. Every precaution is taken to insure good running at the high velocity required. The pulley is 12″ diameter for 12″ belt, and should make about 1800 revolutions per minute. For cutting beams we usually use a 60″ saw, and provide, instead of a clamp vise, a bed-plate with "T" slots.

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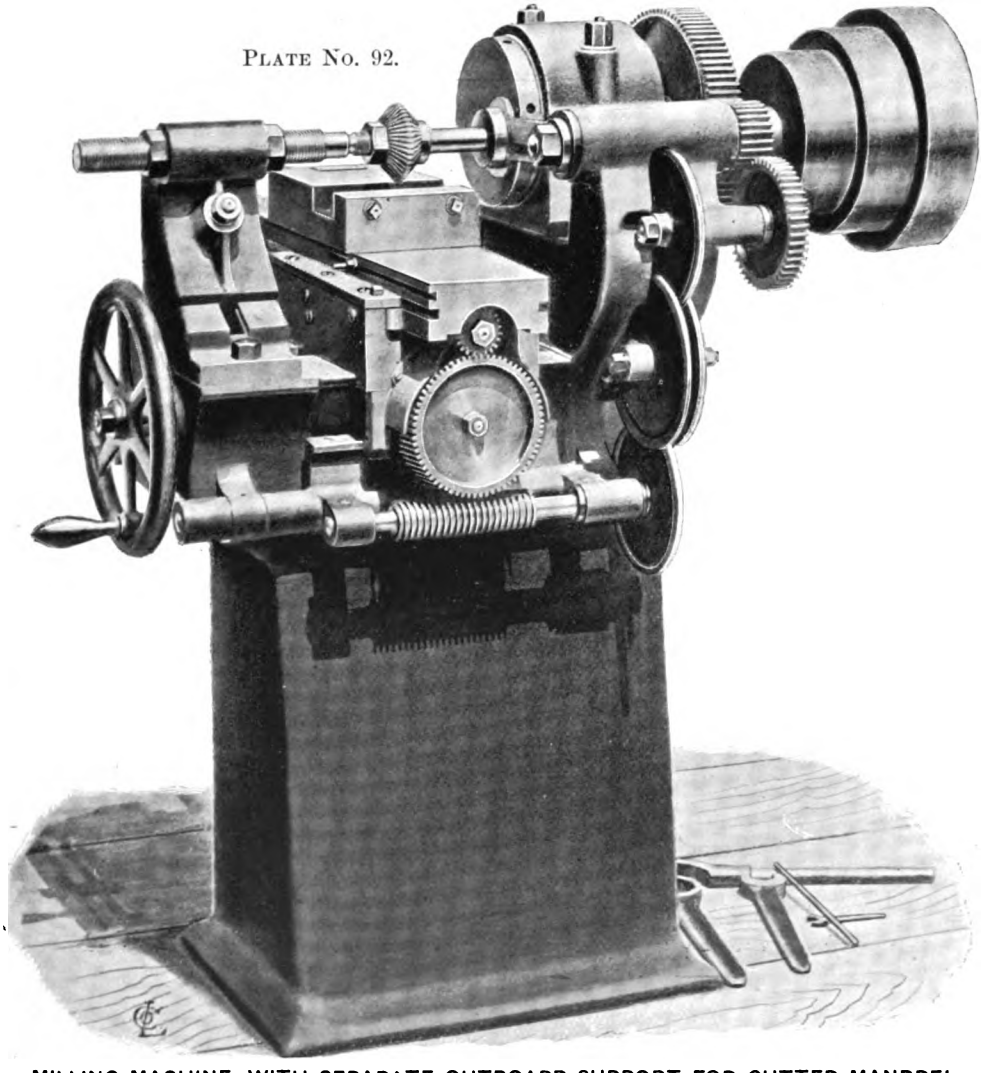


MILLING MACHINE, WITH SEPARATE OUTBOARD SUPPORT FOR CUTTER MANDREL.

Height from centre of spindle to table, adjustable from 7″ to 11″. Table, 8½″ wide, 29½″ long. Cutter mandrel, 1¼″ diameter. Traverse of table, 14″. Power friction feed of wide range. Saddle carrying table, adjustable along bed by hand for 4½″. Clamp vise, with hardened steel jaws, 7″ long by 1¼″ deep; opening, 3″. Table with stops to limit stroke, and quick hand traverse for adjustment. Complete with countershaft, wrenches, and clamp vise. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face. 150 revolutions per minute.

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PLATE NO. 92.

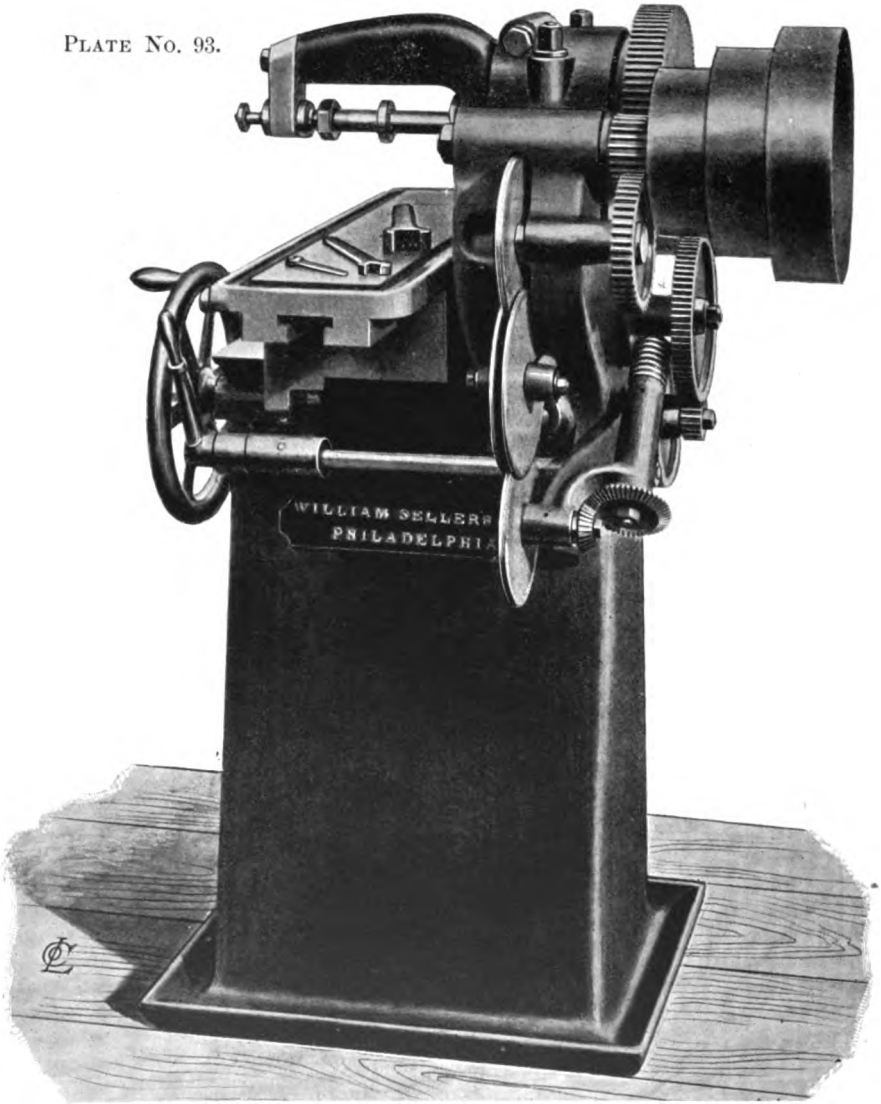


MILLING MACHINE, WITH SEPARATE OUTBOARD SUPPORT FOR CUTTER MANDREL.

Rear view of machine shown in Plate No. 91.

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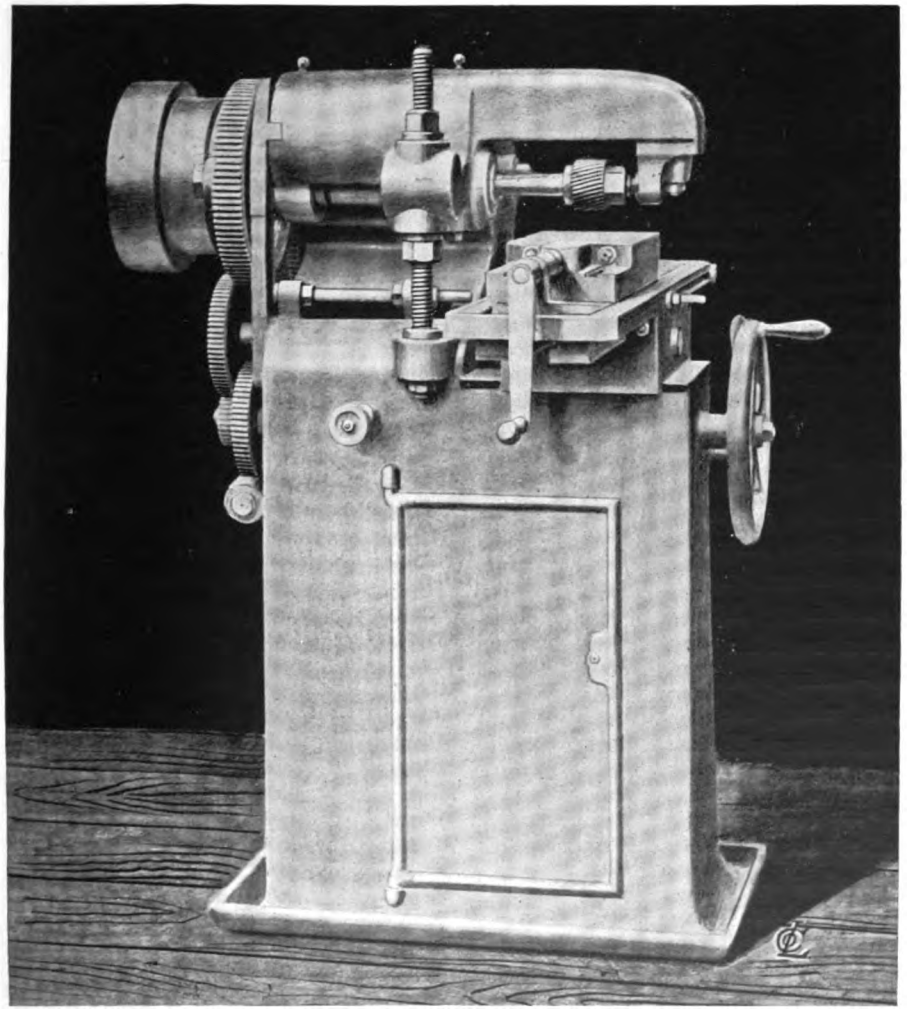
PLATE NO. 93.



MILLING MACHINE.

Height from centre of spindle to table, adjustable from 7″ to 11″. Table, 9″ wide by 30″ long. Maximum traverse of table, 14″, with adjustable stops provided for shorter strokes. Table provided with adjustable friction feed and hand traverse. Mandrel for cutters, 1¼″ diameter. With or without clamp vise for holding work. Fast and loose pulleys on countershaft, 10″ diameter by 4″ face, and should make 150 revolutions per minute.

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MILLING MACHINE.

Height of spindle adjustable above table from 7″ to 11″. Longitudinal adjustment, 4½″. Transverse movement of table across bed, 14″. Longitudinal movement by hand; traverse of table by hand or power, with adjustable friction feed and automatic adjustable stop. Vertical and transverse movement adjustable by double screw to take up lost motion. Machine complete with countershaft, clamp vise with jaws 7″ long, depth 1¼″, opening 3″, cutter mandrel, and wrenches. Fast and loose pulleys on countershaft, 10″ diameter, 4″ face, and should make 150 revolutions per minute.

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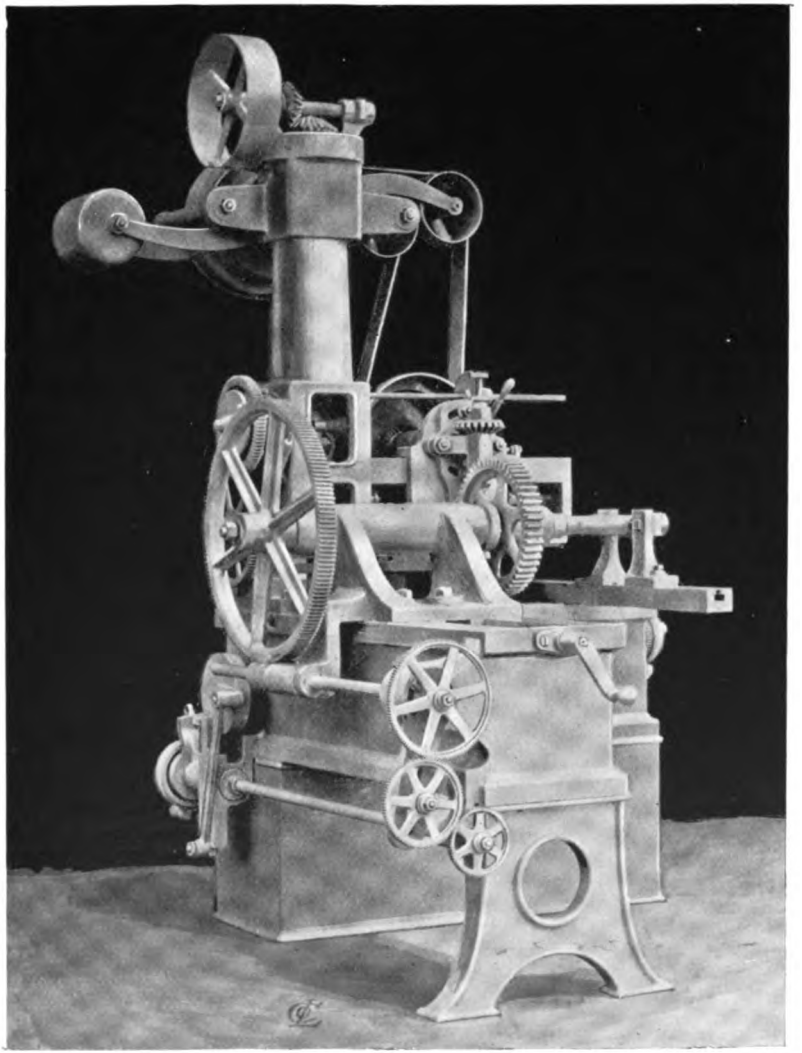
Automatic Gear-Cutting and Wheel-Dividing Machine.

"FOR the great mechanical perfection in its various functions, to perform operations both difficult and recondite, and which for the particular purpose is without a compeer. The designer of this machine has so embodied his own mental faculties into its material combinations that they are involuntarily constrained to do his will, when power is applied, and without any human assistance. All this it performs with the utmost accuracy, and at the minimum of cost."—*See Introduction*, pages 6 to 12.



HIS machine is arranged for cutting both spur and bevel wheels, has a capacity up to 54 inches diameter of wheel, 12 inches face, and will cut a number of small spur wheels of same size at one time. It is entirely automatic, performing all its work after adjustment, without attention of workman, to the completion of the wheel being cut or divided. The division is obtained by a tangent wheel and worm very carefully constructed, and the designated number of teeth is obtained by use of change wheels (a full set of which accompanies the machine). A blank wheel being put in place and the proper cutter adjusted to depth of teeth, length of stroke of cutter-head, etc., the cutter will pass across face of wheel-cutting space between two teeth, will then return at a quick pace to the starting side of wheel, the blank will then be turned to present a second space to be cut, and the cutter will start its proper motion, all the changes being made by the machine itself, not by the attendant. In practice, one man can advantageously attend four of these machines; each machine doing much more work than a hand machine. Too much stress cannot be laid upon this as an example of labor-saving tools, and as an argument in favor of such tools. When a long mandrel is used for this purpose, a steady rest should be placed at its outer end; and when light wheels of large diameter, or any wheel that will spring sideways under cut, is being operated on, a rest block should be placed against the edge of the rim so as to resist the pressure of the cutter. The use of the friction feed-discs enables the feed speed to be varied to the proper amount to suit each case.

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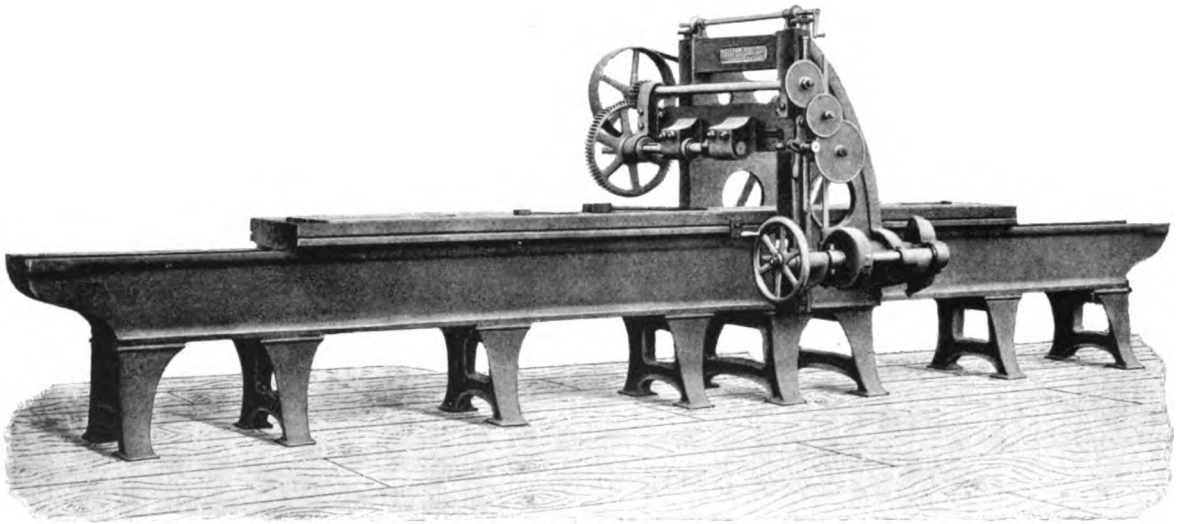


GEAR-CUTTING AND WHEEL-DIVIDING MACHINE.

Automatic in all its motions; arranged to cut bevel and spur wheels to 4′ 6″ diameter and 12″ face. Division made by wheel and tangent screw carefully constructed. One full set of change wheels to effect division of wheels from 10 up to 360 teeth. Feeds self-acting and variable. Complete with countershafts, change wheels, cutter mandrel, and wrenches.

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PLATE NO. 96.



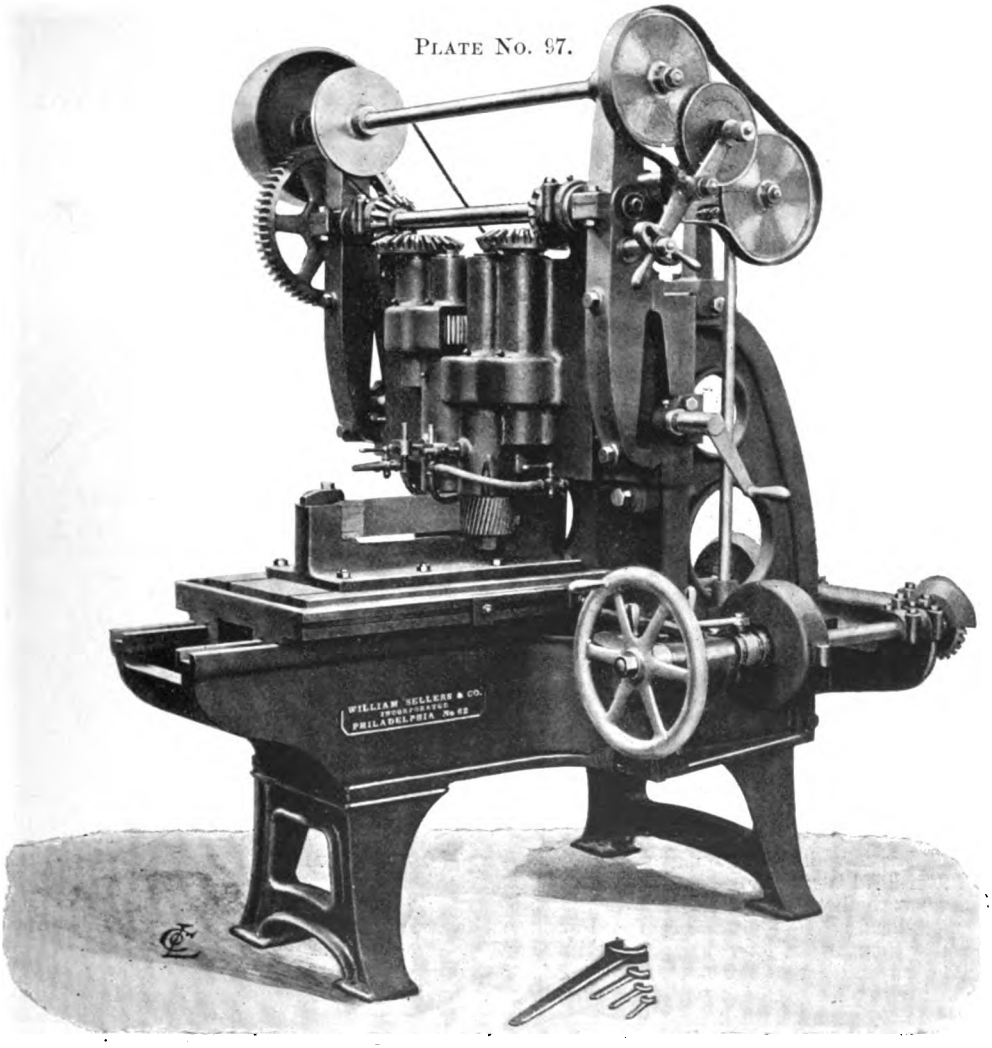
SLABBING MACHINE.

25″ wide between uprights. Table 12′ long, This tool is especially adapted for such work as milling the flats of connecting rods, cutting key seats in locomotive driving shafts, and for doing a great variety of milling operations. Width between uprights, 25″. Table in illustration, 12′ long, may be longer or shorter as required. Operated by spiral pinion same as our planing-machines. Arbor, 22″ diameter. Swing frame to keep belt tight and compensate for vertical movement of cross-head. Feed adjustable by improved friction discs. Knock-out for feed when stroke is completed, and rapid hand traverse to table. Table has raised edge to form dish for soda water. Fast and loose pulleys on countershaft, 20″ diameter, 3″ face, and should make 114 revolutions per minute.

We also have patterns for a very massive machine of this type, 36″ between uprights, and capable of driving cutters 17″ diameter and 17″ face.

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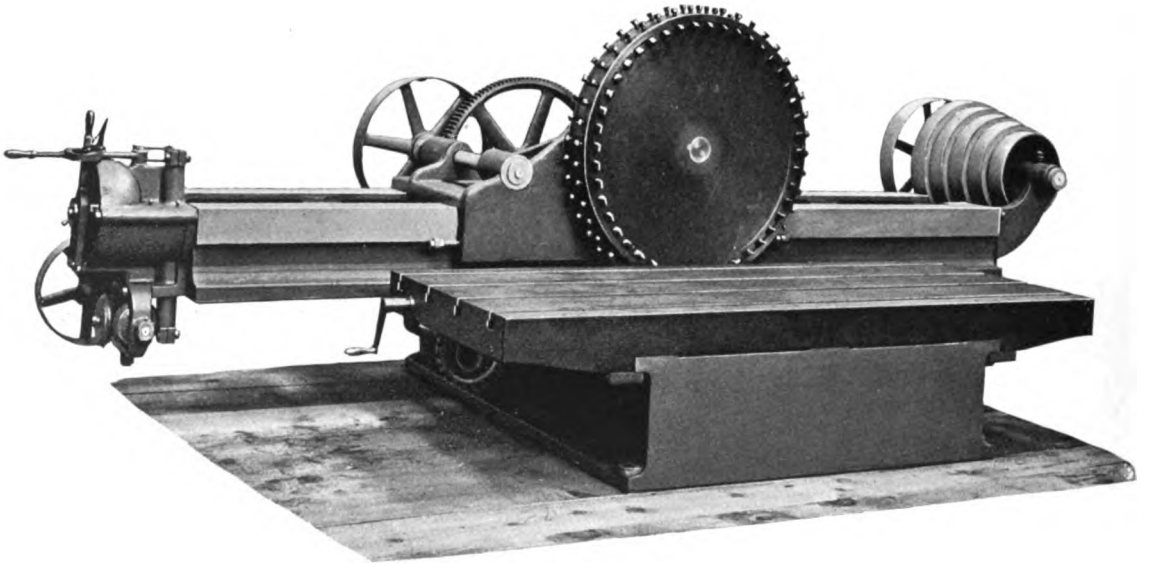
PLATE NO. 97.



TWO-SPINDLE VERTICAL MILLING MACHINE FOR TEST SPECIMENS.

The plate coupons are clamped in a chuck to a thickness of about 3″. Two cutters are fed together by right and left screw to the proper distance as determined by a gauge piece. The automatic feed of the table passes the specimens between the cutters, reducing the central portions to the required width. The maximum stroke of table is 32″. Distance between uprights, 25″. Automatic variable feed, quick hand adjustment, and "knock-out" for end of stroke. Complete with chuck, two sample cutters, wrenches, rotary pump with circulating pipe system, water-tank, drain-pipes, and countershaft. Fast and loose pulleys, 12″ diameter, 3½″ face. 290 revolutions per minute.

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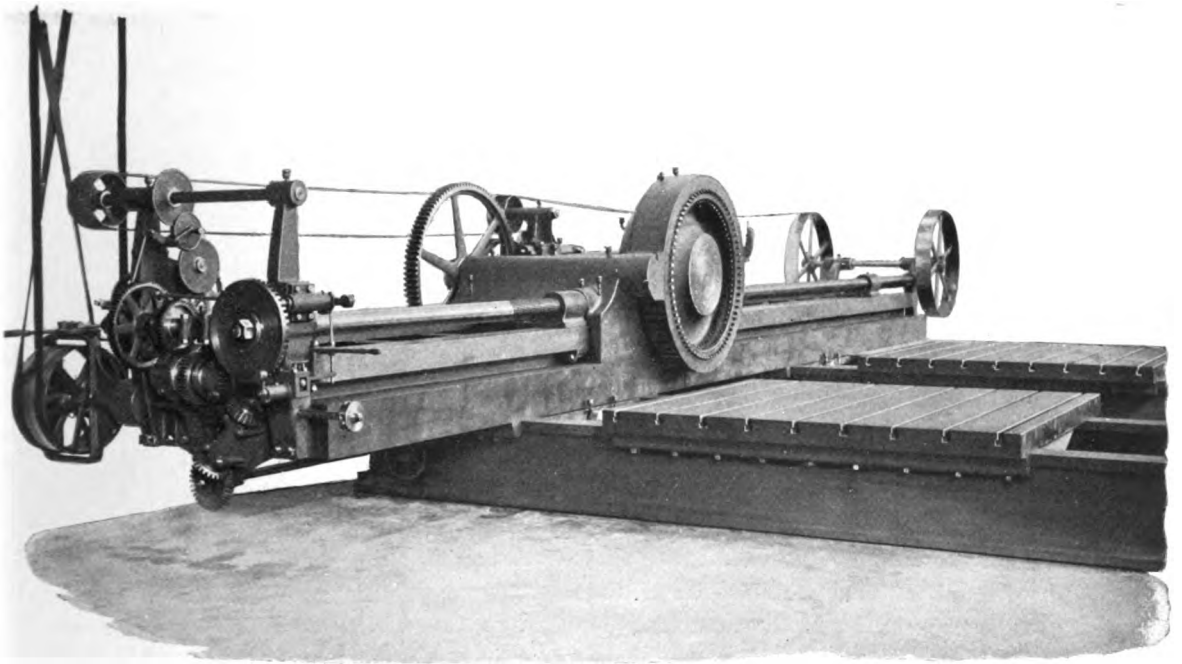
ROTARY PLANER.—WITH 36″ CUTTER-HEAD TO FINISH WORK 6′ LONG.

This machine is provided with 44 tools, arranged in a circle of 36″ internal diameter. Cutter-head is carried upon a heavy spindle, and supported by an extended bearing which is as large as the head itself, and relieves the spindle of bending strain. The saddle carrying this cutter-head is 54″ long, and is gibbed to place with large brass shoes. Cutter-head is driven by belt without use of long shafts and sliding keys. The power feed is adjustable, and varies from ⅛″ per revolution of the cutter-head to 4″. Rapid power traverse is arranged for moving head quickly to place, and the two levers operating the feeding and traversing mechanism are interlocked to prevent both being thrown in at the same time. The table shown in the plate is 8′ long by 36″ wide, and is adjustable to and from the cutter-head to regulate the amount of feed. Fast and loose pulleys on countershaft are 24″ diameter for 4″ belt, and should make 260 revolutions per minute.

N.B.—These machines are made with various lengths of travel and different arrangements for supporting work.

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PLATE NO. 99.



ROTARY PLANER FOR ARMOR PLATES.

The cutter-head having 75 tools, arranged in circle 50″ diameter, will plane work 26′ long, carried upon two tables, each 8′ long by 7′ 6″ wide. These tables are adjustable to and from the cutter-head by power to regulate depth of cut; the head is provided with power traverse at the rate of 20′ per minute for adjustment and variable friction feed. Power is conveyed to head by belts without use of long shafts and sliding bearings. Machine complete with countershaft, wrenches, and sample set of cutters. Fast and loose pulleys on countershaft 24″ by 5½″ face, and should make 400 revolutions per minute.

NOTE.—The cutter-head and saddle of this machine were designed to meet a demand for a more powerful and more rigid tool than any in the market, and special attention was paid to strength of parts and arrangement and size of bearings. We make this machine with various forms of table and for bridge-work, arrange it to swivel.

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Shaping Machines.

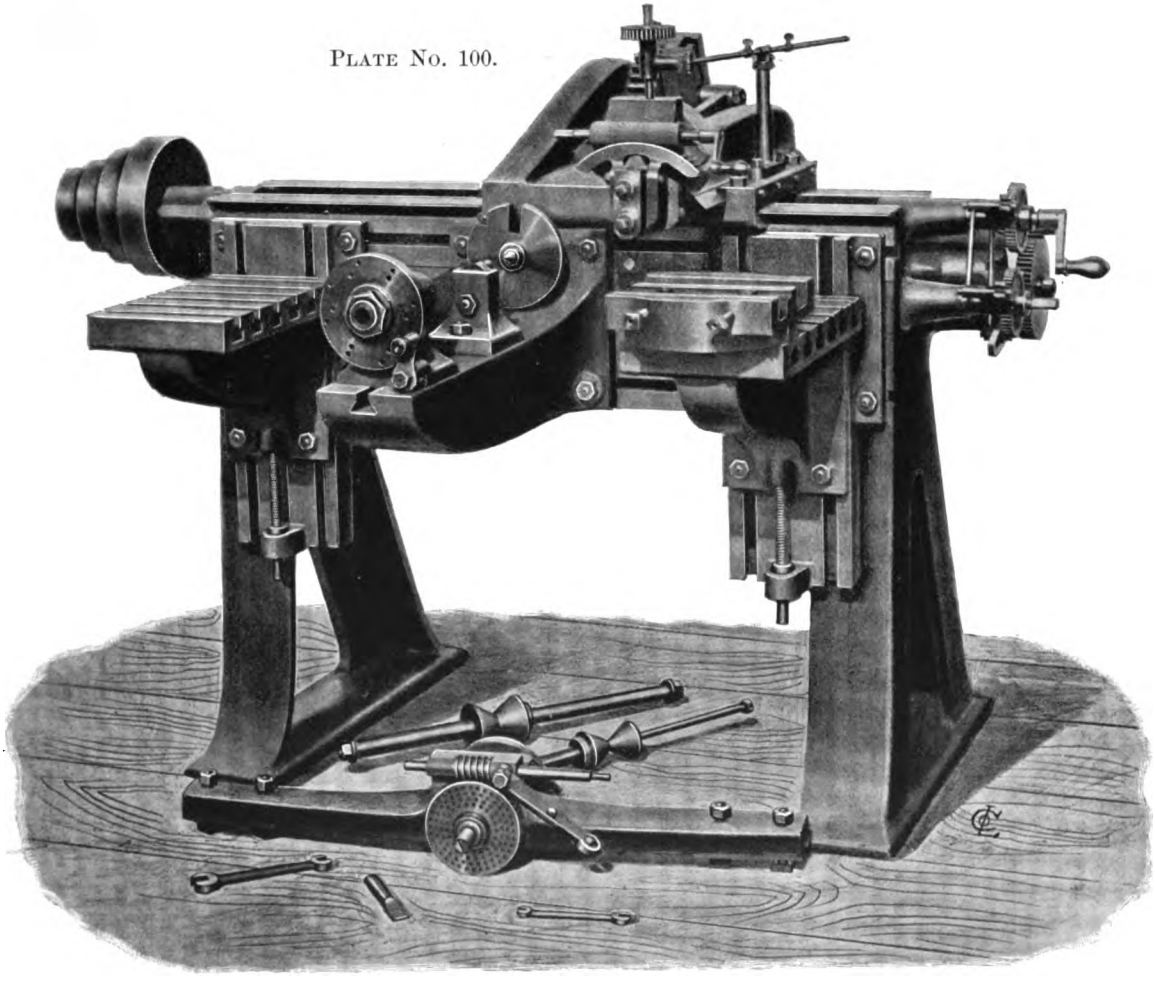
"RECOMMENDED for general excellence as a shaping or planing tool, with the most approved devices for actuating the cutting and return motions and for the perfect arrangement to secure truth and parallelism in the work performed, and in order that the parts may retain their faculties during a long period of hard work, which is a high virtue in a tool of this kind."—*See Introduction*, pages 6 to 12.

THE shaping machine is very useful and convenient on short and light work, and is more economical than the planing machine on pieces for which it is adapted, on account of the greater ease with which the work can be set and the machine adjusted, and the quickness with which it acts. Its merits have hardly received the recognition which they deserve, owing probably to the bad workmanship on many of the machines which have been on the market. It is a difficult machine to build correctly, because the path of the tool, which is produced by the stroke of the bar and the feed of the saddle that carries the bar and driving crank, must be a perfect plane. This necessitates very accurate fitting and perfect truth of the sliding surfaces, the attainment of which is difficult and expensive. We claim to accomplish this, and also that this plane is parallel to the top and perpendicular to the sides of the tables on which the work is held in all positions of the saddle and tool-bar.

The tool-bar is reciprocated by means of an improved Whitwork crank movement, which gives an approximately uniform speed to the cut and a greatly accelerated return, the length of stroke and its position being quickly adjusted to suit the work, and the feed occurring only at the end of the stroke. Good workmanship, correct alignment, and convenience of manipulation are the points in which our shaping machines excel. We make clamping vises adapted to each size of machine for convenience in holding many kinds of work, also, when required, a spindle and chucking cones for doing circular work. We also make centre-heads for each size of machine with index plates carefully divided, and worm and worm-wheel for rotating the spindle. These centre-heads are supported on a stiff bar, so arranged as to be held in line or at right angles to the motion of the tool.

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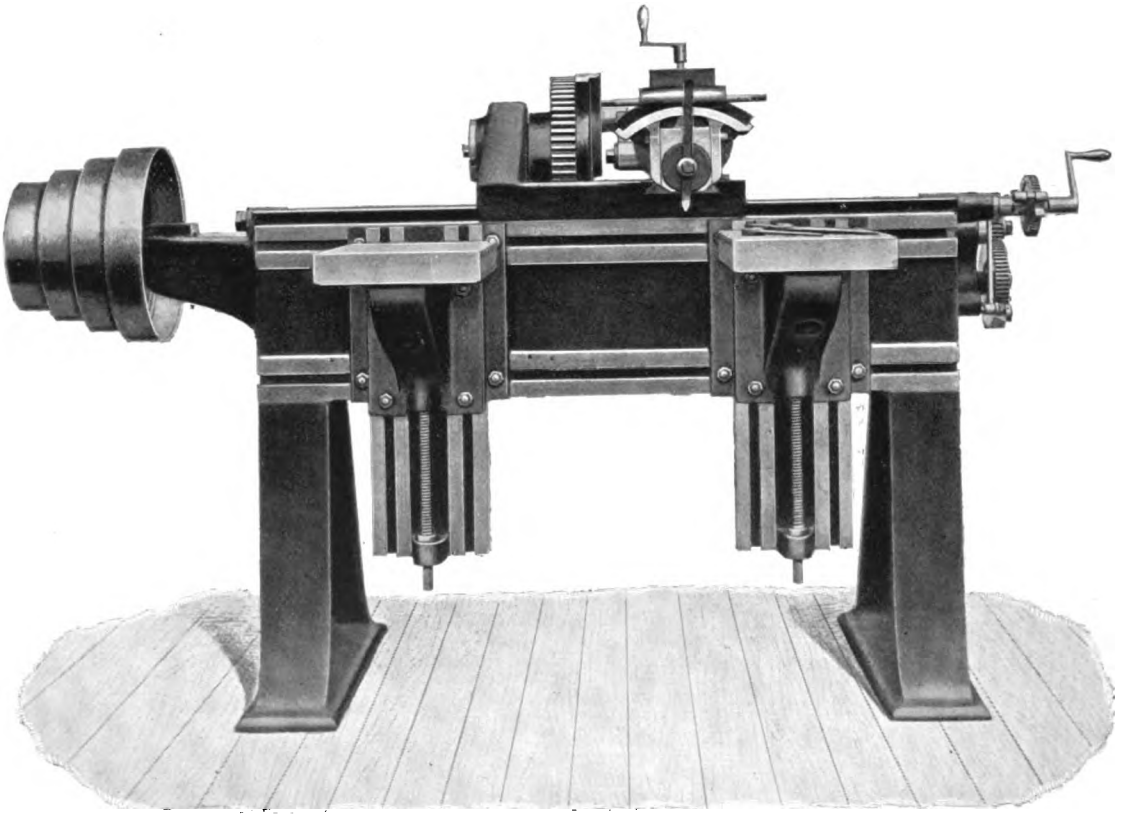
PLATE NO. 100.



9″ SHAPING MACHINE.

Stroke adjustable from 0 to 9″. Shaping bar adjustable 13″ in addition to the stroke. Movement of saddle on bed, 36″. Tables adjustable vertically and horizontally. Extreme distance between outer edges of tables, 42″. Greatest distance between table and shaping bar, 11″. Overhang of tables, 14¾″. Vertical feed of tool, 3½″. Motions for straight, curved, vertical, and angular work. Revolving hollow spindle in bed to carry mandrels and cones for circular work, clamping vise, and centre-heads with index plates furnished to order. Countershaft with two sets of fast and loose pulleys, one for short stroke, 6″ by 2½″, to run 400 revolutions, and one for long stroke, 10″ by 2½″, to run 150 revolutions per minute.

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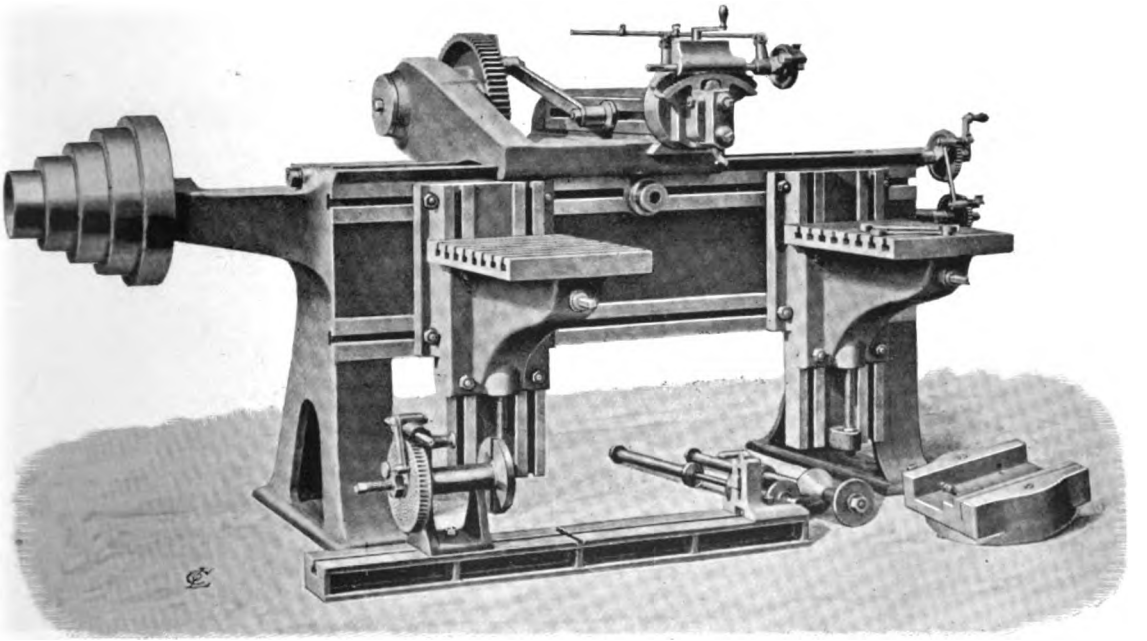


12″ SHAPING MACHINE.

Stroke adjustable from 0 to 12 inches, with Whitworth motion, giving uniform cutting speed and quick return. Shaping bar adjustable 18″ in addition to the stroke. Movement of saddle on bed, 48″. Tables adjustable vertically and horizontally. Extreme distance between outer edges of tables, 58″. Greatest distance between table and shaping bar, 13½″. Overhang of tables, 19″. Vertical feed of tool, 5″. Motions for straight, curved, vertical, and angular work. Revolving hollow spindle in bed to carry mandrels and cones for circular work, clamping vise, and centre-heads with index plate, furnished to order. Countershaft with two sets of fast and loose pulleys, one for short stroke, 9″ by 4″, to run 200 revolutions, and one for long stroke, 16″ by 4″, to run 66 revolutions per minute.

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PLATE NO. 102.

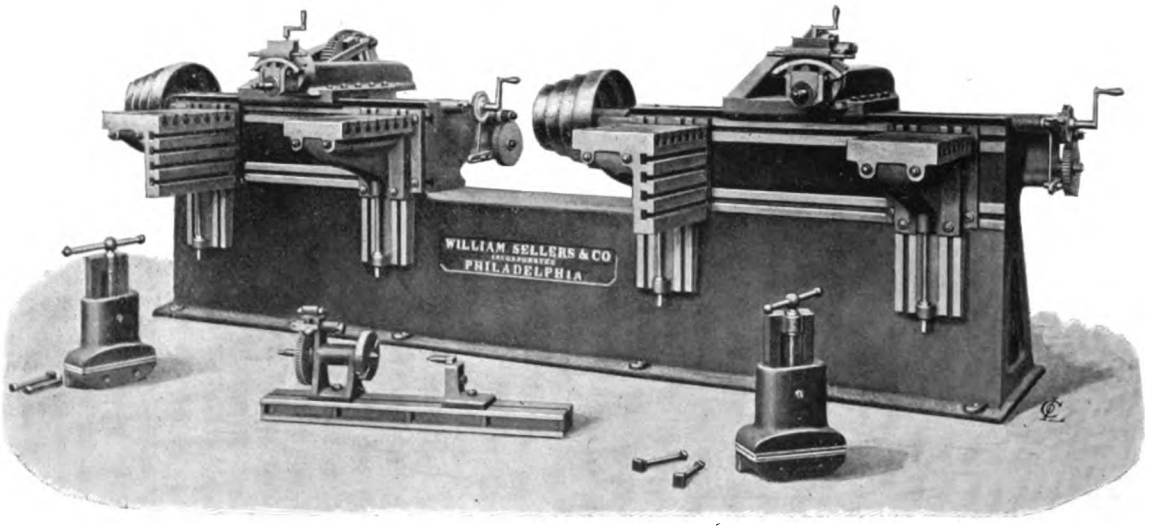


16″ SHAPING MACHINE.

Stroke adjustable from 0 to 16″, with Whitworth motion, giving uniform cutting speed and quick return. Shaping bar adjustable 25″ in addition to the stroke. Movement of saddle on bed, 66″. Tables adjustable vertically and horizontally. Extreme distance between outer edges of tables, 77″. Greatest distance between table and shaping bar, 16½″. Overhang of tables, 23″. Vertical feed of tool, 6½″. Motions for straight, curved, vertical, and angular work. Revolving hollow spindle in bed to carry mandrels and cones for circular work, clamping vise, and centre-heads with index plate, furnished to order. Countershaft with two sets of fast and loose pulleys, one for short stroke, 10″ by 4″, to run 380 revolutions, and one for long stroke, 18″ by 4″, to run 135 revolutions per minute.

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PLATE No. 103.

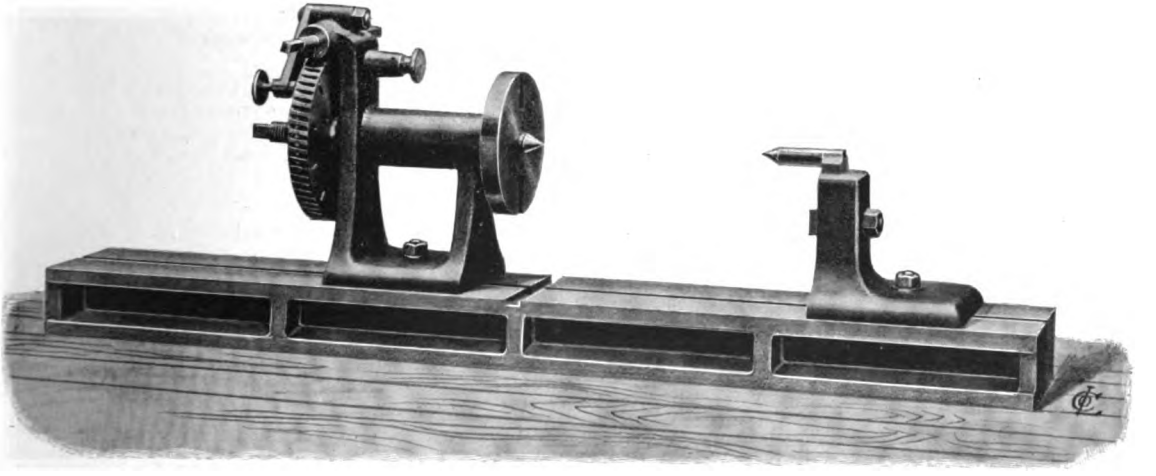


DOUBLE SHAPING MACHINE.

Two 12″ shaping machines on one base, 13′ long. Stroke of each machine adjustable from 0″ to 12″, with Whitworth quick return motion. Shaping bar adjustable 18″ in addition to stroke. Movement of each saddle, 48″. Tables adjustable vertically and horizontally. Extreme distance between outer edges of tables on each machine, 58″. Extreme distance between outer edges of outer tables, 13′. Overhang of tables, 19″. Vertical feed of tools, 5″. Motions for straight, curved, vertical, and angular work. Each machine driven independently. Can be used as two machines or as one, according to the length of the pieces to be planed. Revolving hollow spindle in one or both beds to carry mandrels and cones for circular work. Clamping vise, and centre-heads with index plate furnished to order. Two countershafts, each with two sets of fast and loose pulleys, one for short stroke, 9″ by 4″, to run 200 revolutions, and one for long stroke, 16″ by 4″, to run 66 revolutions per minute.

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PLATE NO. 104.



CENTRE-HEADS AND BAR FOR SHAPING MACHINES.

These are designed of different capacities to suit the different sizes of shapers. One head is provided with worm rotating gear, dividing plate, and adjustable centre. In addition to a carefully made dividing plate with five or six rows of holes and screw stop, there is a spring stop provided, fitting twelve equally spaced slots; useful for a great variety of work, as the changes can be made very quickly. One of the centres is made adjustable in height for taper work. The diameter of the circle which will swing between the centres is equal to the nominal capacity of the shaper.

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Slotting Machines.

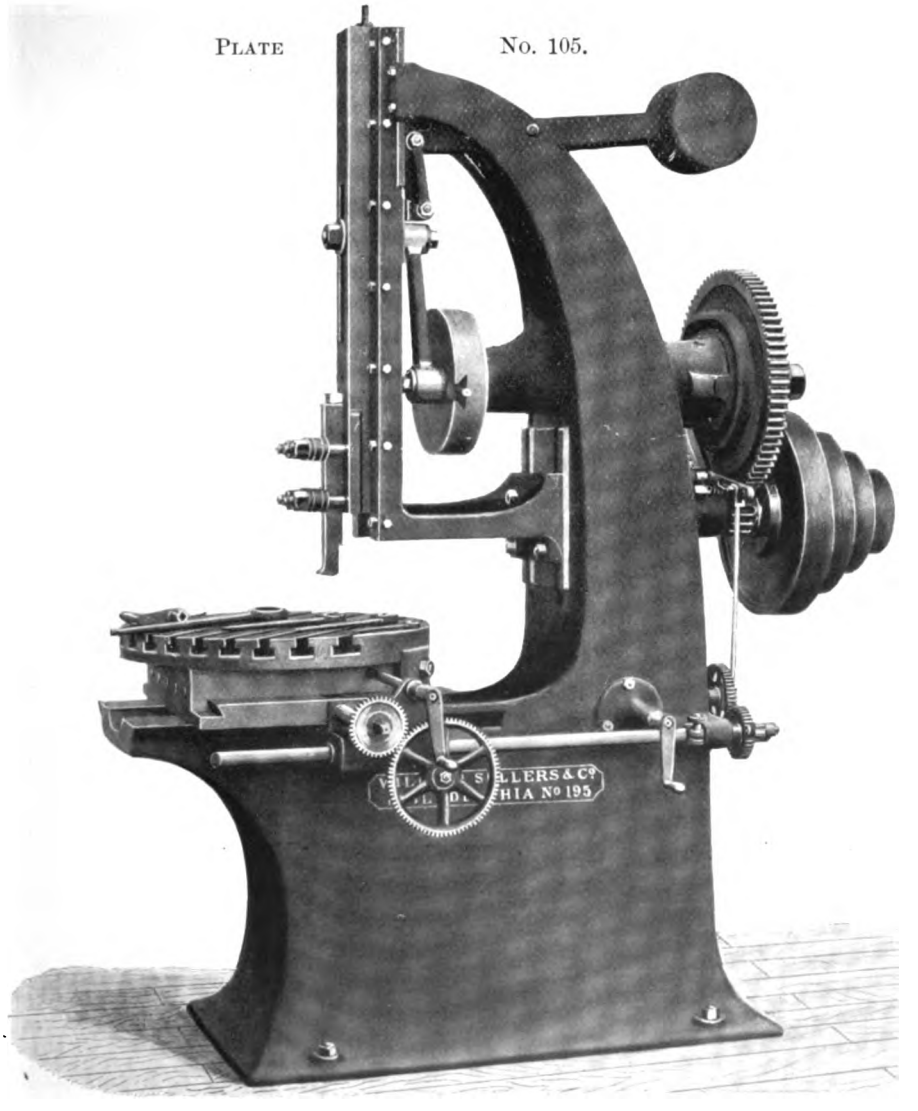
"FOR general excellence as a shaping or planing tool, with the most approved devices for actuating the cutting and return motions, and for the perfect arrangement to secure truth and parallelism in the work performed, and in order that the parts may retain their faculties during a long period of hard work, which is a high virtue in a tool of this class."—*See Introduction*, pages 6 to 12.



HE quality and amount of the work which can be done by a slotting machine are probably more dependent upon its design and workmanship than is the case with any other machine tool. The driving gear should run smoothly, and should move the tool-bar with an approximately uniform speed when the tool is cutting, but with a greatly accelerated speed on the return stroke. We accomplish this by means of carefully cut gears and a properly designed and proportioned Whitworth crank motion. The tool-bar should be relatively long and very well fitted and bedded to a slide of the same length, the lower end of which should be as close down to the work as possible, in order to give a solid support to the bar. We make this slide adjustable so that its height can be readily changed to suit the work. This avoids the necessity of an excessively heavy bar, thus facilitating its adjustment up and down in relation to the connecting-rod pin. This adjustment is made by a crank and screw conveniently located, and enables the stroke of the tool to be brought to the proper height from the table. The length of stroke is altered by a crank and screw shifting the crank-pin. The tool-bar is counterbalanced in such manner that all lost motion is taken up and the reciprocation of the bar is accomplished without shock or jar. We thus give a smooth, running, uniform cutting speed, and a quick return motion to the tool-bar, which is supported close to the work, and the stroke and position of which can be

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PLATE No. 105.



36″ SLOTTING MACHINE.

From face of tool to frame, 18″. Stroke adjustable from 0 to 10″. Uniform cutting speed and quick return. Table, 24″ diameter, with rotary, transverse, and longitudinal motions. Variable self-feed occurring at top of stroke, and all crank handles in a convenient position. Transverse and longitudinal travel of table, 17″. Floor to top of table, 32¾″. Extreme height from top of table to underside of frame, 11½″.

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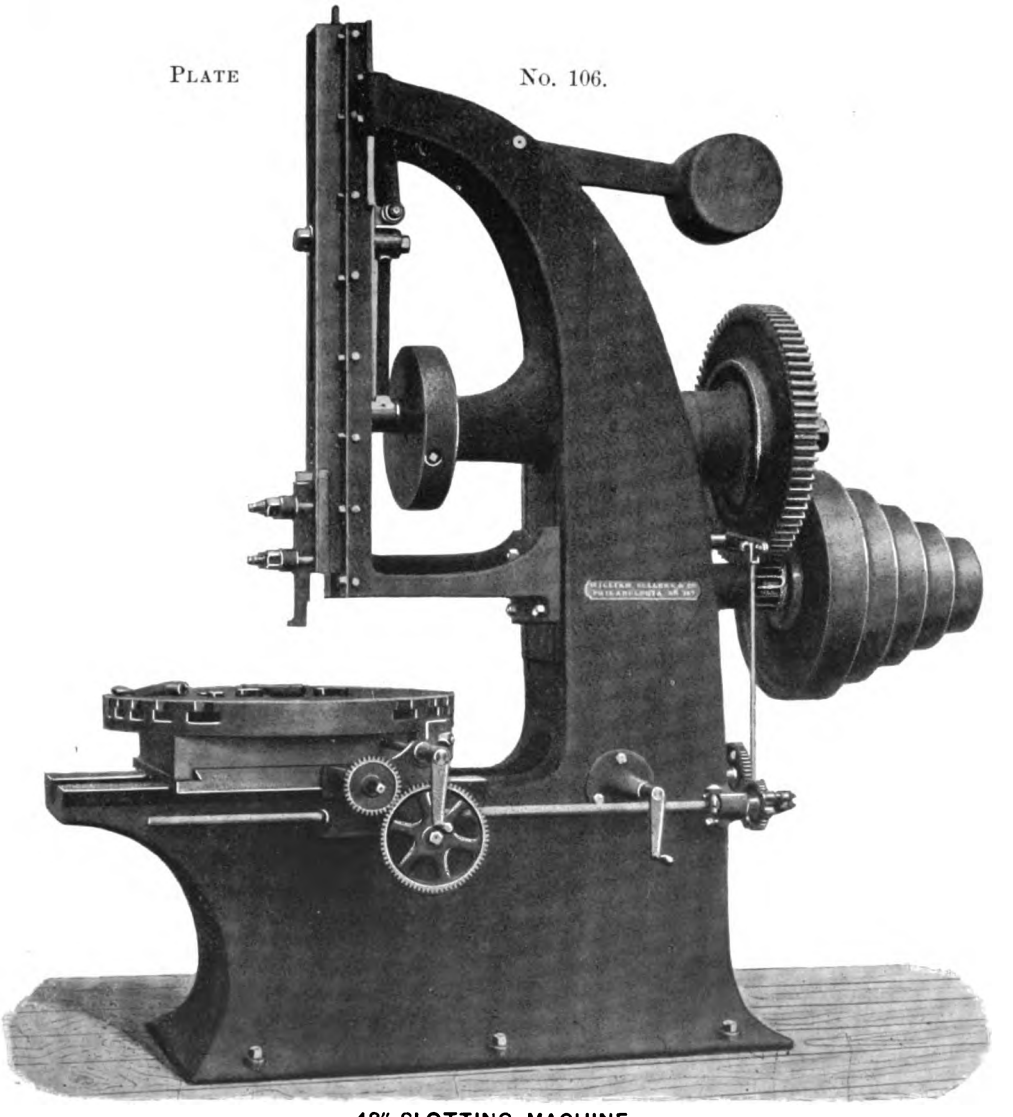
quickly adjusted, the whole being carried by a bed properly proportioned to resist the stresses brought upon it.

The table is circular and has convenient T slots for bolts to hold the work, and has a circular trough around it, which will collect the oil or lubricant used on the tool, and prevent waste and dirt. It is exactly perpendicular to the line of motion of the tool. It is rotated upon its axis by means of a worm, but can be firmly clamped at any desired point. It is carried by a cross-slide, which is fitted to a longitudinal slide fitted to the bed. All of these sliding pieces have large bearing surfaces carefully scraped together to form a solid mass and to avoid wear. The slides are exactly at right angles and all the movements are such that very accurate work can be done. The crank handles to produce these movements are within reach of the operator when he is in the best position for seeing the work. All the movements are automatic at will, but the automatic feeds can occur only when the bar is at the top of its stroke, in order that the tool may return through the path it has just cut, and never be dragged over a new surface.

The machine has been designed with a view to ease and quickness of manipulation, for the reason that, on the class of work it is required to do, it requires very close watching on the part of the workman. It seldom takes long cuts, being generally but a little while under power feed at a time, and then its amount of production, other things being equal, depends upon the readiness with which the attendant workman can do his part of the movements in adjusting and re-adjusting the work in various positions and keeping the tool under cut as much of the time as possible. The material has been distributed so as to produce the greatest stiffness with the least weight, and every attempt has been made to make the machine easy to handle, and not to sacrifice convenience to an appearance of great weight and strength.

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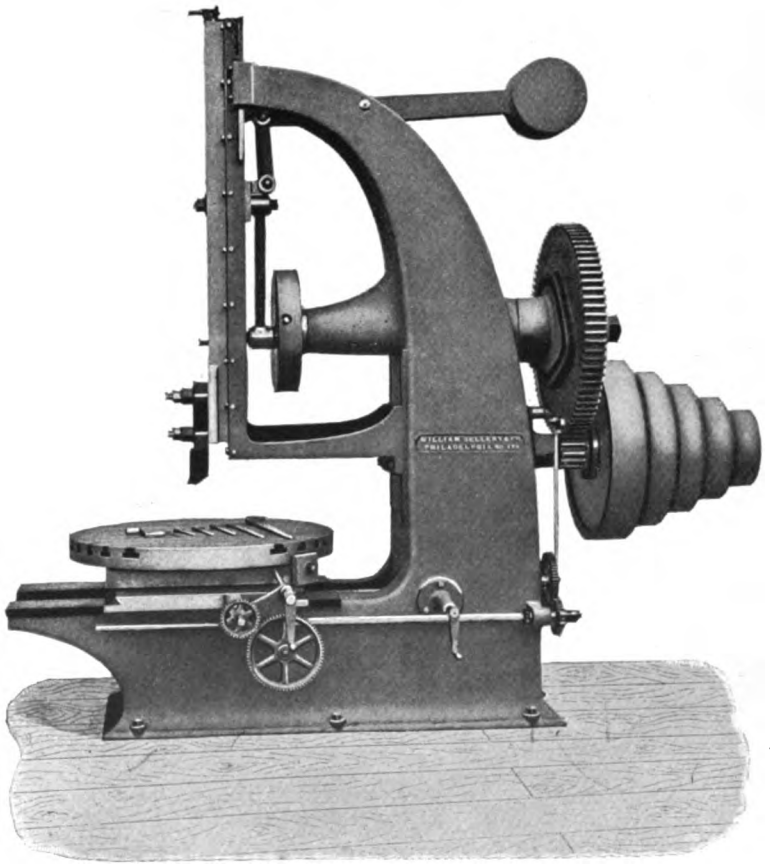
PLATE No. 106.



48″ SLOTTING MACHINE.

From face of tool to frame, 24″. Stroke adjustable from 0″ to 13½″. Uniform cutting speed and quick return. Table, 32″ diameter, with rotary, transverse, and longitudinal motions. Variable self-feed occurring at top of stroke, and all crank handles in a convenient position. Transverse and longitudinal travel of table, 23″. Floor to top of table, 32¾″. Extreme height from top of table to underside of frame, 15½″.

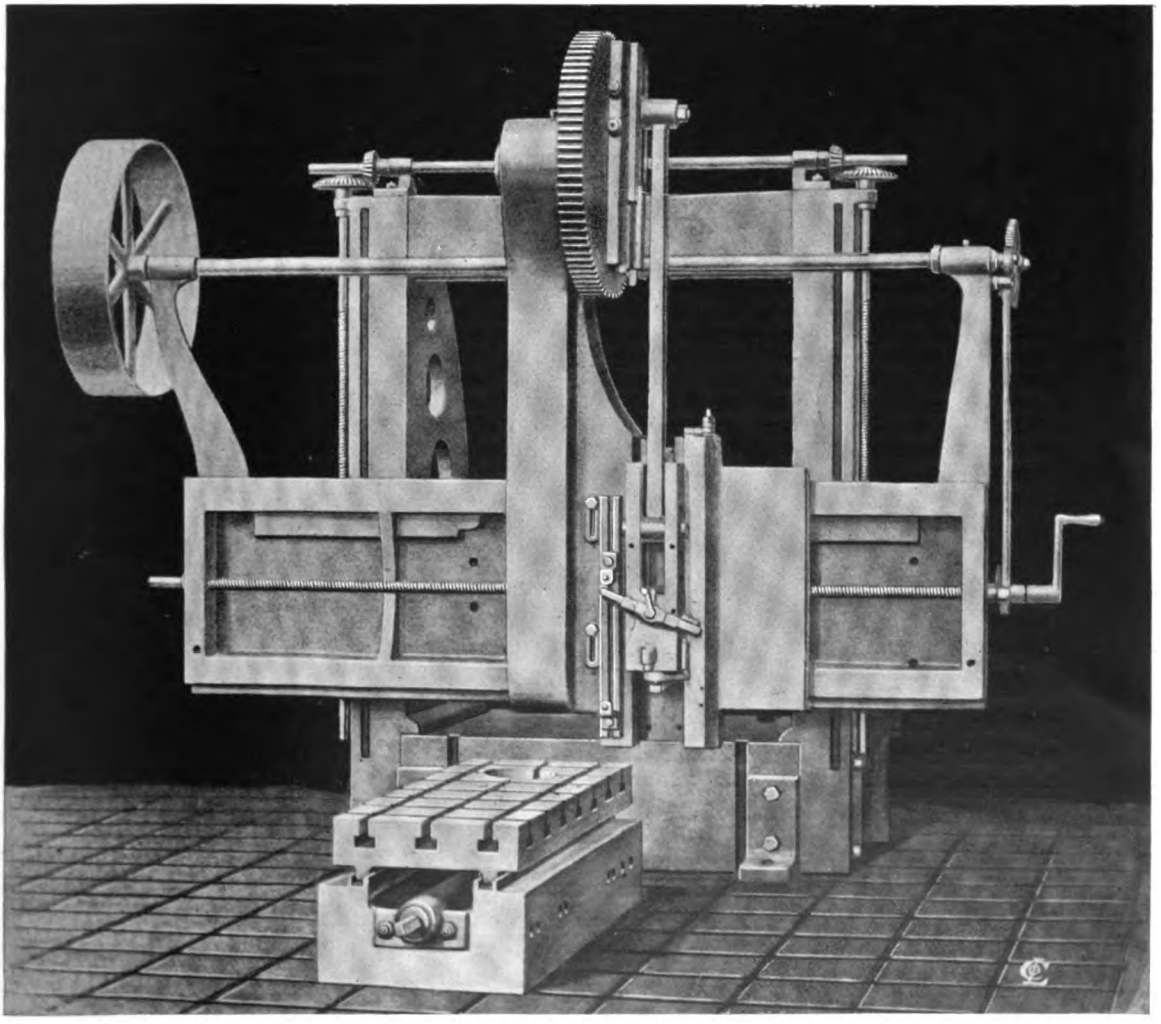
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72" SLOTTING MACHINE.

Distance from face of tool to frame, 36″. Stroke adjustable from 0″ to 20″, with Whitworth motion, giving uniform cutting speed and quick return. Compound table, 48″ diameter, with rotary, transverse, and longitudinal motions, all with variable self-feed occurring at top of stroke, and all crank handles near together in a convenient position. Transverse and longitudinal travel of table, each 34″. Height from floor to top of table, 32¾″. Extreme height from top of table to underside of frame, 23½″.

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48″ TRAVERSE SLOTTER.

Mounted upon a cross-head carried on uprights. This machine can be used for a great variety of work. The slotting bar can be used on different portions of the cross-head, and the cross-head itself can be inclined to slot at an angle, and raised or lowered to suit different work. Cross-head 8′ long; traverse of tool about 6′; the slotting bar has an adjustable stroke varying up to 23″. Power feeds for the slotting-head along the cross-head and to feed the tool out automatically for work, such as gear cutting.

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Planing Machines.

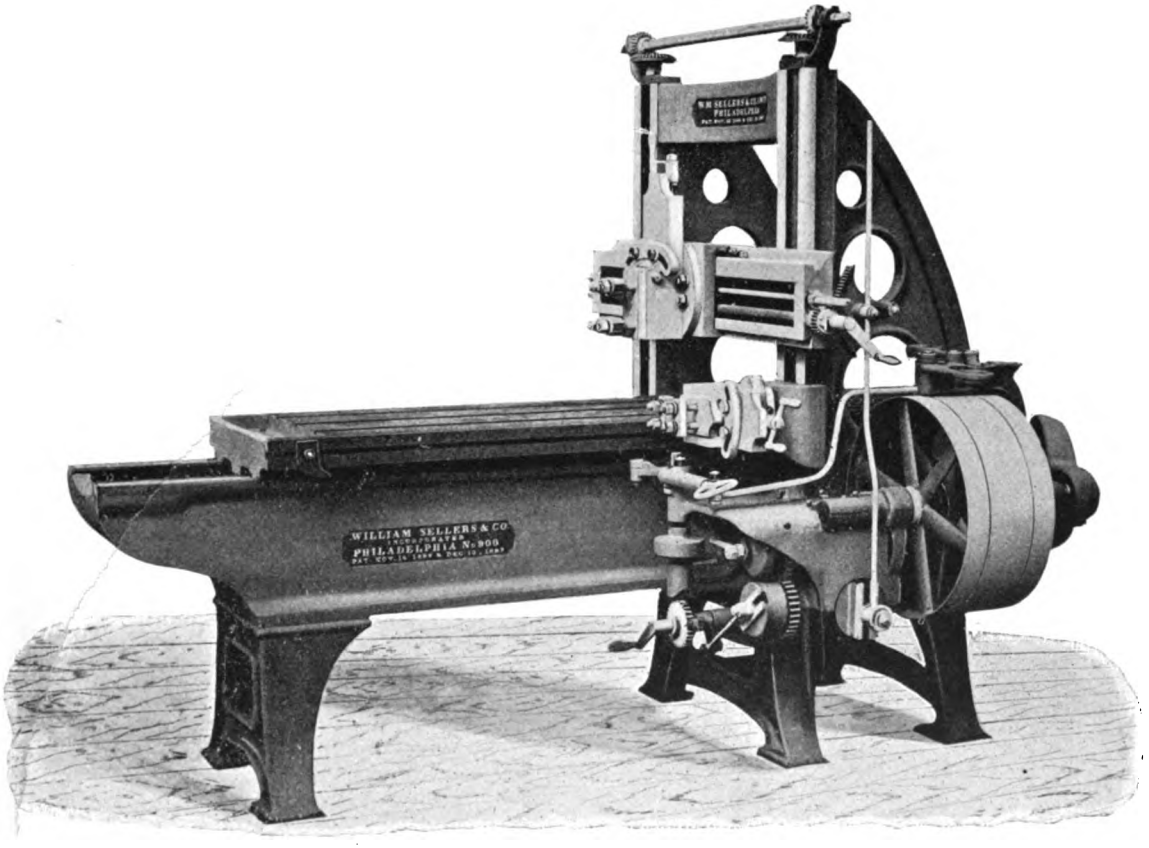
"RECOMMENDED for originality, general excellence, and refined mechanical skill in the construction of planing machines for metal. New combinations of gearing, made up of various original devices, are introduced, whereby greater efficiency, strength, and economy are obtained, as well as a soft, uniform, easy motion, to afford smooth planing. For originality in the various arrangements connected with the belt motions; for convenience of manipulation by the attendant, to avoid the usual struggle between the open and cross belts at the reversing points, thus economizing power and avoiding wear and tear. Also, for originality in the means employed for giving the feed motion at the proper nick of time, as also for the arrangement which raises the cutting instrument from the work during the return of the planing table, which is both direct and decisive; and, as a whole, the belt and feed combination is characterized by great mechanical refinement, the result of matured thought and experience."—*See Introduction*, pages 6 to 12.



INCE the introduction of our method of driving planer tables by a spiral pinion engaging with an inclined rack, our planing machines have become so well and favorably known that we do not feel it necessary to give at this time any extended description of the details of their construction. We may say, however, that we have kept these machines thoroughly up to date, making from time to time such alterations as were demanded by modern practice. Thus we have greatly stiffened the beds and tables, strengthened the uprights, improved the construction of the cross-head and vertical slides, and have introduced many minor alterations, all of which are calculated to make the machine more convenient and more serviceable. We have invented and applied to this machine a new feed motion, in which the reversing mechanism is operated at a constant rate of speed and entirely independent of the velocity of table movement: its rate of speed is moderate, and it is quiet in its action. Since the speed of this feed motion is entirely independent of the rapidity of table movement, we are enabled to increase the reversing speed of the table up to the limits which may be efficiently reached by a shifting belt reversing motion. A certain amount of time is inevitably necessary at each end of the stroke to shift the belt and to start up the

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PLATE No. 109.



25″ x 25″ PLANING MACHINE.—TO PLANE 6 FEET LONG.

For horizontal, vertical, and angular planing. Improved feed motion; feed takes place at back end of return stroke. Automatic tool lifter operating at any angle. Vertical slide-rest on right-hand upright, with independent feeds. Usual speed of cut, 18 feet per minute; return speed of table, 72 feet per minute. Complete with countershaft and full set of cranks and wrenches. Vertical slide-rest extra.

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table in the opposite direction. If the reversing speed be increased beyond a certain point, so much time is lost in reversing at the ends of the stroke, that there is but little or no gain derivable from the increased speed. This is especially noticeable where the stroke of the table is relatively short. We therefore have considered it wise to limit the speed of the reversing motion of these planers to three or four times the usual cutting speed; that is to say, reversing at about 54 to 72 feet per minute, according to the size of the machine. We are aware that some shifting belt planers have been sold to reverse at a higher speed than this, but we are satisfied that no real gain results from this attempt.

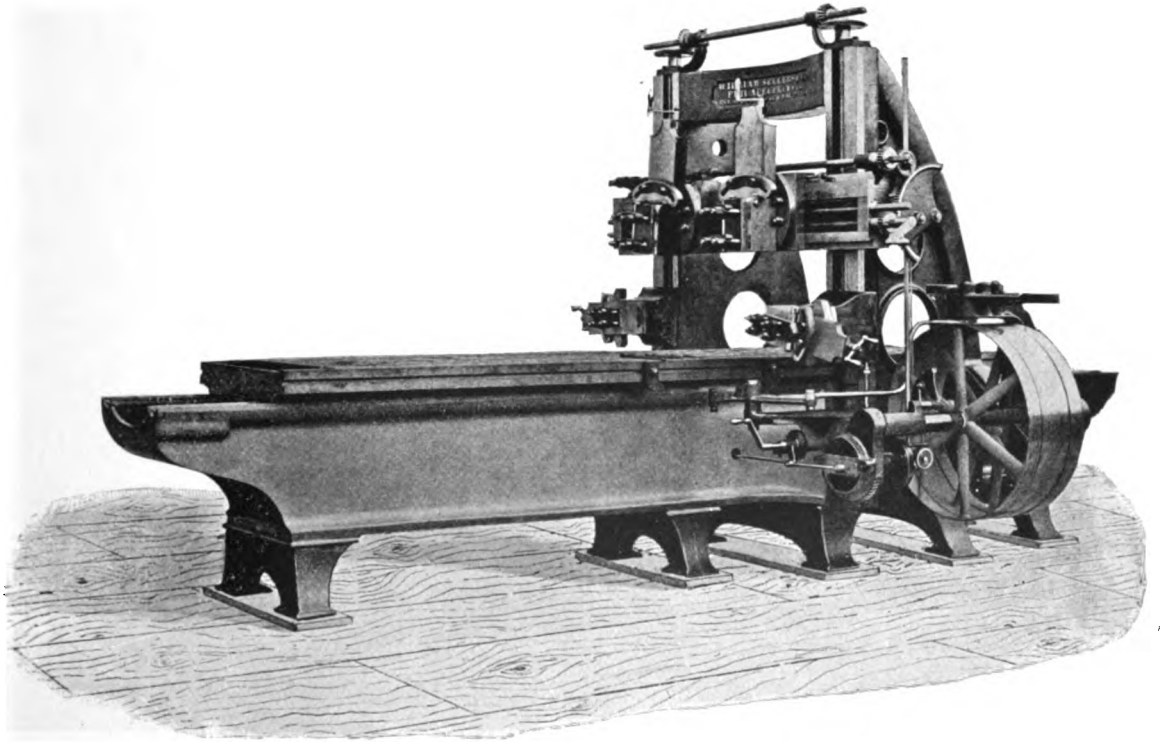
Our planing machines stand parallel with the overhead shafting, thus economizing shop room. When required to drive at right angles to the shafting, mule pulleys can be provided to carry the countershaft belt. We manufacture a full line of planers of this type, the usual sizes of which are given in the following table, together with the shortest practicable length in each case.

Name of Planer.	Will Plane		Shortest Length of Table.
	In Width.	In Height.	
20 inches.	20 inches.	20 inches.	3 feet.
25 "	25 "	25 "	4 "
30 "	30 "	30 "	5 "
36 "	36 "	36 "	5 "
42 "	42 "	42 "	6 "
48 "	48 "	48 "	6 "
54 "	54 "	54 "	7 "
60 "	60 "	60 "	8 "
72 "	72 "	72 "	9 "
84 "	84 "	84 "	10 "
120 "	120 "	120 "	14 "

These machines can be made of any additional length required. They can be furnished with one or two tools upon cross-head, and those above 30″ can be provided

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PLATE No. 110.



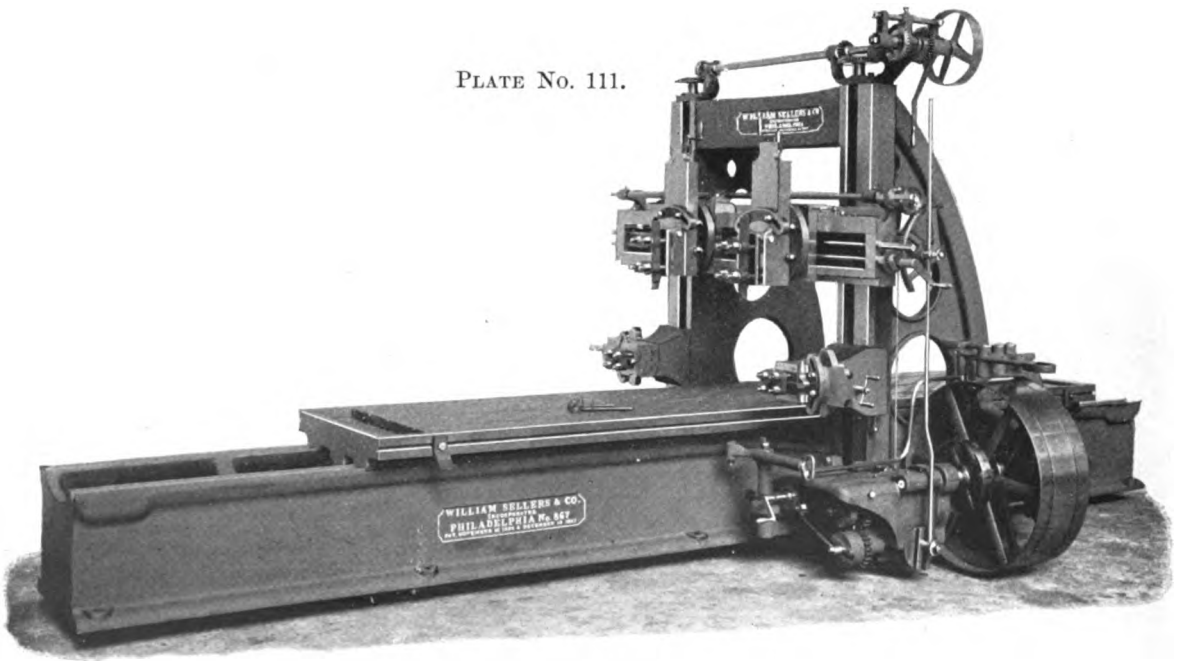
36" x 36" PLANING MACHINE.—TO PLANE WORK 10 FEET LONG.

With two saddles on cross-head and two vertical slide-rests. Automatic tool lifter operating at any angle. Separate screw for extra slide-rest. Complete with countershaft and full set of cranks and wrenches. Second saddle on cross-head and vertical slide-rest, extra.

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with vertical slide-rests on one or both of the uprights. When two saddles are used, we generally provide an additional horizontal screw to give independent horizontal feed to each saddle, the vertical movement being controlled by the same feed-rod. For some cases, it is preferable to have both saddles on the same screw, in order that they may be moved simultaneously. This we can also accomplish when desired. The projection of the tools on the cross-head and vertical slide-rests is the same, so that the horizontal and vertical tools begin and end their cut at the same time. Planers of 36″ and over are provided with power-lifting gear for the cross-heads. All are furnished with countershaft complete and necessary wrought-iron wrenches. Knees, V-blocks, ribs and cross-plates, and other tools, extra.

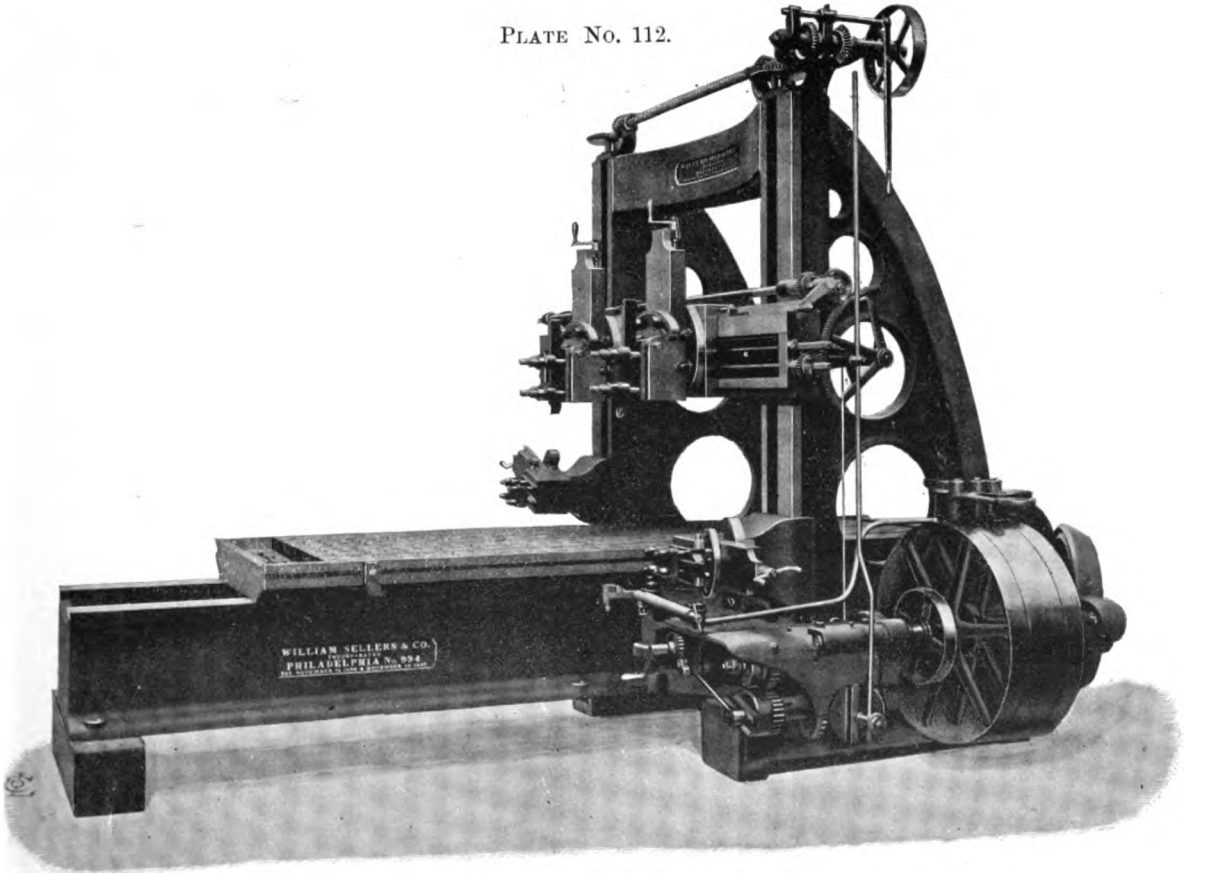
PLATE NO. 111.



42″ x 42″ PLANING MACHINE.—TO PLANE WORK 12 FEET LONG.

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PLATE NO. 112.



60″ x 60″ PLANING MACHINE.—TO PLANE WORK 10 FEET LONG.

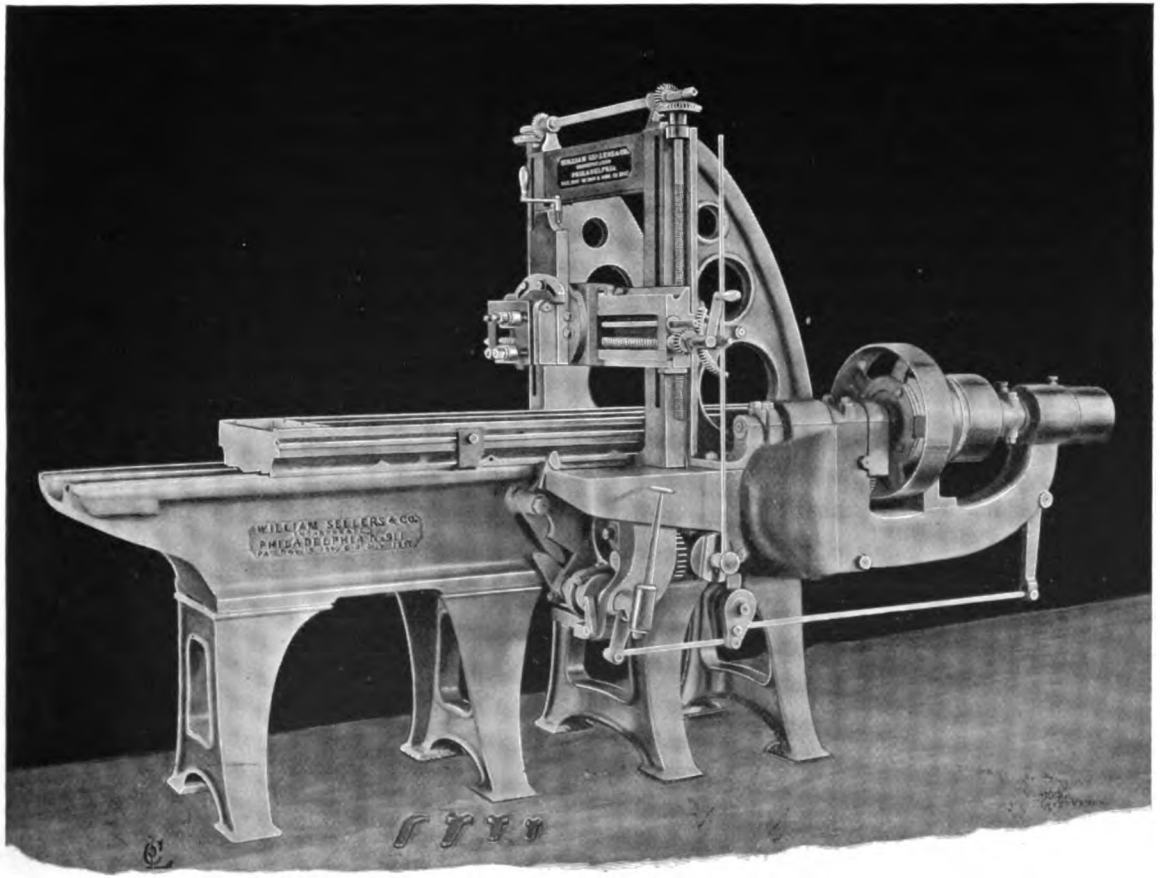
With improved feed motion. Automatic tool lifter, operated at any angle. Extra saddle on cross-head and vertical slide-rest on both uprights. Separate screw for extra saddle. Power elevating gear for cross-head. Usual speed of cut, 18 feet per minute; return speed of table, 72 feet per minute. Complete with countershaft and full set of cranks and wrenches. Additional slide-rest on cross-head and vertical slide-rest, extra.

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Patent Spiral-Geared Planing Machines.

IN addition to the planers just described, we have recently perfected another class of machines which we denominate our "spiral-geared" planers, from the fact that in them we have dispensed with the bevel gears formerly used between the pulley-shaft and that of the driving-pinion, and have substituted a spiral pinion gearing into a spur-wheel. In designing this machine, we sought to produce a planer that would do better work and more work than had ever been accomplished, to eliminate "chatter" marks in the work, to increase the driving power, and to accelerate greatly the reversing speed of the table. The substitution of the spiral gearing described above has produced a smoothness of work which has never been excelled; and, in order to increase the reversing speed, we operate the reversing mechanism by means of friction clutches driven by belt or belts running constantly in the same direction. In our earlier machines of this type open and cross belts were used, but we now build these machines with but a single belt, the reversing being made through a suitable train of gearing. The table, the pinion-shaft, and the clutch-shaft are the parts of the planer which suffer reversal, the first two move at comparatively slow speeds, while the latter is kept as light as possible, and special means are provided for absorbing its momentum. When the stop on the table strikes the lever at one end of the stroke, it draws one clutch out of engagement and presses lightly against the other, which is, of course, running in the opposite direction. In this way the pinion- and clutch-shafts are quickly checked. The table moves forward in relation to them so far as to take up the backlash of the teeth, with the result that when the pulley-shaft is reversed there is no jar. The reversal of the pulley-shaft is not directly effected by the contact of the stops on the table with the tappet levers on the bed; all that is done by them, is first to knock off the driving power, then to apply the brake, and to simultaneously set in gear an escapement motion, by which certain wheels and a

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20″ x 20″ PATENT SPIRAL-GEARED PLANING MACHINE.—TO PLANE WORK 5 FEET LONG.

Driving and reversing gear operated by friction clutches. Return speed of table, 144 feet per minute, or eight times the usual cutting speed. Feed-motion operated from either side of machine. Complete with countershaft and full set of cranks and wrenches.

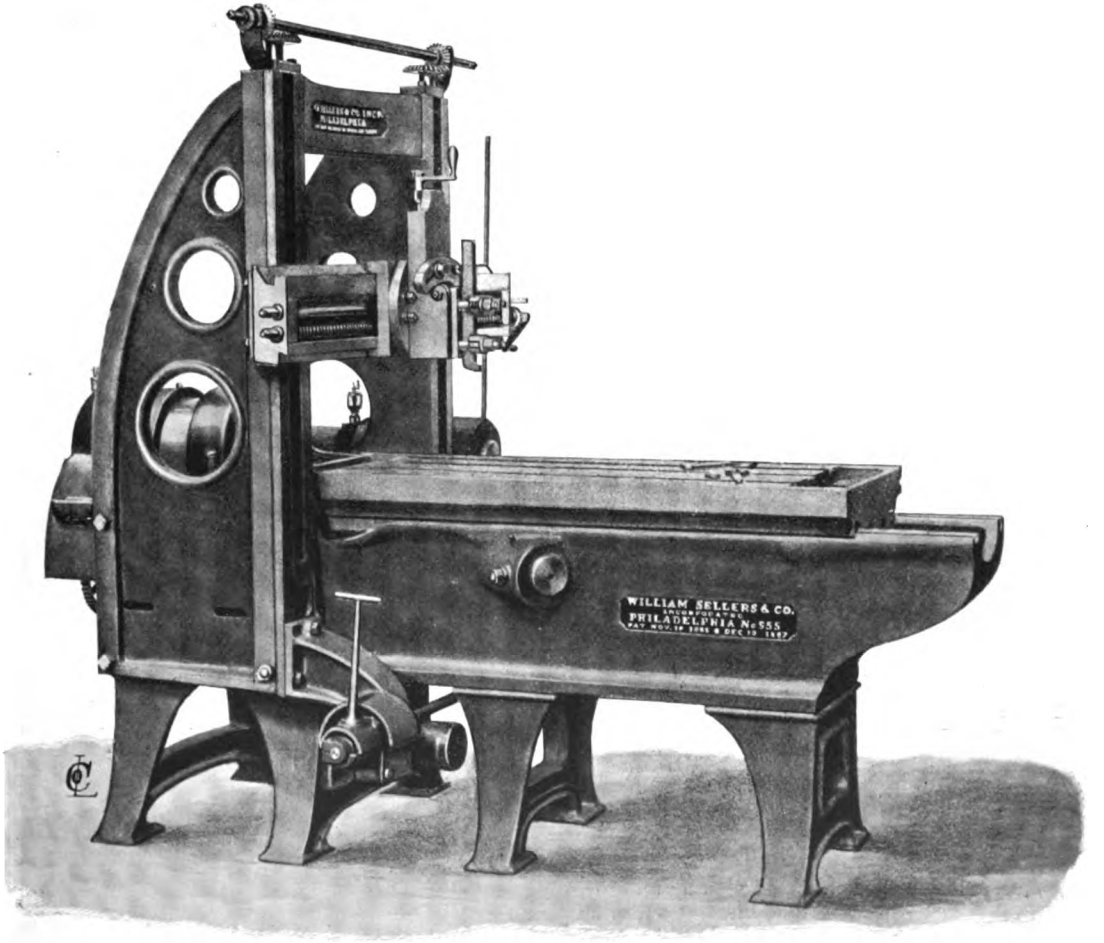
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cam are made to give a semi-revolution, and nothing more. With this method of driving, the motion of the table is uniform from end to end of stroke in either direction; it overruns very slightly, and the table is brought to rest and started up in the opposite direction quickly and yet quietly, and entirely without shock. Moreover, the act of reversing is very uniform, and with the stops in a given place, the machine reverses with almost the regularity of a crank shaper. This is an important matter when working between confining points, such as shoulders or in planing key-seats between two drilled holes. The hand lever permits the table to be controlled with great ease and certainty, stopped, started, and reversed as required, while a partial rotation of the lever cuts out the feed or starts it as required.

The speed of reverse in these machines is limited only by the amount of power which it is considered wise to expend for the purpose. For light machines, a reversing speed of eight times the cutting speed, or say 144 feet, is what we usually provide; but in larger machines, on account of the power required, this is reduced to six or four times. The cross-heads of these machines are of massive construction, and consist of a practically continuous beam, reinforced on the back by an arch between the uprights, the top and bottom flanges being tied together by a central web. Independent screws and feed-rods are used for the two saddles, so that two cutting tools on the cross-head will be entirely independent of one another in the direction of feeds. The planer may be operated from either side of the bed. Another special feature of these machines is the arrangement of the guides in the bed; one is made flat, the other V shaped, with the V terminating on each side in a nearly vertical surface. The V bearing itself is very flat, thus making the table run easily under light loads; but heavy side cuts tending to shift the table, are resisted by the vertical walls above the V. These machines are heavier and stronger than the corresponding sizes of our older type of planer, and the driving power has been increased to a large extent. We are prepared to manufacture a full line of these machines from 20″ between uprights to 120″ or more, if required. The usual sizes correspond with those in the table of our bevel-geared machines, page 188.

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PLATE NO. 114.

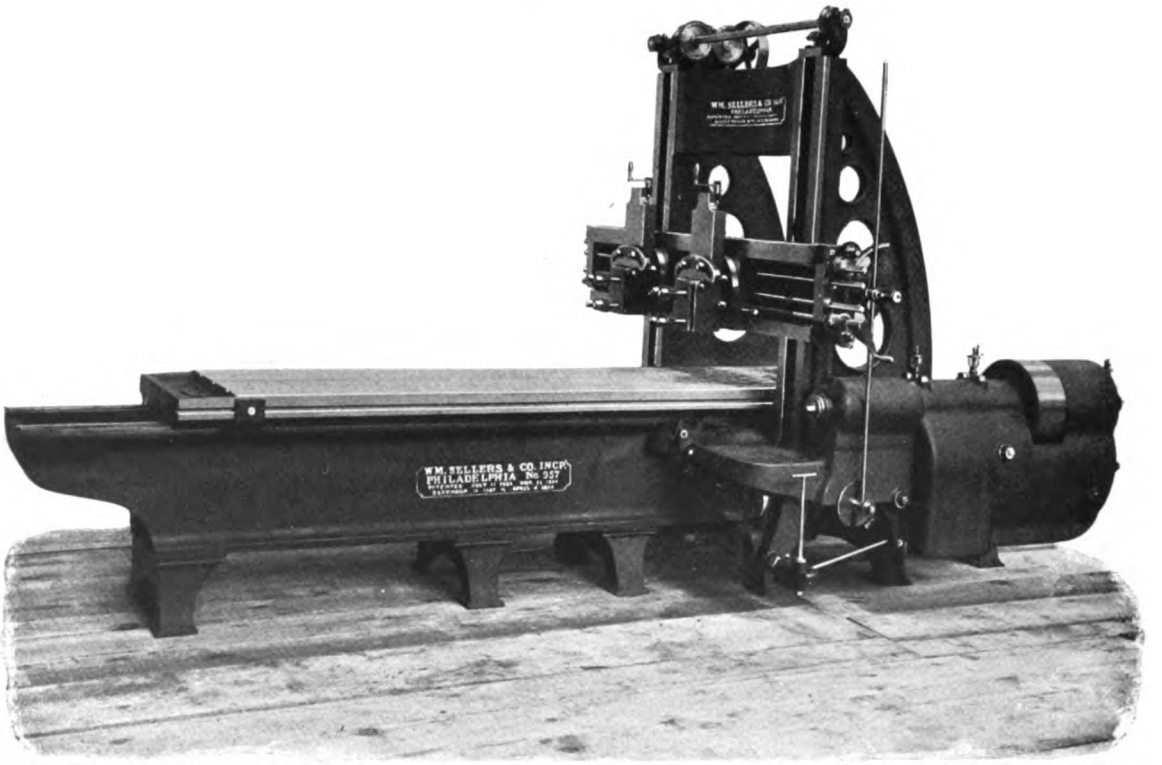


25″ x 25″ PATENT SPIRAL-GEARED PLANING MACHINE.—TO PLANE WORK 4 FEET LONG.

Single belt, driving planing and reversing mechanism through friction clutches. Return speed of table, 144 feet per minute, or eight times usual cutting speed. Table with one flat and one special V bearing having vertical surfaces to take side thrust. Bearings for table protected from dust and dirt. Movement of table and feed can be operated from either side of the machine. Complete with countershaft and full set of cranks and wrenches. Vertical slide-rest, one or both uprights, extra, if required.

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PLATE NO. 115.

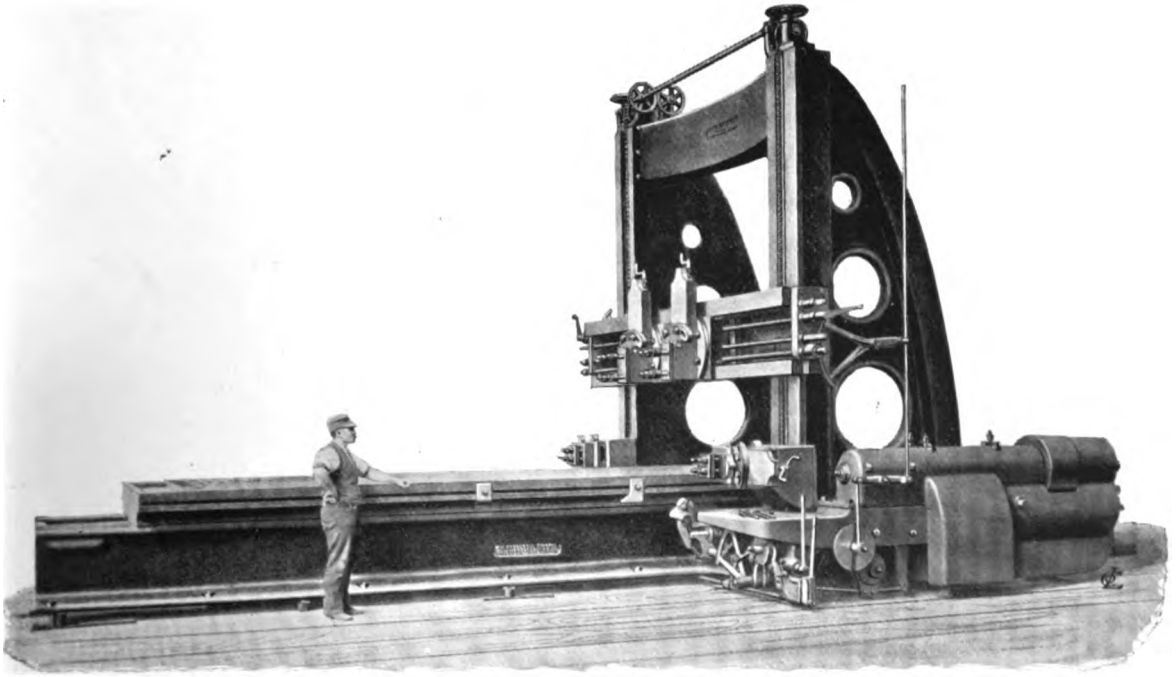


36″ x 36″ PATENT SPIRAL-GEARED PLANING MACHINE.—TO PLANE WORK 10 FEET LONG.

Single belt, driving planing and reversing mechanism through improved friction clutches. Return speed of table, 144 feet per minute, or eight times usual cutting speed. Patent table, with one flat and one special V bearing, with vertical surfaces to take side thrust. Bearings for table protected from dirt. Movement of table and feed-motion can be operated from either side of machine. Improved cross-head, with internal saddles and separate feed-rods and screws. Improved power frictional raising gear for cross-head. Complete with countershaft, cranks, and wrenches. Furnished with one or two saddles on cross-head and with or without vertical slide-rests.

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PLATE NO. 116.

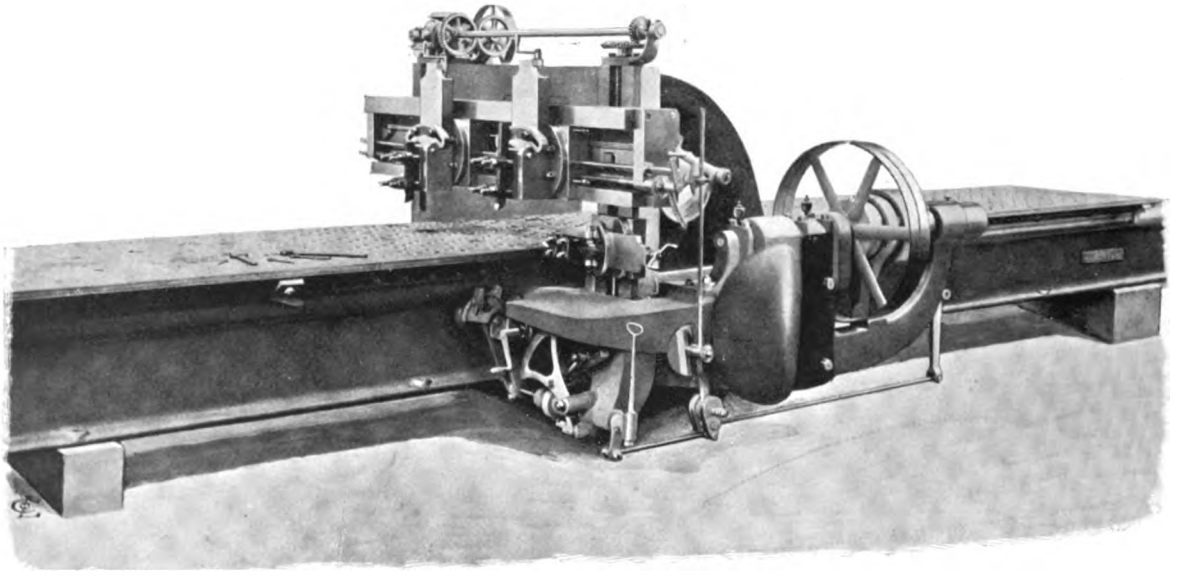


120″ x 120″ PATENT SPIRAL-GEARED PLANING MACHINE.—TO PLANE WORK 24 FEET LONG.

Two saddles on cross-head and vertical slide-rests on both uprights. Single belt, driving planing and reversing mechanism through improved friction clutches. Return speed of table, 72 feet per minute, or four times usual cutting speed. Patent table, with one flat and one special V bearing, with vertical surfaces to take side thrust. Bearings for table protected from dirt. Movements of table and feed-motion can be operated from either side of machine. Massive cross-head of improved construction, with internal saddles and separate feed-rods and screws. Feed of saddles independent in direction and amount. Power frictional raising gear for cross-head. Vertical slide-rests counterbalanced. Complete with countershaft, cranks, and wrenches. This machine can be furnished with one or two saddles on cross-head and with or without vertical slide-rests. Can also be made to plane any length desired.

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PLATE NO. 117.



62″ x 18″ SPIRAL-GEARED LOCOMOTIVE FRAME PLANING-MACHINE.—TO PLANE 35 FEET LONG.

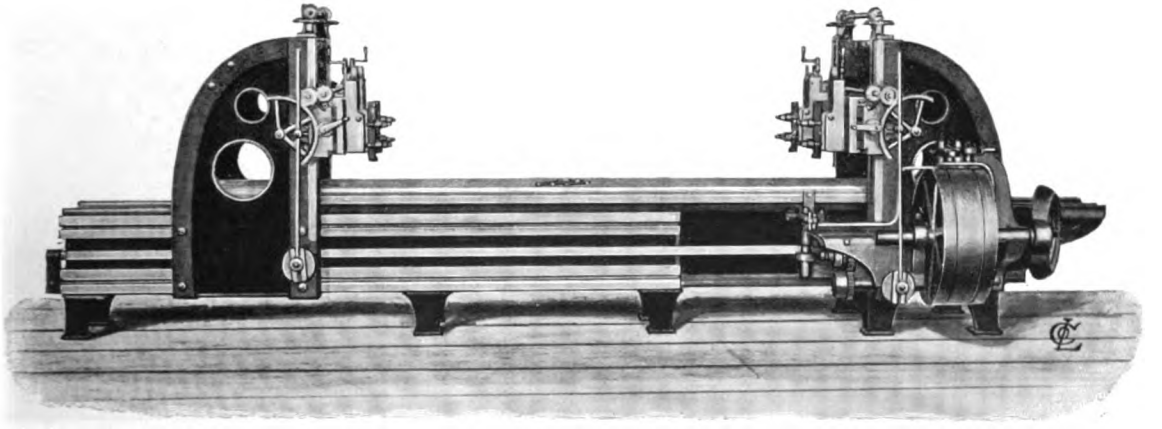
Table 4′ 8″ wide, with top plate 3″ thick. Width between uprights, 5′ 3″. Height from top of table to underside of cross-head, 19″. Return speed of table, 160′ per minute.

This is a powerful, massive machine, capable of taking any cut that the tools will stand. It may be made longer or shorter, as required.

The very rapid return speed of this planer is of great importance on long side frames, and greatly increases the product of this machine over that obtainable upon any other planer yet produced.

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PLATE NO. 118.



36" ROD PLANER.—TO PLANE RODS FROM 3 FEET TO 12 FEET LONG.

Arranged with two sets of uprights; two cross-heads with two saddles on each. Saddles arranged so that the tools on each cross-head can be brought to 6" from centre to centre. Table driven by spiral pinion, so arranged as to move table at same speed in each direction, as it takes cut both ways. Distance between heads adjustable from 3 feet to maximum. Will plane both ends of two connecting rods at the same time. Very heavy and substantial machine, capable of taking very heavy cuts. Cross-heads are adjustable in height above table. Can be used to advantage on four guide bars at the same time. Complete with countershaft, cranks, and wrenches. Fast and loose pulleys, 16" x 4", which should run at 245 revolutions per minute, to produce a cutting speed of 20 feet per minute.

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Planing Machines for Stationary Work.

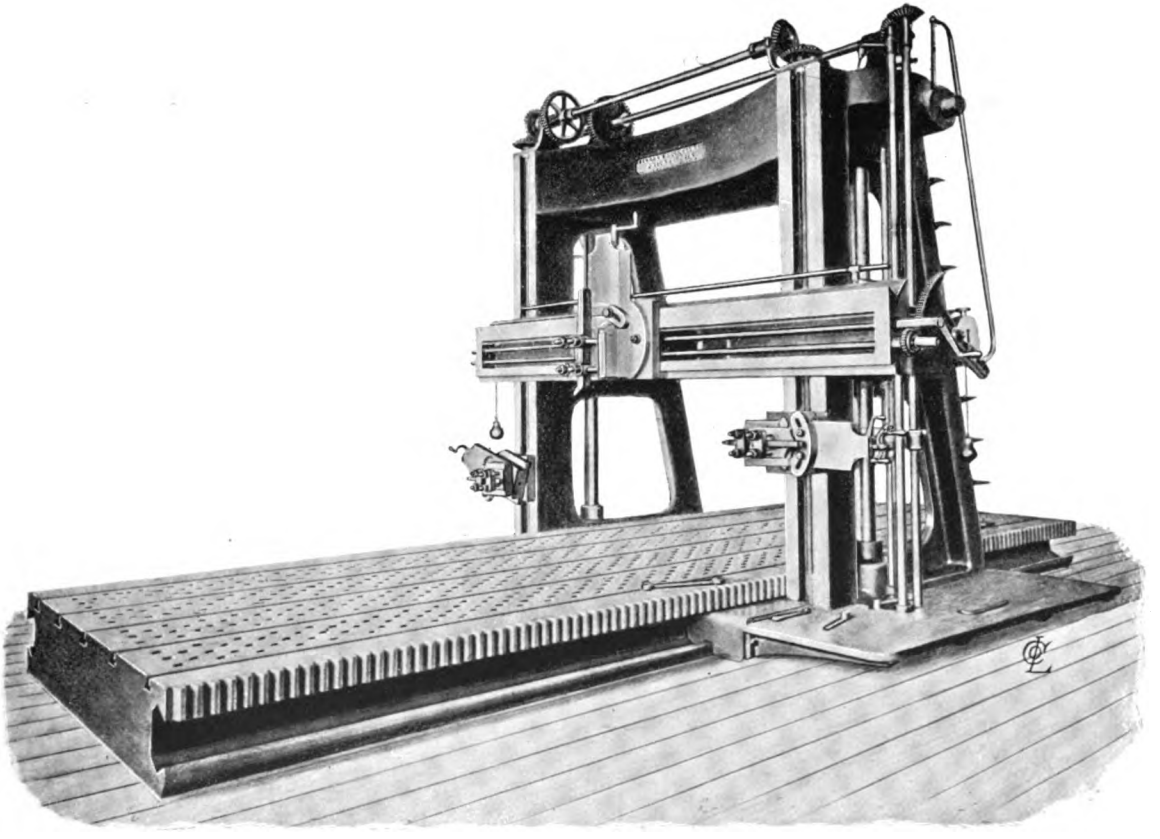
THERE are certain classes of work which, from their size or weight, or unwieldy form, are so difficult to handle upon the moving table of an ordinary planer, that it becomes more economical to pass the tool over the work. In other words, to move the planing machine instead of the work upon which it is to operate. A large machine of this type is the 8-foot planer shown on the opposite page.

The machine illustrated in Plates 117 and 118 carries out the principle of the tool moving over stationary work to the fullest extent, and produces the three movements of planing,—in a vertical or horizontal plane parallel with the axis of the bed of the machine,—of slotting, that is, planing vertically and shaping, or planing horizontally at right angles to the axis of the bed. The work in this case is supported upon heavy floor plates beside the machine. The bed upon which the carriage moves is 38 feet long by 9 feet wide. The frame of the carriage resting on the V's is 14 feet long. The main upright is 16 feet high and is firmly braced by diagonal braces to the carriage. Upon the face of the upright moves a well guided frame which is the saddle of the cross-slide or shaping bar.

The motion up and down constitutes the slotting movement. The motion of the shaping bar across the face of the uprights constitutes the shaping movement. The motion of the carriage on the bed gives the planing movement. To the slotting saddle on the upright is attached a platform, and upon this the workman stands. The platform is surrounded by a hand-rail, and easy access to it is obtained by steps on the frame of the machine. Upon this platform all the devices used in operating the various feed-motions are arranged within easy reach of the workman. He can start or stop the machine; make any of the feed-motions by hand or power; can adjust the amount of power-feed, and, in fact, can thoroughly control the machine in its performance of any one of its functions. It will plane work 24 feet long; slot 12 feet vertically, and the shaping motion has 6 feet stroke.

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PLATE No. 119.

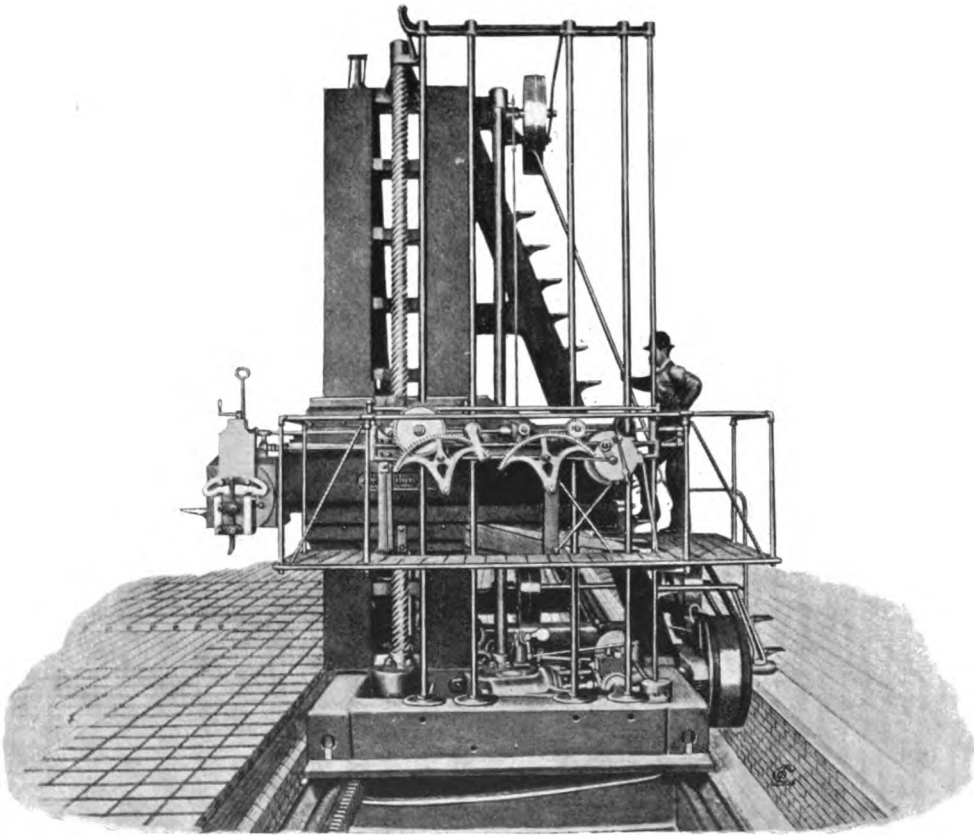


96″ x 96″ PLANING MACHINE.—WITH STATIONARY TABLE 24 FEET LONG, 8 FEET WIDE.

Two vertical slide-rests on uprights. Machine is driven from long belt carried upon countershaft and tightener. Fast and loose pulleys on the machine 30″ diameter for 3½″ belt. Should make 224 revolutions per minute. Uprights carried upon double V bearings in bed with brass taper shoes. Movement of travelling mechanism by rack and pinion on both sides of table. Quick power return. Machine operated from platform at base of upright. Ladder gives easy access to upper parts.

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PLATE NO. 120.

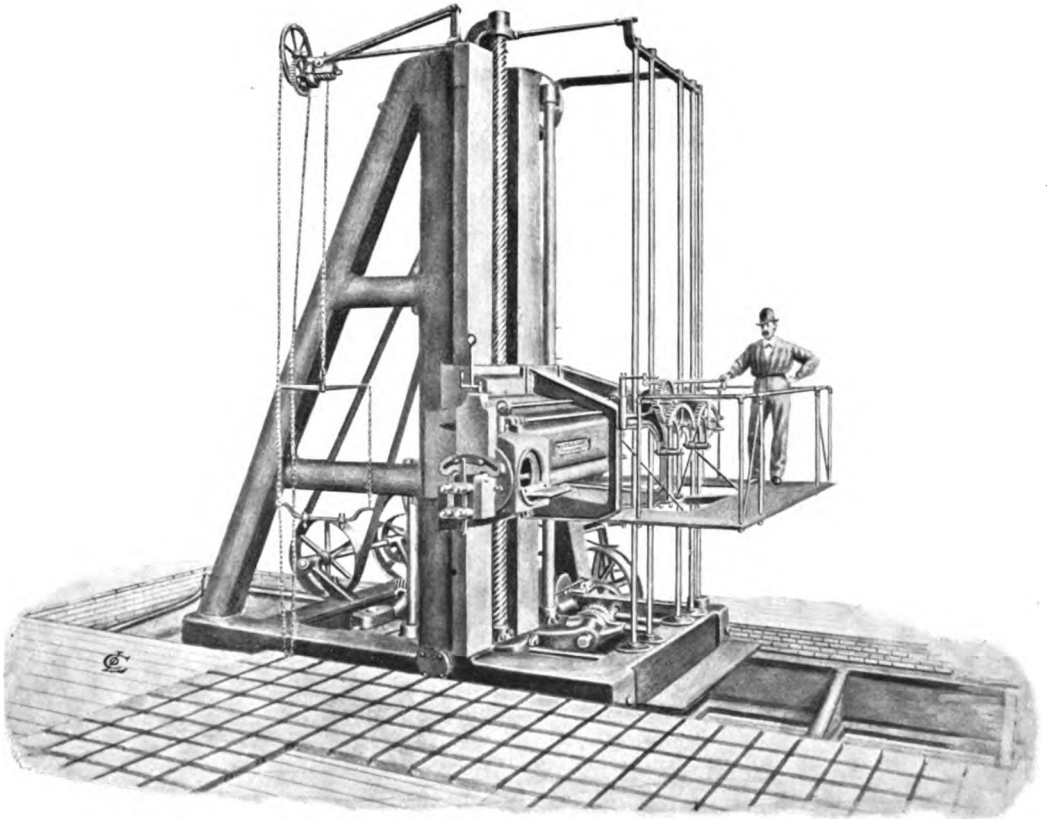


PLANING, SHAPING, AND SLOTTING MACHINE.—TO PLANE 24 FEET; SLOT 12 FEET; SHAPE 6 FEET. (END VIEW.)

Length of bed, 38′; width of bed, 8′ 9½″; length of saddle on the bed, 14′; height of uprights, 16′. Machine is driven by long belt carried under ceiling. Rapid return speed to each movement. The slide-rest and tool-holder can be lifted from end of shaping-bar to side or bottom as required by the different kinds of work, a convenient hoisting device being supplied for this purpose. Driving pulley on the machine is 32″ x 7″, and should make 230 revolutions per minute to give 18 feet of cutting speed.

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PLATE NO. 121.



PLANING, SHAPING, AND SLOTTING MACHINE.—TO PLANE 24 FEET; SLOT 12 FEET; SHAPE 6 FEET. (SIDE VIEW.)

Length of bed, 38′; width of bed, 8′ 9½″; length of saddle on the bed, 14′; height of uprights, 16′. Machine is driven by long belt carried under ceiling. Rapid return speed to each movement. The slide-rest and tool-holder can be lifted from end of shaping bar to side or bottom as required by the different kinds of work, a convenient hoisting device being supplied for this purpose. Driving pulley on the machine is 32″ x 7″, and should make 230 revolutions per minute to give 18 feet of cutting speed.

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PLATE NO. 122.

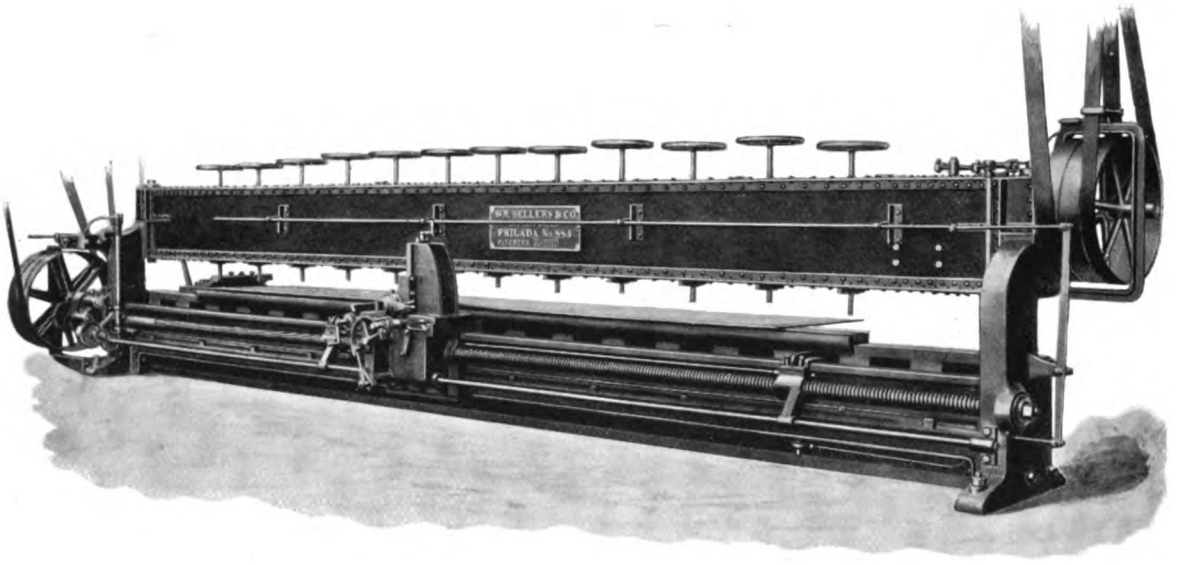


PLATE-PLANING MACHINE.—WITH END-PLANING ATTACHMENT FOR PLATES 22′ LONG, 5′ WIDE, AND 2″ THICK, AT ONE SETTING.

End-planing attachment for plates 5 feet wide. Clamping-beam in form of heavy box-girder. Saddle operated by large screw, provided, on account of its length, with adjustable intermediate supports. Saddle has two tool-holders arranged for cutting in opposite directions. One is provided with a hand vertical adjustment of 9″, for planing angles or bent plates. This tool-holder is arranged to reverse, so that the same tool may be used in cutting each one, if required. Adjustable automatic feed is provided with a self-acting stop-motion, to limit the amount of stroke. A heavy bracket or table on the back of the machine helps to support the plate, while the clamping-screws hold the front edge. Complete with necessary countershafts and wrenches. Fast and loose pulleys on countershaft, for edge-planing, 28″ diameter, 7″ face, and should make 280 revolutions per minute. Fast and loose pulleys on countershaft for butt-planer, 24″ diameter by 7″ face, also 280 revolutions per minute. Housings are offset so that sheets of any length may be planed in successive settings.

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PLATE NO. 123.

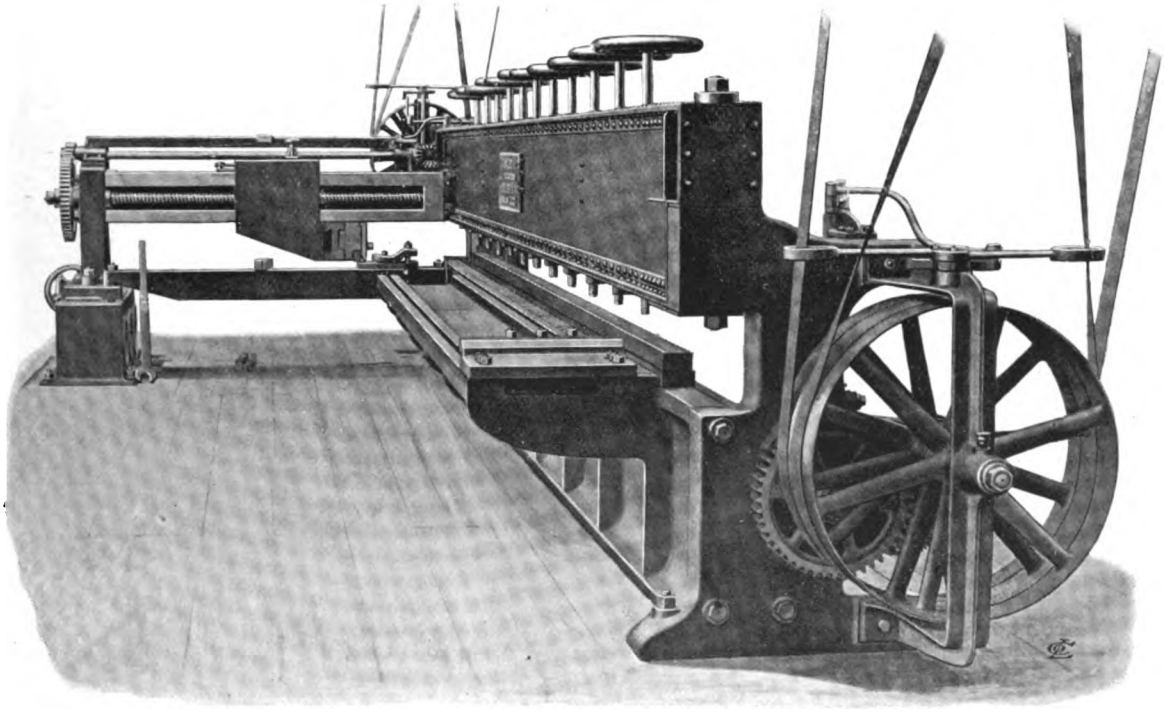


PLATE-PLANING MACHINE.—FOR PLATES 22′ LONG, SHOWING END-PLANING ATTACHMENT.

[See specification under Plate No. 122.]

NOTE.—We are prepared to build these machines of various lengths and capacities, and make them with clamping screws as shown in these plates, or with independent screw-jacks, as preferred. For short machines, say for plates not over 16 feet long, we use cast-iron clamping-beam (see Plate No. 124); but for longer machines, we prefer the built-up box girder.

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PLATE NO. 124.

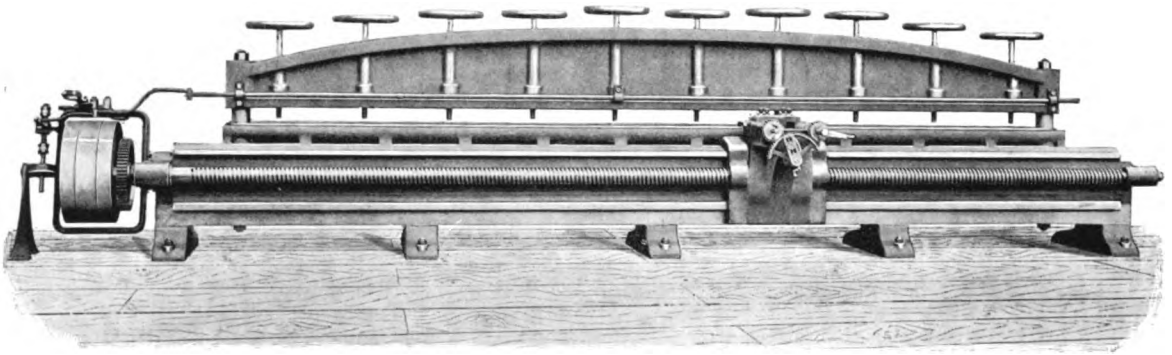
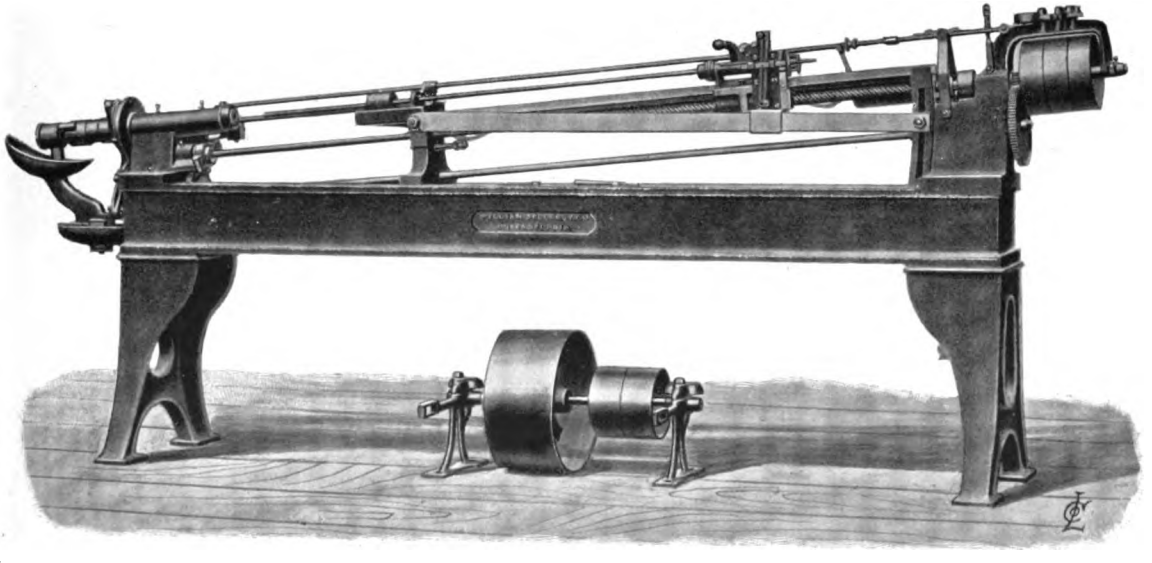


PLATE-PLANING MACHINE WITH CAST-IRON CLAMPING-BEAM.—TO PLANE PLATES 14 FEET LONG AT ONE SETTING.

Arranged with a continuous table on back of machine to support plate. Cast-iron clamping-beam is provided with nine 1½″ screws to clamp plate against hard wood bolster, resting in groove in the top surface of the bed. Bolster may be replaced by one of curved form for ship-plates, if required. Saddle carried on narrow horizontal bearing, with deep vertical beam, thus enabling the attendant to go much closer to the work than in machines where the saddle is carried upon a horizontal surface alone. This is a point of considerable importance. Saddle is operated by 4″ steel screw, and carries two tools arranged to take cuts in both directions. Has an automatic feed, and automatic relief for the tool on the return stroke. Complete with countershaft and wrenches; fast and loose pulleys on countershaft 16″ diameter for 6″ belt, making 280 revolutions per minute. Adjustable stop for automatically regulating length of stroke. Built also for sheets 16′ long with 10 clamping screws, and arranged, if required, with overhanging end supports to enable sheets of any length to be planed in successive settings.

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PLATE NO. 125.



RIFLING MACHINE FOR GUN BARRELS.

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Punching and Shearing Machines.

"RECOMMENDED for general excellence of design, for the proportions of strength at particular points to meet successive strains, and for the soundness of the entire structure; also, for the convenient manner in which the punching die is arranged in order to give facility for operating upon varied and intricate forms of articles; as also for the very perfect stop-motions that are applied both to the punching and shearing slides."—*See Introduction*, pages 6 to 12.

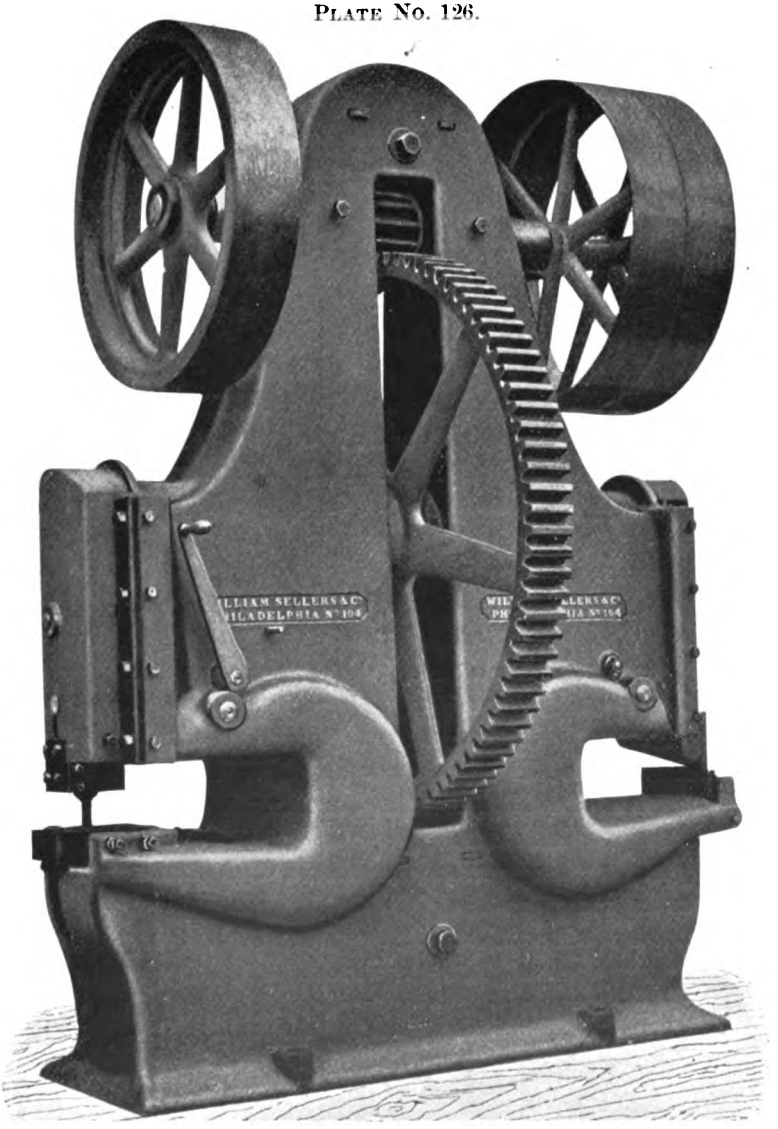


UR punching and shearing machines include two types, known as crank and lever machines, to designate the manner of driving. In the first type the vertical slide is driven directly by a crank shaft, and power is received through spur gearing from a pinion-shaft parallel thereto and in line with the machine, while in the second type, the vertical slide is driven indirectly through the intervention of a heavy steel lever by an eccentric shaft across the machine. This eccentric shaft is driven through spur gearing by a pinion-shaft parallel thereto, and at right angles to the position assumed in the first type of machine. Each type has its own peculiar advantages, among which the position of the machine, with reference to the line shafting, will be at once apparent; but for durability and economy of power in heavy service, we decidedly prefer and recommend the lever machine, which we believe is demonstrably superior in design.

It is evident that in all punching or shearing machines driven by belt or engine, there must be a conversion of rotary into reciprocating motion, and in crank machines the working pressure comes directly on the crank pin, which must perform a large part of its revolution under this load, causing considerable friction and wear. On the other hand, when the vertical slide which carries the punch is operated by a lever, the sliding surfaces are larger and their amount of sliding almost inappreciable, while the eccentric, which really does the work at the long end of the lever, has

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PLATE NO. 126.



PUNCHING AND SHEARING MACHINE COMBINED.

Overreach, 17¾″ for punch and 20½″ for shears. Will shear ¾″ plate and punch 1″ holes in ⅝″ plate. 36″ x 7″ pulleys. 144 revolutions per minute. External punch for flanges and angles. Wrenches, shear blades, punch and die holders, sample punches and dies.

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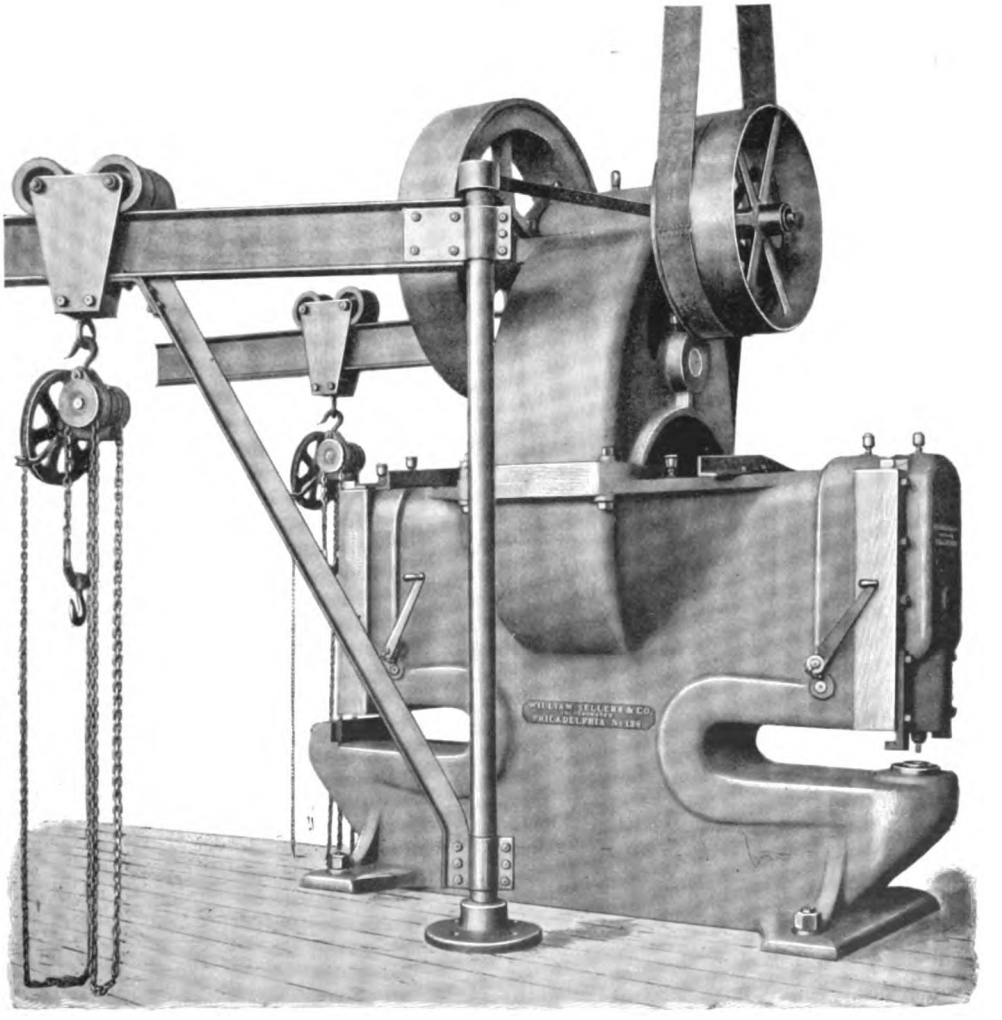
less pressure to carry and moves more freely on large bearing surfaces. In both types of these machines care has been taken to avoid the use of bevel gearing, the transmission of power being effected through spur gearing in the most direct and durable manner. On this account our punches and shears run quietly, and will maintain their proper action until worn out in service.

Formerly, on lever machines, the lever was raised by a cam for punching and allowed to return by gravity, but, in some cases, the weight of the lever proved insufficient to do the stripping, and in punching machines it is now actuated by an eccentric and strap, so that a positive motion in both directions is obtained. In some cases the eccentric is loose on the shaft, and connected thereto at the will of the operator by a four-toothed clutch for starting and stopping, while in other cases the eccentric is keyed to the shaft and the slide is engaged or disengaged by a gag-block. For slow moving machines these methods of starting and stopping are quite satisfactory, but with the demand for higher speeds, and the reduced time for operating, the danger of a partial engagement of the clutch or gag-block increased to such an extent that something better became necessary. To meet this requirement, we have introduced our patent toggle-joint stop-motion in the sliding-head, whereby the facility of operation is vastly increased and the risk of a partial engagement entirely avoided. This is illustrated on some of the lever machines, and can be applied equally well in a modified form to the crank machines. As may easily be imagined, an ordinary toothed clutch or gag-block cannot be moved in either direction when caught by the working pressure, and even with careful handling, clutches with broken corners and "gag-blocks" with battered edges, or entirely deformed, are matters of frequent observation. But by means of our improved stop-motion, pressure cannot come upon insufficient surfaces, and if the toggle-joint is not straightened enough to transmit pressure, it simply "knuckles," and gives the operator another opportunity to engage it at the end of the return stroke. No other stop-motion operates so easily, safely, and absolutely without shock.

The sliding-head is counterweighted, and when the gag-block is out of action,

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PLATE NO. 127.



PUNCHING AND SHEARING MACHINE COMBINED.—30″ OVERREACH.

Capacity, 1½″ hole in 1½″ plates. Will shear 1½″ plate. 36″ x 7″ pulleys. 200 revolutions per minute. With or without cranes attached. Cranes shown in the plate, 5000 lbs. capacity. Gearing enclosed in housing. Complete with set of shear blades, sample punch, and die.

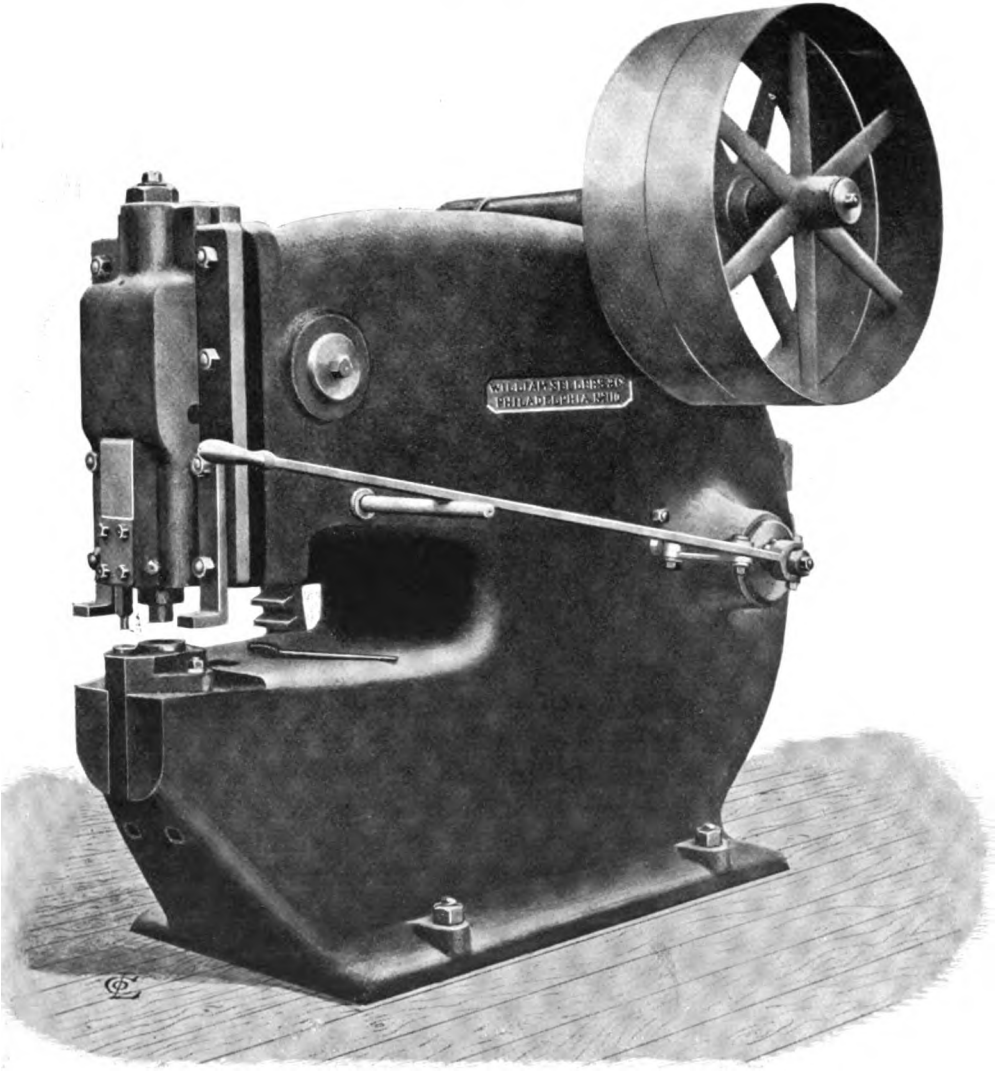
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it may be moved up or down by hand, a matter of special convenience in adjusting plates for punching. An important feature in our punching and shearing machines is their mutual convertibility, so that, for a slight additional cost, the same machine can, when desired, be used either as a punch or as a shear. We do not fit up all machines in this way, but the extra cost is so trifling that, unless the work to be done is very special in character, the advantage of the larger range of usefulness is generally worth considering. The change from one to the other is as readily effected as the change of blades in a shearing machine or of punches in a punching machine, but where work is abundant and varied, it may be more advantageous to have two machines or a punch and shear combined. To meet this requirement, which applies quite generally to boiler plants, we build a punching and shearing machine combined, in two sizes. In this machine the two heads are driven alternately up and down by a common crank shaft, and each head is controlled independently by a gag-block.

All of our lighter machines are made with flat bases, to stand upon a level floor or upon foundation stones; but as the overreach and pressure increase, the necessary depth of jaw would, if the same style were continued, raise the die to an inconvenient height. To avoid this we carry the housing of our very heavy machines below the floor line. This necessitates separate piers for the two ends of the machine.

When required to do so, we can arrange our machines to run continuously, or to stop automatically on the completion of each stroke, the change from one to the other being very readily accomplished by the operator. The sliding-head can be arranged so that the punch will stop at any desired height above the die. We can also provide a means for moving the head by hand when the gag-block is withdrawn. We make our machines either single or double geared, according to circumstances. In the double-geared machines the higher speed attainable on the first shaft allows the use of a much smaller engine and fly-wheel, or of pulleys in the belt-driven machines. The weight of the rapid running parts is thus reduced; but, as it is not always convenient to develop high belt speeds from slow running line shafts, the

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PUNCHING MACHINE.—26″ OVERREACH.

Arranged with auxiliary punch for flange punching and adapted for shearing attachment. Capacity, 2″ hole in ½″ plate. 36″ x 7″ pulleys. 144 revolutions per minute. Frame, 22″ wide. Auxiliary punch will punch flanges of boiler heads down to 12″ diameter.

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single-geared machines are frequently preferred. The various machines in the following illustrations are typical of the class to which they belong, but they by no means represent all of the modifications we have been called upon to make to meet special requirements.

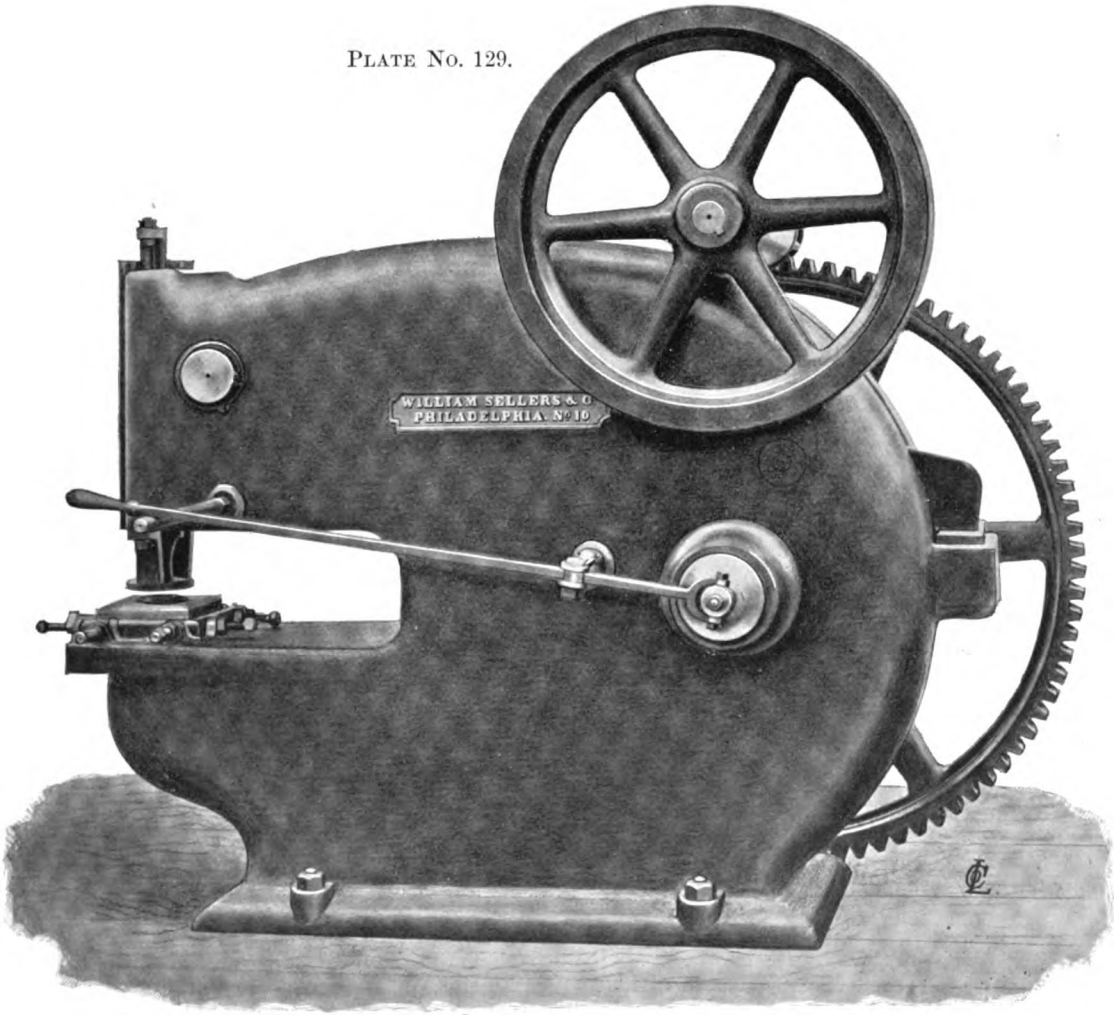
We are prepared to build machines of any class with more or less overreach and more or less clear height between upper and lower jaws. These variables can be adjusted to the requirements of the work or the preference of the purchaser, but the width of the housing is limited to certain fixed dimensions, which serve as an index to the bulk and strength required. Thus, a punching machine 30″ overreach might be 22″, 28″, or 32″ wide, and from the illustrations the character of machine referred to in any case will be understood. So also with the combined and crank machines.

Shearing Machines.

All of our lever punching machine patterns can be adapted to make shearing machines either for plate or bars or angles as required. We therefore have a series of shearing machines covering a great variety of work made from the 22″, 28″, and 32″ patterns, that is, those measuring these amounts in width of housing. We also adapt many of our punching and shearing machines to do both classes of work, the machines being arranged for both shearing and punching attachments. They may be driven by fast and loose pulleys or by separate engines, and are made both single and double geared, according to circumstances. It is sometimes desirable to increase the size of the belt and decrease its velocity, in which case the single-geared machine is the most suitable. But with the higher velocity of the double-geared machines a smaller fly-wheel is required to do the work and less width of belt. The illustrations of shearing machines immediately follow those of punches.

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PLATE NO. 129.



LEVER PUNCHING MACHINE.—26″ OVERREACH.

Arranged for punching large washers or hand-holes in plates up to ½″ thick. Capacity, with flat punch, 2″ hole in ½″ plate. 36″ x 7″ pulleys. 144 revolutions per minute. Frame, 22″ wide. Complete with die holder, punch holder, sample punches, and dies.

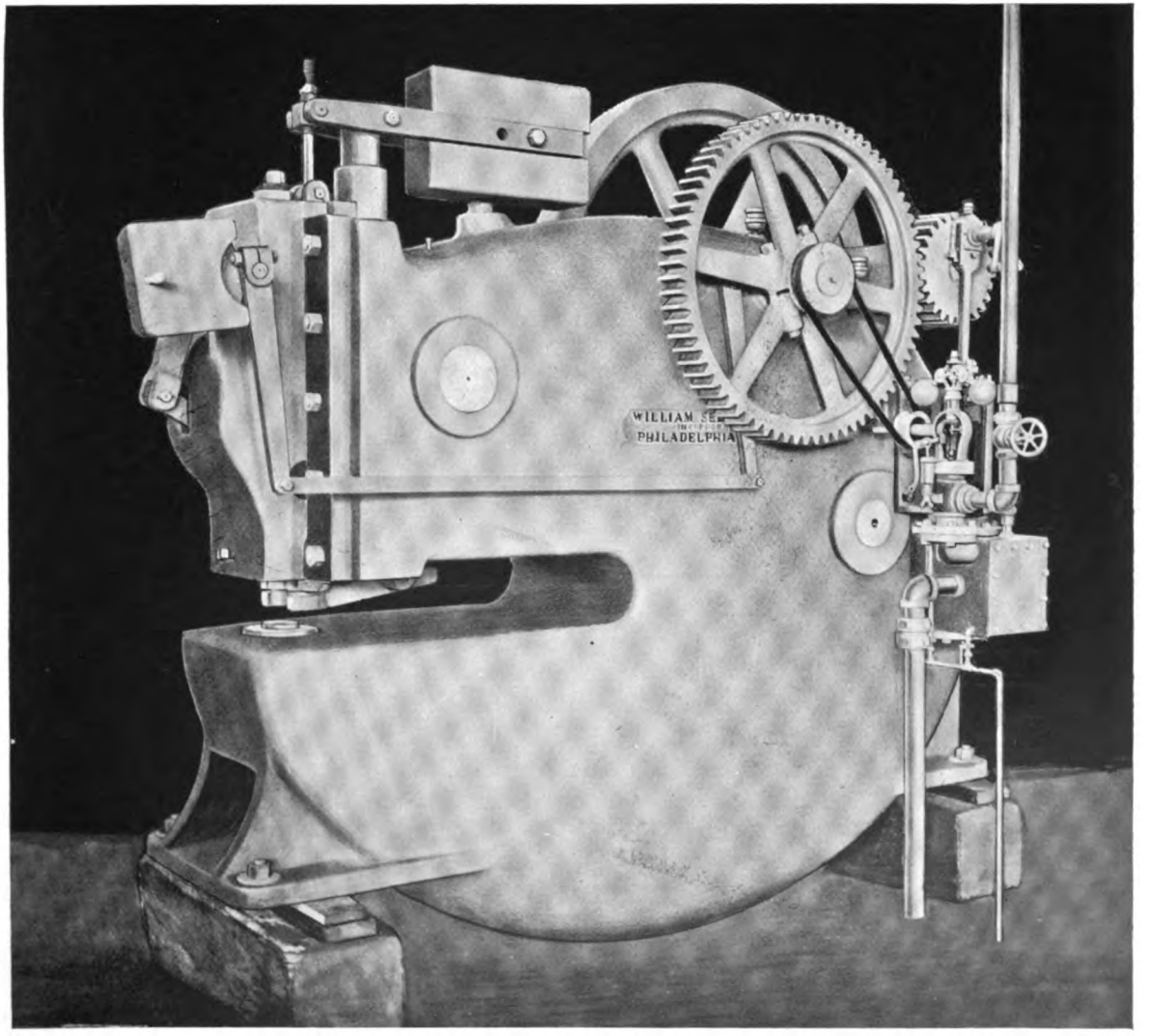
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Lever Punching Machine.—36 Inch Overreach.

THE machine shown in Plate No. 130, on opposite page, is a very massive one, designed for a working pressure of 400,000 lbs., under a working stress in the machine not exceeding 3000 lbs. per square inch in cast-iron. This machine is double-geared and arranged with independent engine for driving it. We also build this machine to drive by belt when it is desired to do so. In order to obtain the necessary strength, the frame of the machine, which is 28″ wide, is carried down below the floor level in the central portion, so as to avoid raising the dies to an inconvenient height. This machine is provided with our patent toggle-joint stop-motion, which knuckles if it be not thrown fully into gear, and thus prevents accident. The stop-motion is thrown in by a counterweight, which can be set to make the machine run continuously, or when thrown to the other side of the shifting lever it will cause the machine to stop at the end of each stroke automatically. The slide is counterbalanced by an adjustable counterweight, which may be set to give any amount of preponderance required, while the sliding-head being adjustable, with reference to the counterweight, can be set to stop at any desired height above the work.

We also extend the counterweight levers and provide a means for moving the head by hand, in order to set the punch conveniently. Capacity of the machine shown is 1½″ hole in 1½″ steel plates. We make various other modifications of this 28″ frame, giving greater or less overreach as may be desired. When run with an engine, a governor is provided to keep the speed uniform.

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LEVER PUNCHING MACHINE.—36" OVERREACH.

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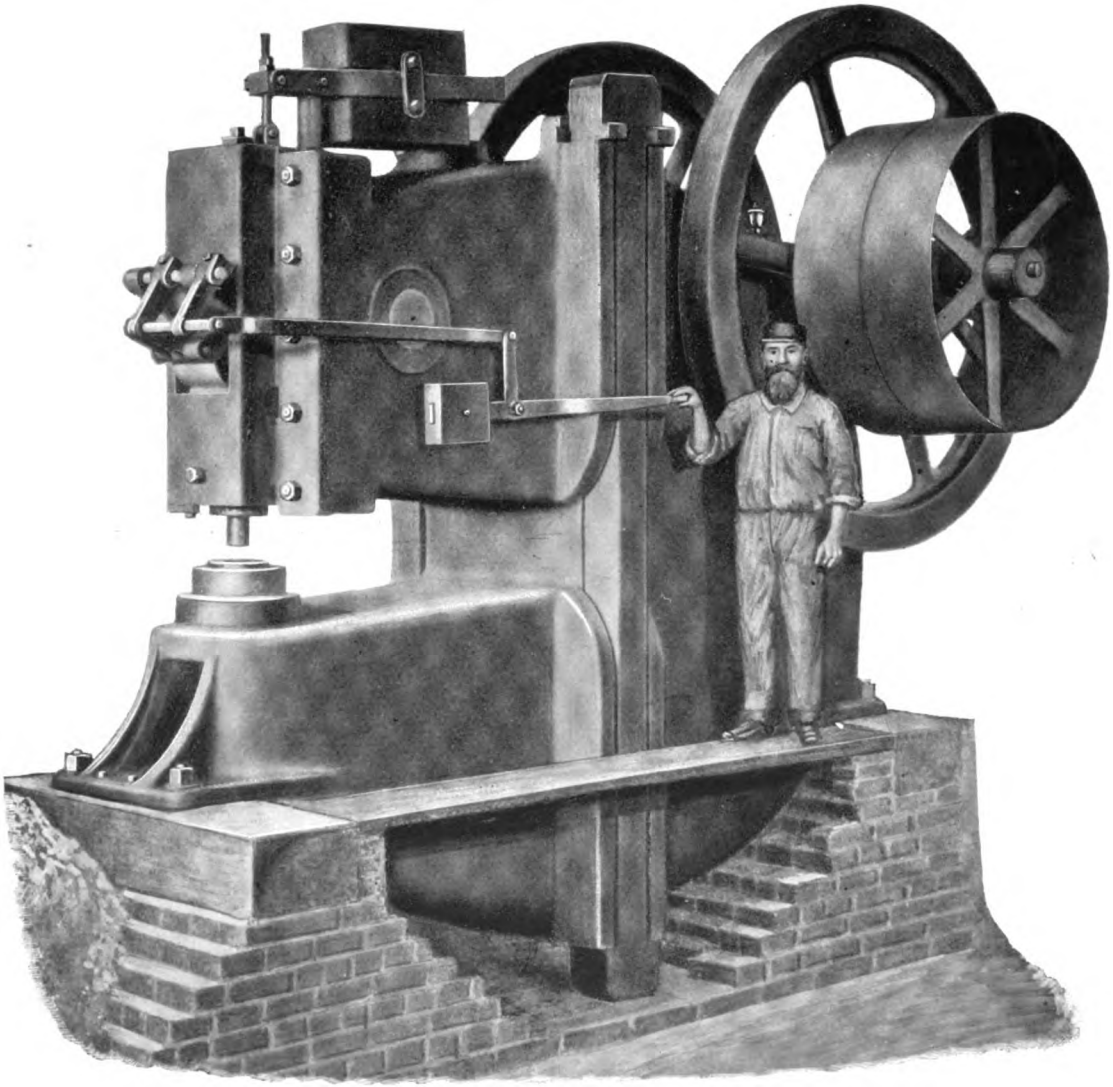
Lever Punching Machine.—48 Inch Overreach.

THE huge machine shown on the opposite page, Plate No. 131, is designed to work under a pressure of 500,000 lbs., without exceeding a safe working load in the frame or levers. The housing is made of two parts put together with a horizontal joint and connected by T-head bolts and wedges. It is provided with our patent toggle-joint gag-block and counterweighted slide. We have arranged this machine for simply round punching, as shown in the plate, and have also in other cases extended the front and adapted the machine for punching flue holes up to 26″ diameter in ¾″ plate at one operation; and also in this case it can be arranged for punching, at one stroke, about 30 rivet holes around the circumference of the large flue opening. In order to get sufficient strength for the great overreach and heavy service for which this machine is adapted, we have been obliged to carry the frame down below the ground level, but have thus maintained the die at the usual height, and provide for carrying the machine by extending a flat foot or bearing at each end of the machine. The width of this frame is 32″.

The capacity of the machine is usually assumed as equal to punching a 3″ hole in a 1½″ plate with flat punch. With bevel or shearing punch we have punched a 4″ hole in 1½″ plate. The pulleys are 48″ x 12″, and should run 120 revolutions per minute.

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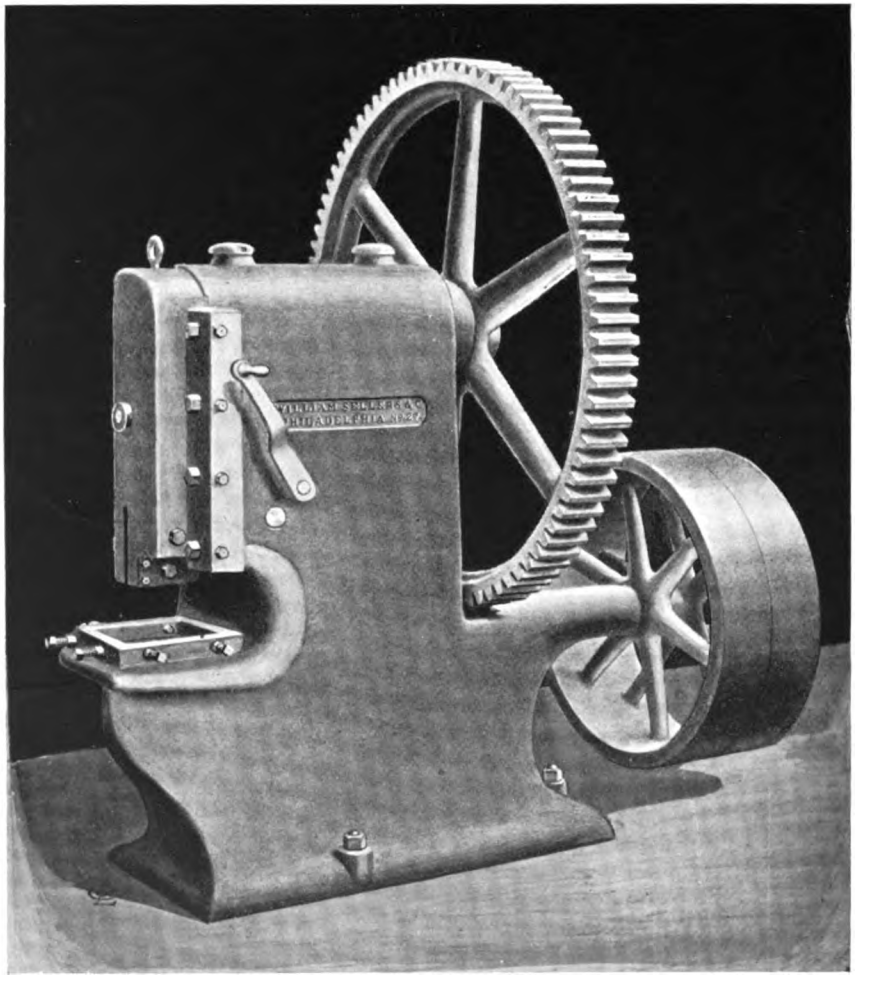
PLATE NO. 131.



LEVER PUNCHING MACHINE.—48″ OVERREACH.

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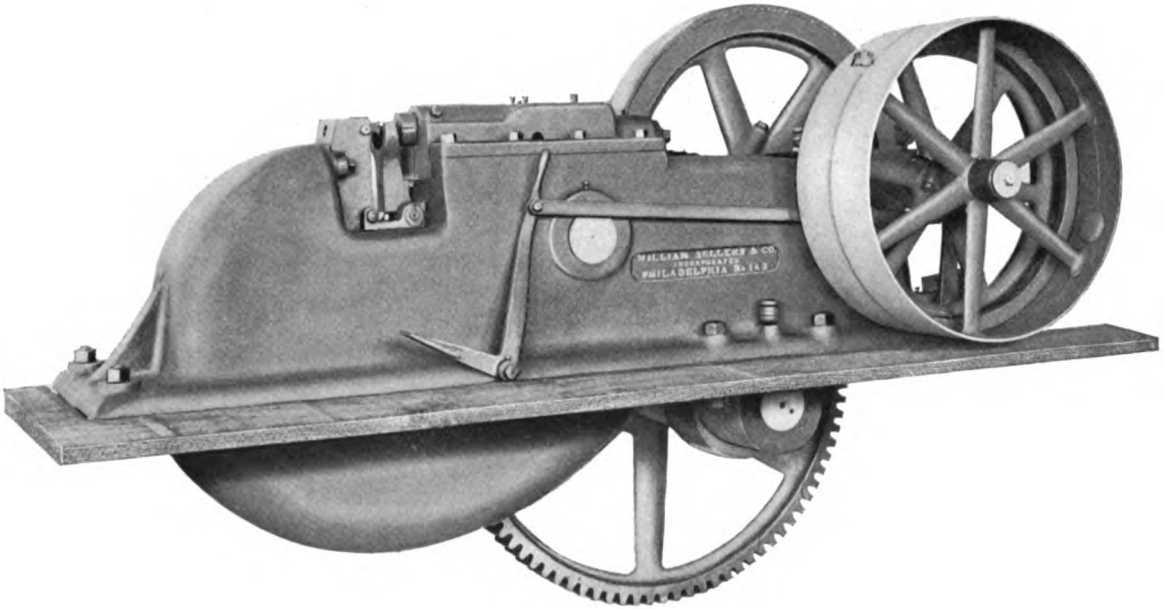
PLATE NO. 132.



CRANK PUNCHING MACHINE.—7″ OVERREACH.

Capacity, 1″ hole in ½″ plate. 36″ x 7″ fast and loose pulleys, should make 144 revolutions per minute. Complete with wrenches, sample punch, and die, etc.

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HORIZONTAL PUNCHING MACHINE.

This is a lever punching machine, driven by eccentric and operated by our patent toggle-joint stop-motion. It has capacity to punch 1″ hole in 1″ plate, and an overreach of 10″. It is especially designed for fire-box and boiler-head work, and is convenient for punching a great variety of other shapes. The toggle-joint may be thrown in by hand or foot. This machine is provided with an adjustable stripper, die holder, sample punch, and die.

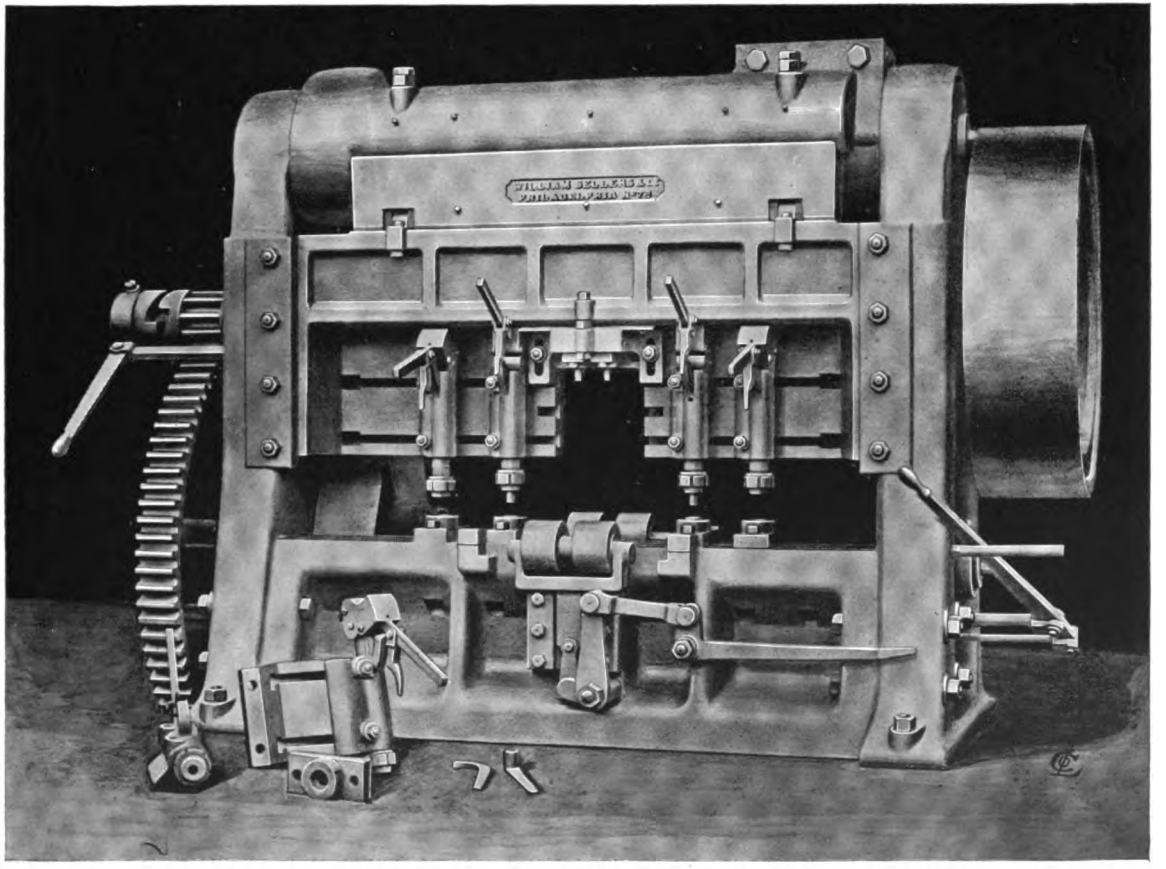
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Multiple Punching Machine.

PROBABLY the most complete machine that has been made for punching plate girder work. In combination with a very handy spacing carriage, this machine is used for punching webs and flanges of plate-girders, and the flanges of I-beams or channels placed back to back. The punches are held in special holders bolted to the slide, and arranged so that each punch may be engaged or disengaged as required. Fifteen punches may be used at one time, and web plates punched in one passage through the machine, not only along the edges, but also transversely. Four angles or two channels are punched at the same time. We furnish with this machine, to complete its equipment, the following: 12 cylindrical punch holders, 6 side punch holders, 4 angle punch holders; supporting apparatus for channels, beams, etc., consisting of supporting blocks, die holders, and grips, 6″, 8″, 10,″ 12″ sizes; four die-blocks with holes to one side for angles; twelve die-blocks, with holes central; one stripper bar for plates; one set of angle strippers; one set of blocks for holding adjusting spring to angle stripper; two angle grippers; three plate grippers; one spacing carriage, arranged to space to any multiple of ¼″ up to 13½″ between rivet holes; one guide carriage; fourteen stands with rollers complete, to support work and carry rails for supporting carriage; 124 feet of geared rails and 124 feet of plain rails, permitting a traverse of spacing and guide carriage of 62 feet; one blocking piece; two stands without rollers. If it is desired to work plates longer than 62 feet, additional rails and stands can be provided. To adapt the machine for use as a plate punch, the gap in the centre of the cross-head is filled by a block. The spacing carriage can be set with great readiness to the distances required, and the work punched without templets. There are lifting rollers to raise the work from the dies, so as to clear the fins resulting from the punching, and to enable the spacing device to work freely.

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PLATE No. 134.

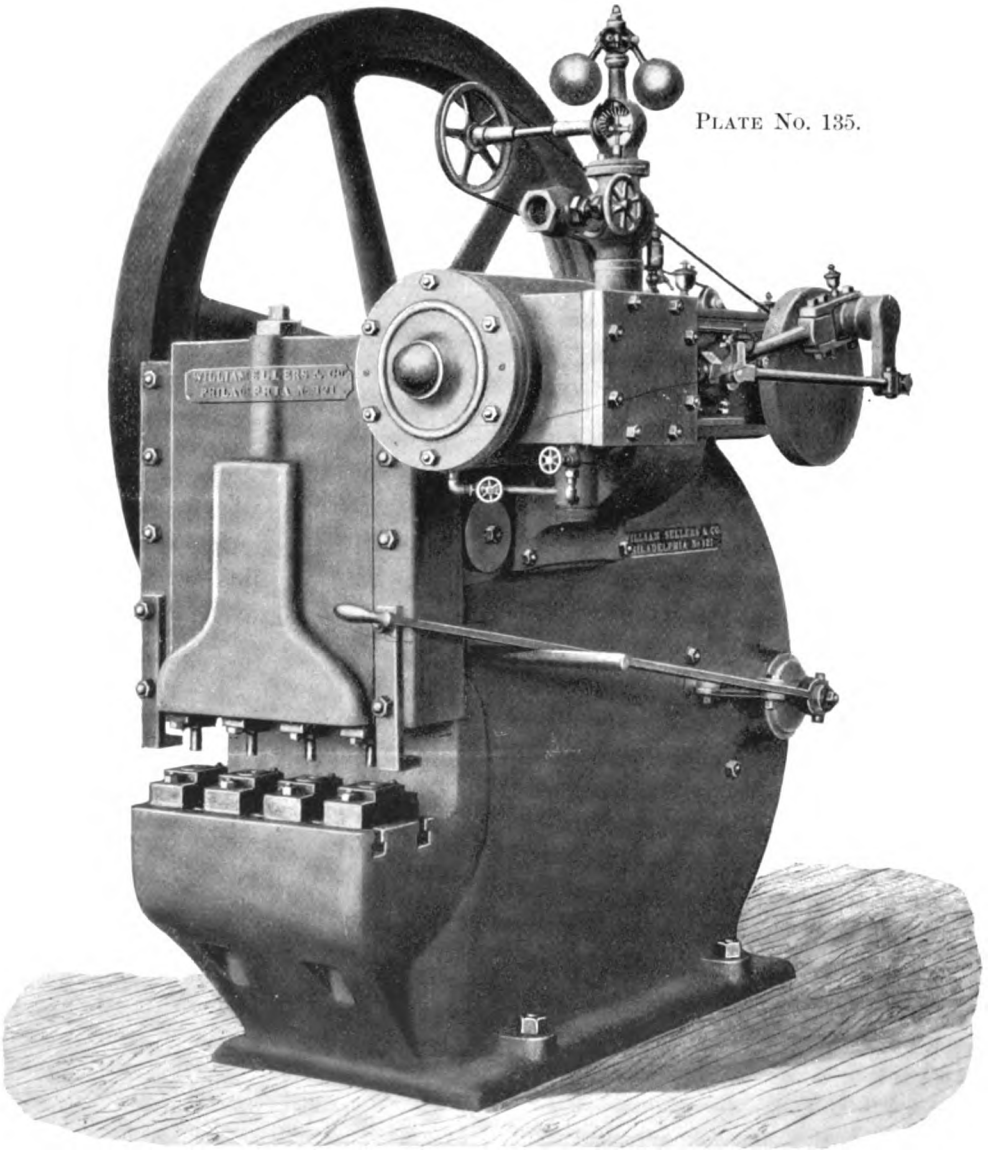


MULTIPLE PUNCHING MACHINE.—FOR PLATES, ANGLES, CHANNELS, AND Z-BARS.

Will permit plates 5′ 2″ wide to pass between housings. Stops and starts by moving cam on cam-shaft, or by clutch on pinion-shaft, as shown. Driving pulley, 42″ diameter, 12″ face, should make 120 revolutions per minute.

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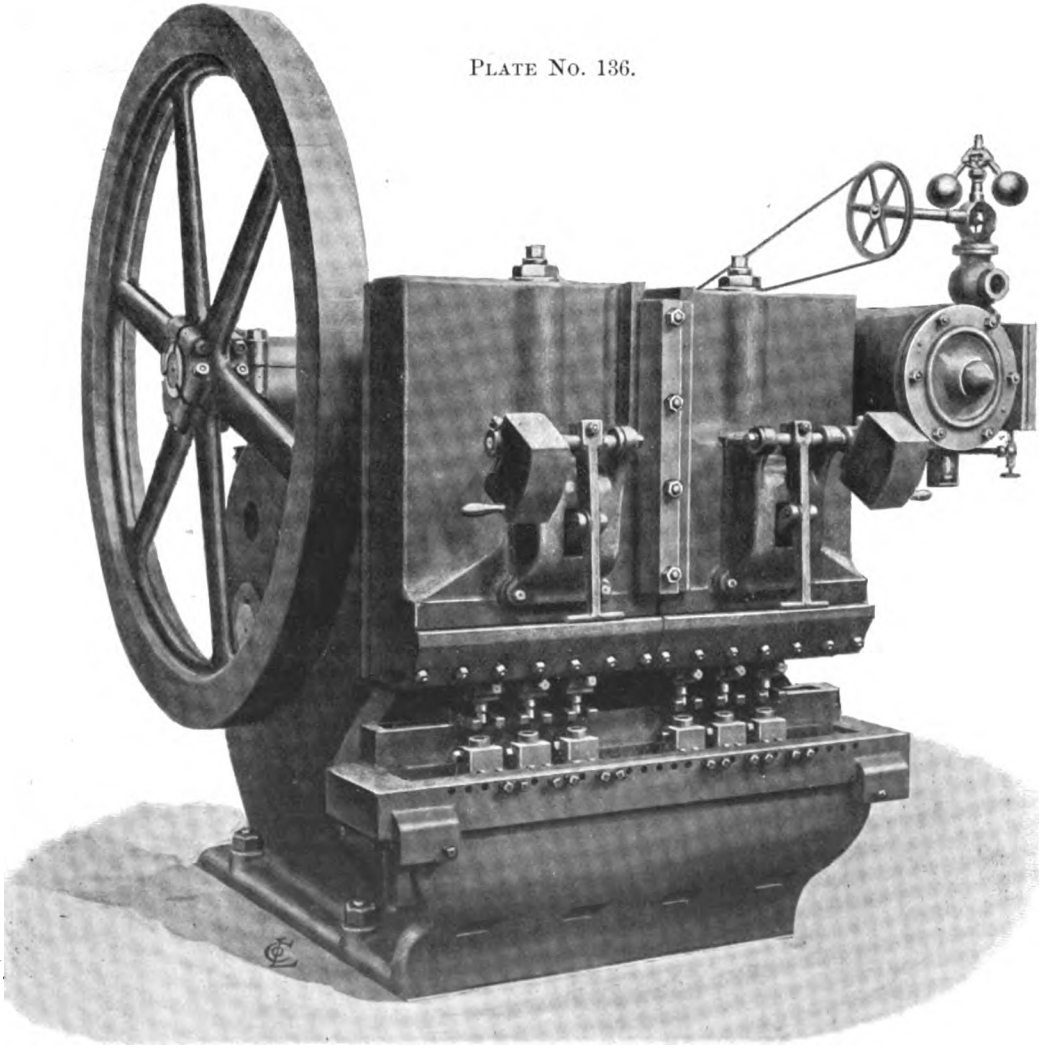
PLATE NO. 135.



PUNCHING MACHINE FOR FISH PLATES.—7″ OVERREACH.

Driven by 10″ x 12″ engine, 112 strokes per minute, equal to 16 strokes of punch. Stopped and started by clutch on cam-shaft, operated by lever. Especially adapted for railway splice plates and similar work.

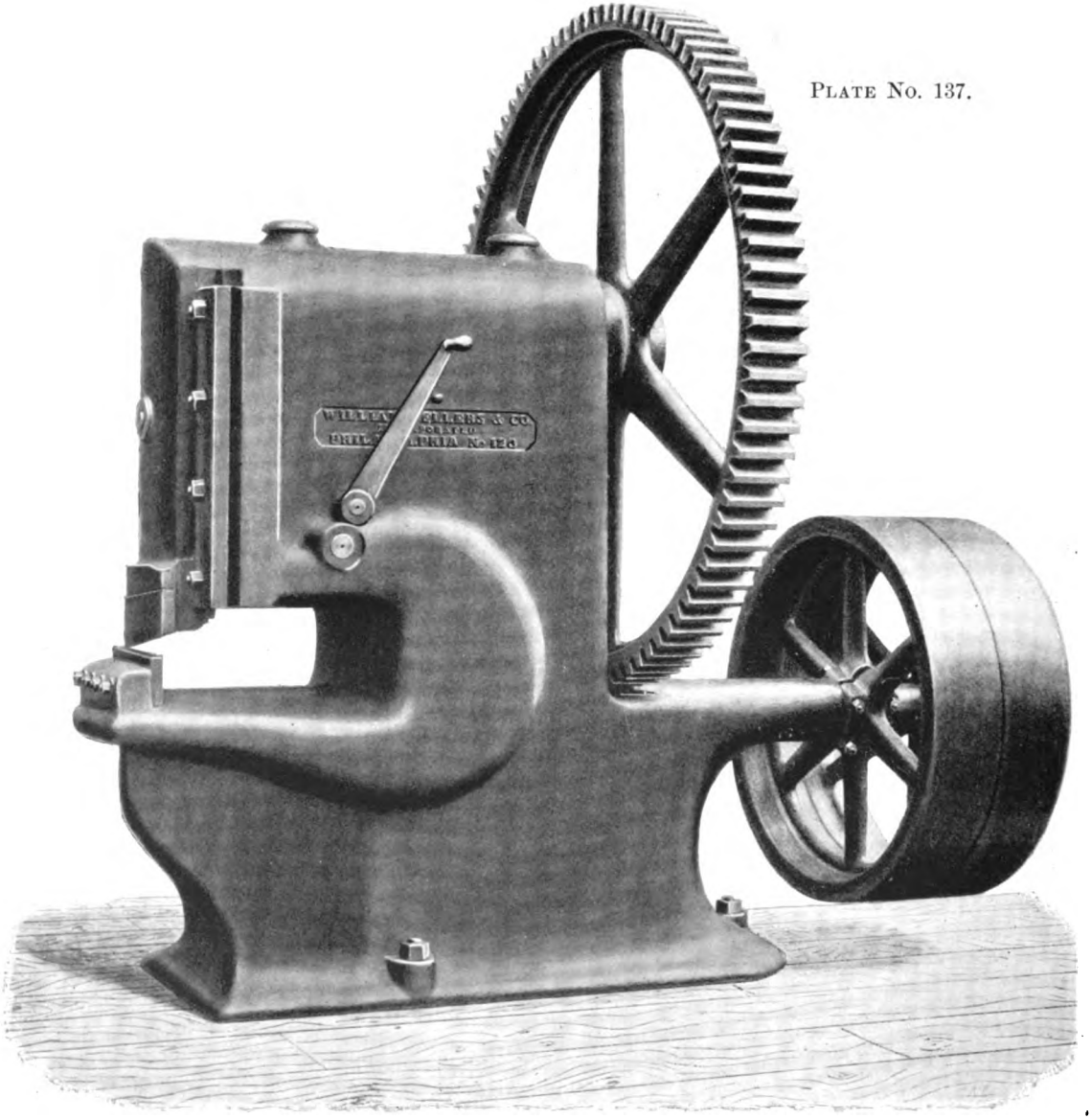
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DOUBLE LEVER PUNCHING MACHINE FOR SPLICE PLATES.

Designed for modern heavy railway splice plates, having six holes per plate. Adapted for punching through flat or angle plates. All six holes at one time. Punches and dies adjustable over length to 45″. Sliding-heads driven independently by separate levers, operated by patent toggle-joint stop, so that one or both punching heads can be used as desired. Slides of cast-steel.

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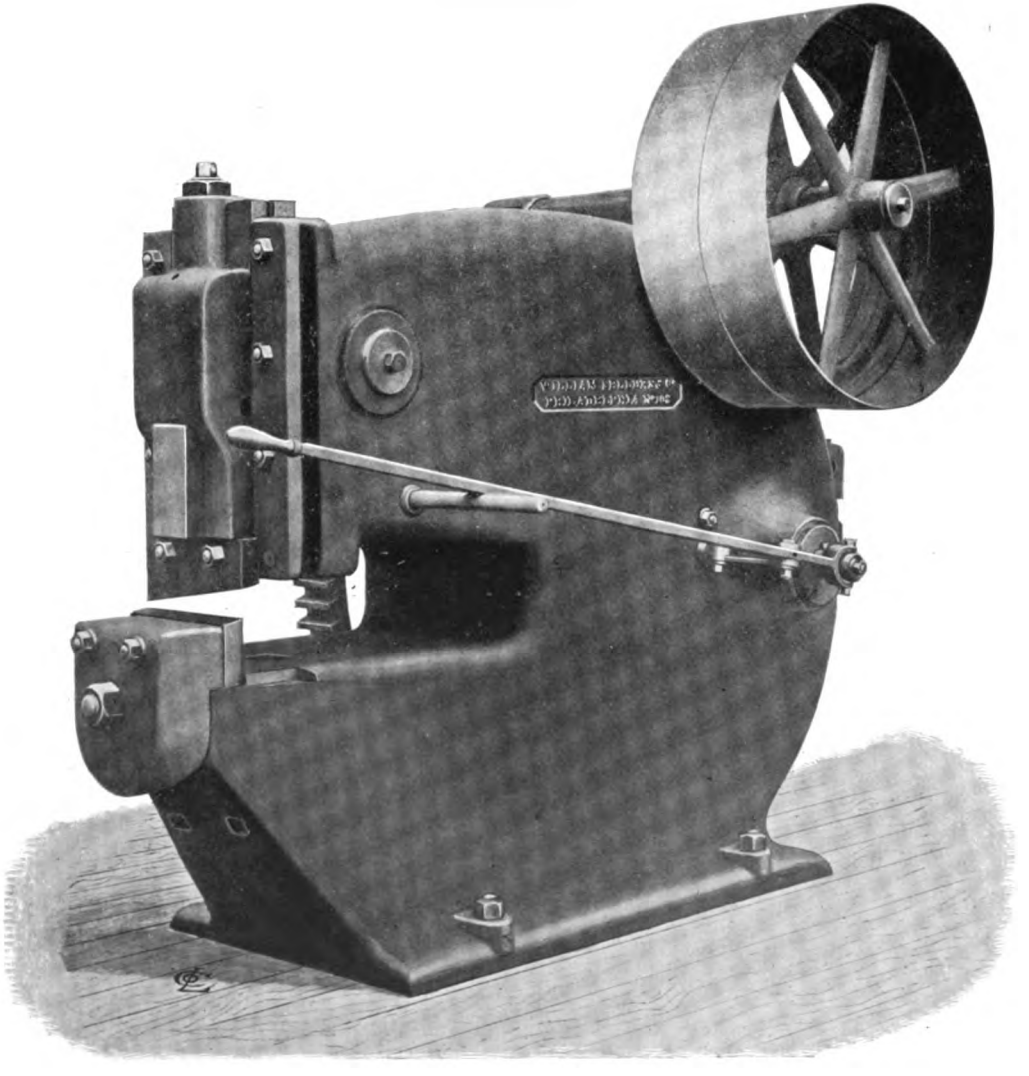


CRANK MOTION SHEAR.—18″ OVERREACH.

This machine is driven by an eccentric shaft, not by a vibrating lever. It is capable of shearing $\frac{3}{4}''$ plate, and has $36'' \times 7''$ fast and loose pulleys, and should make about 150 revolutions per minute.

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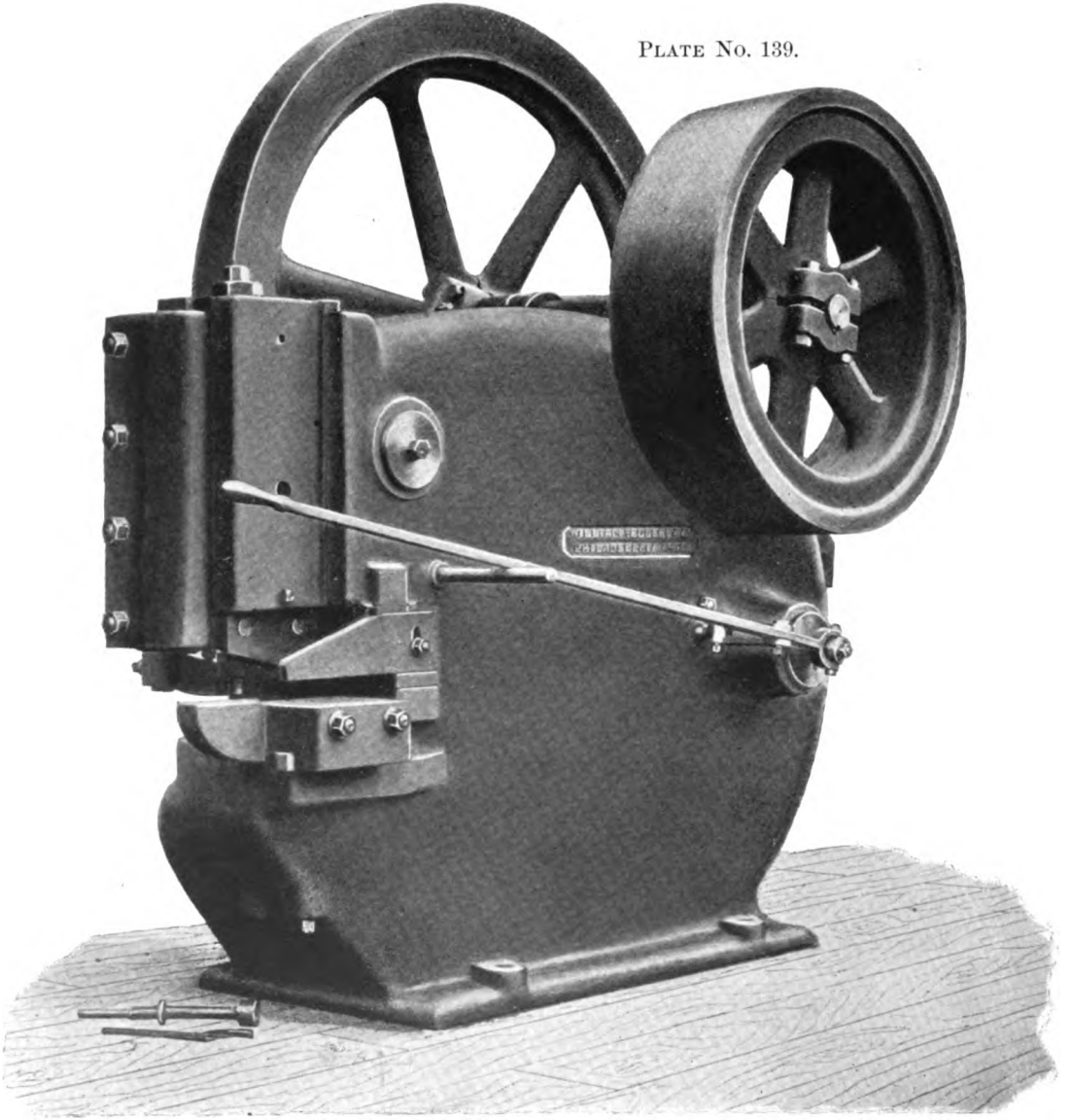
PLATE NO. 138.



SHEARING MACHINE.—26″ OVERREACH.

Adapted for shearing 1¼″ plate. 36″ x 7″ fast and loose pulleys. Should make 144 revolutions per minute. May also be arranged to shear 2″ plate. 22″ housing.

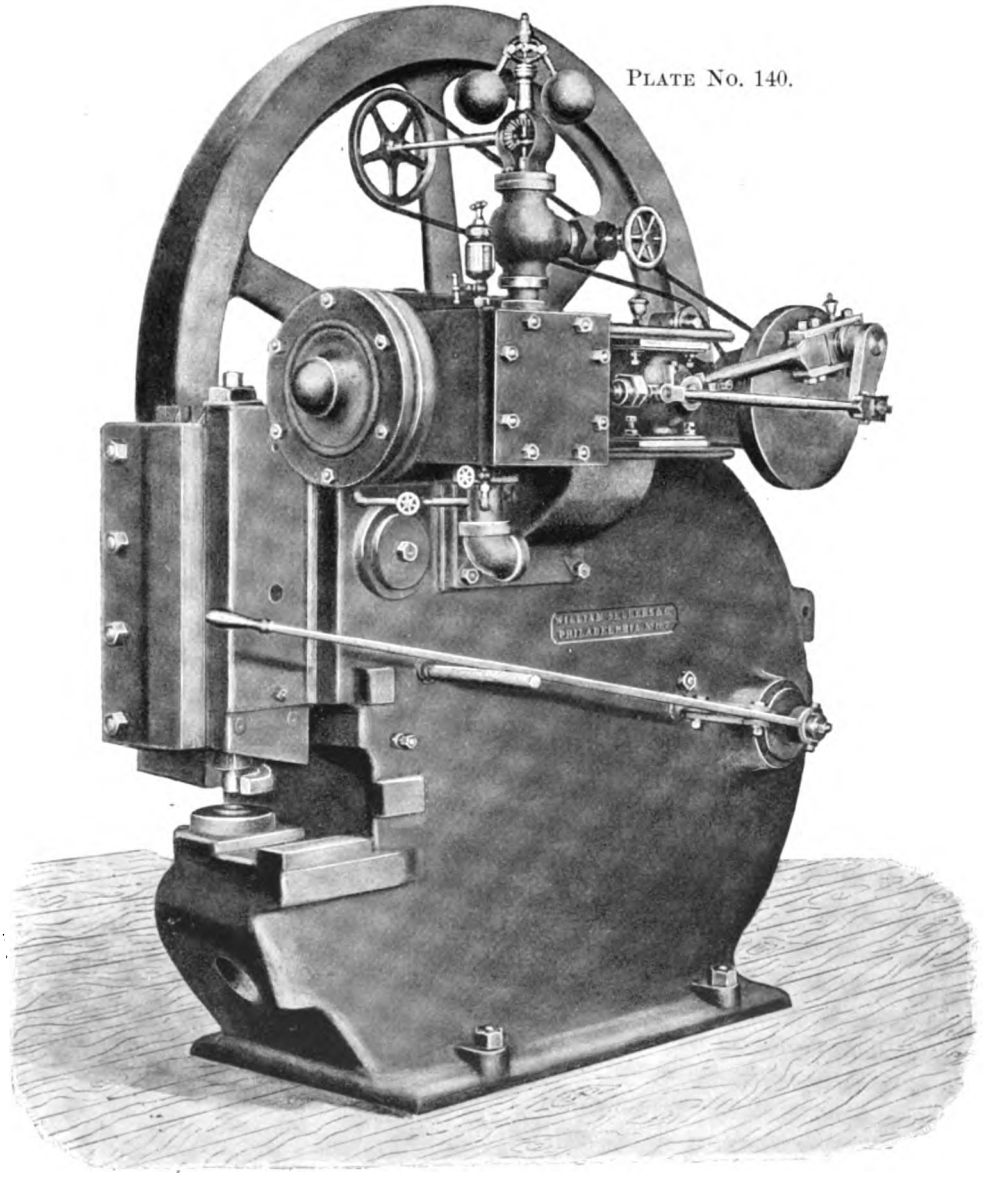
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BAR SHEAR, WITH PUNCHING ATTACHMENT.

Driven by belt. Will punch 2″ hole in 1½″ plate, or shear 6″ x 1½″ bar at one stroke.

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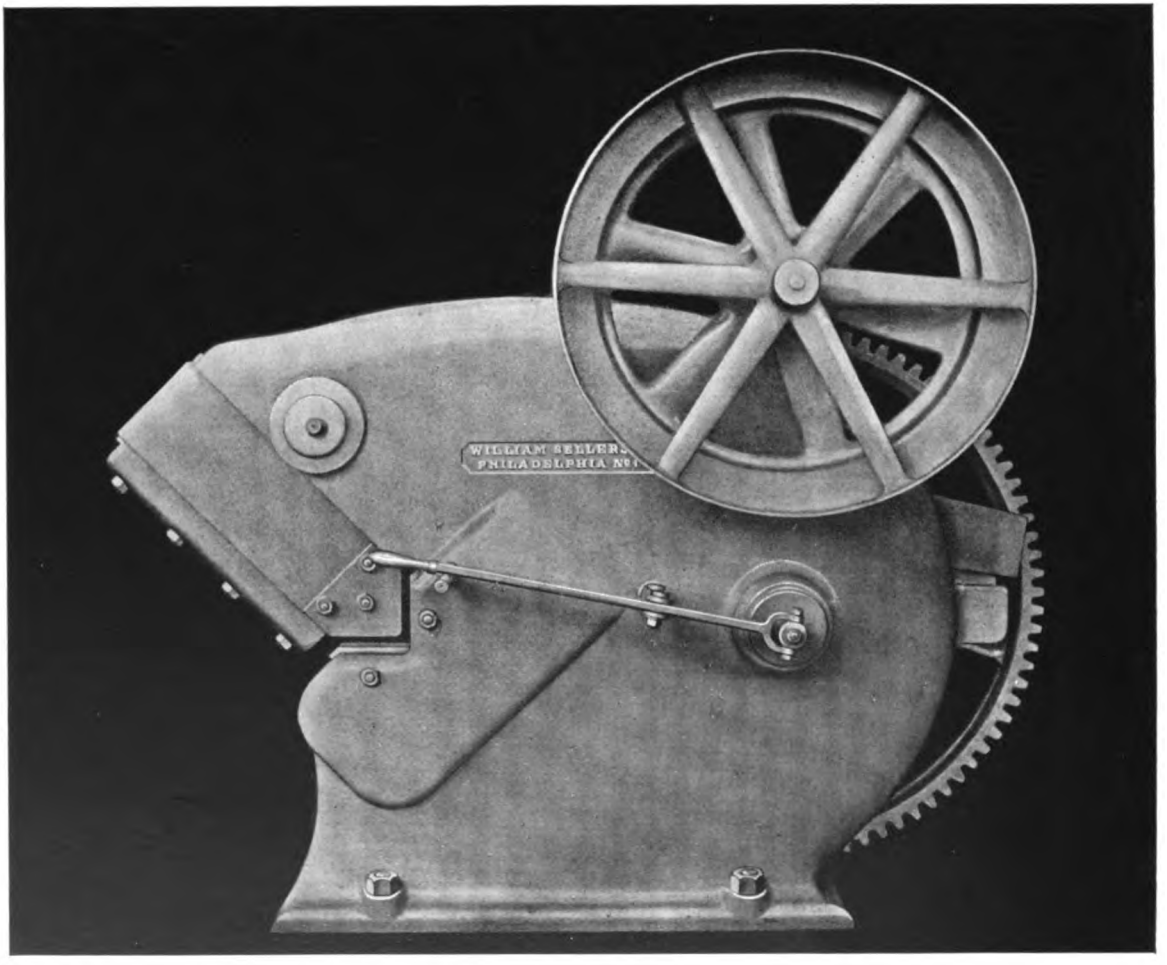


BAR SHEAR, WITH PUNCHING ATTACHMENT.

Driven by independent engine. Will punch 2″ hole in 1½″ plate, or shear 6″ x 1½″ bar at one stroke.

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PLATE NO. 141.

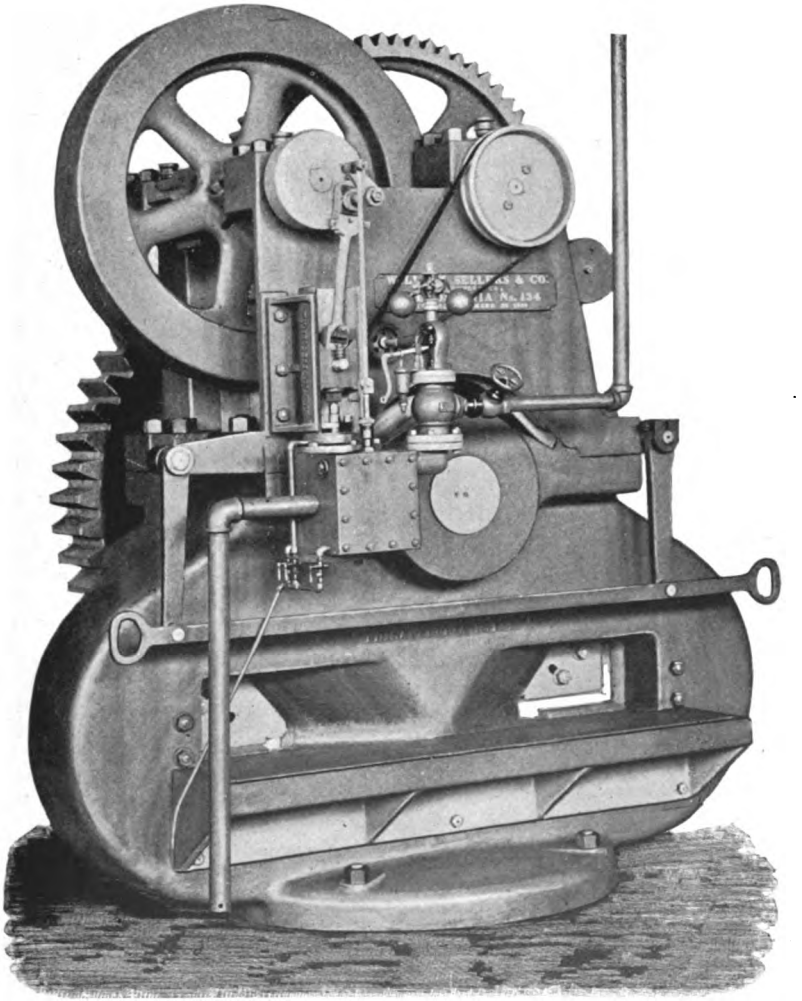


ANGLE SHEARING MACHINE.

For 6″ x 6″ x 1″ angles. 42″ x 7″ pulleys. 112 revolutions per minute.

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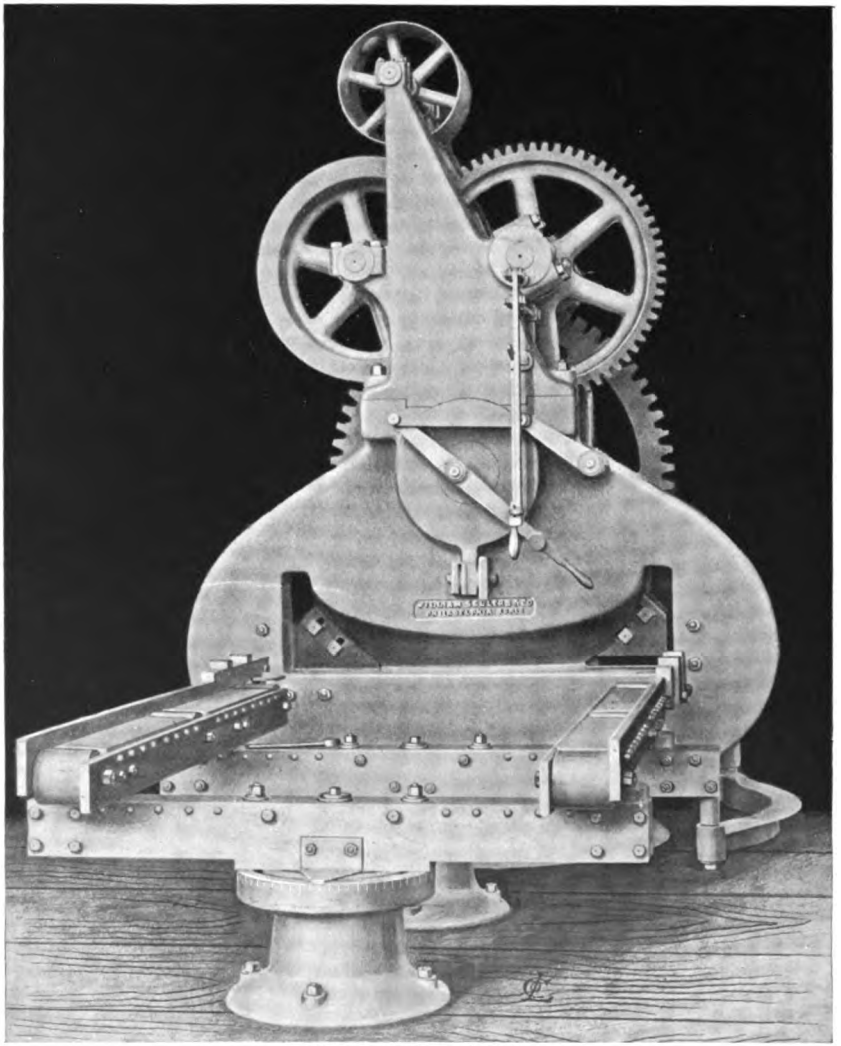


DOUBLE ANGLE SHEAR.—FOR ANGLES UP TO 8″ X 8″ X 1″, SQUARE OR BEVEL CUT

Driven by 8″ x 8″ engine attached to frame. Can be arranged for Z-bars up to 6″ x 3″ x ½″. May be arranged for plate if desired.

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PLATE NO. 143.

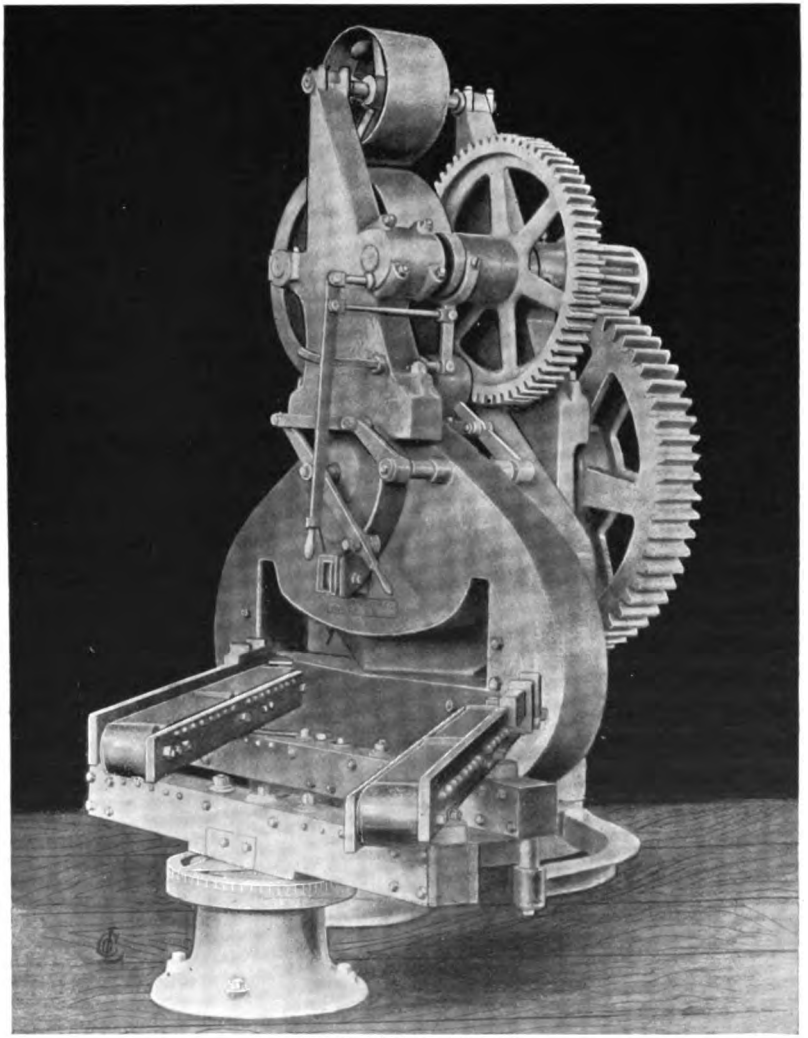


DOUBLE ANGLE SHEAR.

Arranged on swivelling base, with supporting table for work. Will shear 6″ x 6″ x 1″ angles from 30° in either direction to square, without changing the direction of the angle-iron. That is, instead of swinging the angle-iron, the machine is swivelled, thus greatly economizing shop room. Driven by belts from countershaft overhead. Safety arrangement prevents danger of throwing in wrong slide.

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PLATE NO. 144.



DOUBLE ANGLE SHEAR.

Arranged on swivelling base, with supporting table for work. Will shear 6″ x 6″ x 1″ angles from 30° in either direction to square, without changing the direction of the angle-iron. That is, instead of swinging the angle-iron, the machine is swivelled, thus greatly economizing shop room. Driven by belts from countershaft overhead. Safety arrangement prevents danger of throwing in wrong slide.

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60″ Plate Shearing Machine.

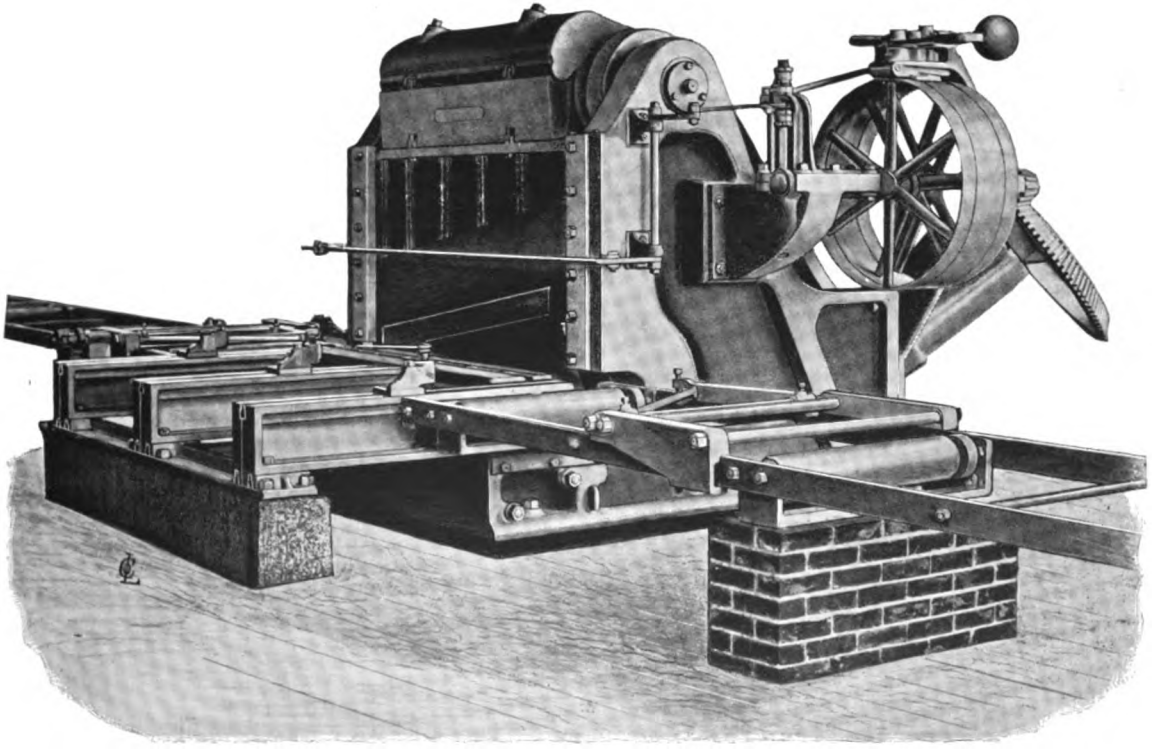
"RECOMMENDED for great originality in its arrangement, the excellence of its general design, and the admirable manner in which various ideas have been combined and reduced into a harmonious, sound, and convenient, practical tool; also, for convenient arrangement to afford handy manipulation, precision in cutting to any determined point upon a line (the determining motions being automatic), and for skilful distribution of the shearing strains and their entire expenditure within the structure."—*See Introduction*, pages 6 to 12.



HIS machine is especially adapted to meet the wants of modern bridge construction and ship-building. The plate clamped to place can be sheared with exceeding exactness, either in trimming the edges of long plates or cutting off plates up to 5″ wide to suitable lengths. The driving device is similar to the well-known arrangement of our planers; a spiral pinion gearing into a toothed segment produces the motion of the cross-slide between the uprights, an automatic stopping device being provided to stop the shear in its highest position, and to reverse it when it has attained its lowest. That is, it makes its down stroke, immediately reascends, then stops to wait for the readjustment of the plate. A hand-rod in front of the machine is convenient to shift the belts and start the cut. The machine is so constructed as to have its strains all within itself, and is not in any great measure dependent upon foundations for rigidity. Curved blades can be placed on the vertical slide for trimming curved work. Long plates are moved and guided by spacing carriage; the weight of the plates being taken upon rollers at convenient distances, and suitable clamps being arranged to lock the plate at the moment the shear enters. The stroke of the shear is adjustable and the reversing speed is double that of cutting. The descending plate can be stopped at any point desired and reversed, or the motion continued as required. That is, the shear is thoroughly under control and may be stopped and started as desired, even after it has entered a cut.

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PLATE No. 145.



60″ PLATE SHEARING MACHINE.

For trimming edges of long plates or cutting off to length plates 5′ wide. Will shear wrought-iron plates 1″ thick. Cutting blade adjustable in length of stroke, returning at double the speed of its down stroke. Counter has 24″ pulleys, 7″ face. 272 revolutions per minute.

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Steam Hammers.

"RECOMMENDED for general excellence of construction throughout, more especially for originality in the form and arrangement of the working hammer, and likewise the hammer head, and for the manner in which the head is secured to the hammer, and for the practical results which flow from the arrangements, and the convenience of fixing and unfixing which the combination affords. For originality in the mode of working the steam-valve, and for the introduction of several marked improvements in connection therewith, by which the steam part of the apparatus is put under favorable conditions for efficiency, either for automatic working or by hand, and by which the blow is effectually controlled."—*See Introduction*, pages 6 to 12.

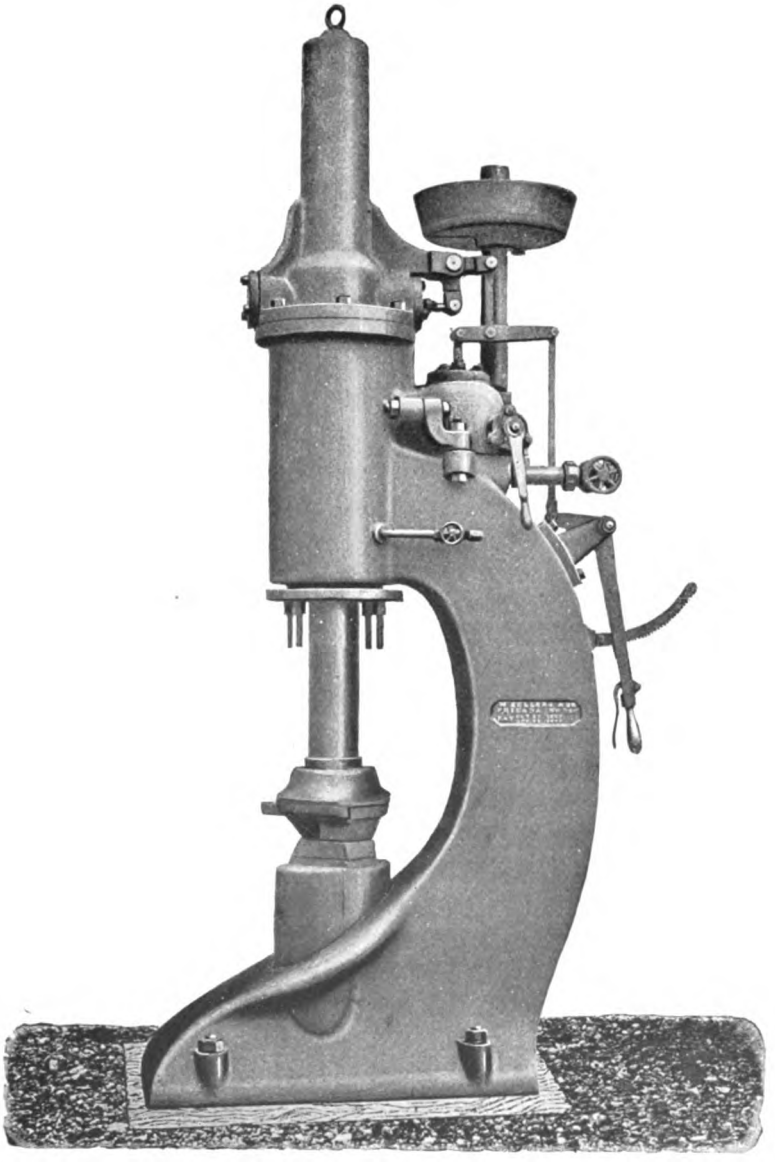


HERE are two distinct types of direct-acting steam hammers. One in which the weight of the falling mass is concentrated in a head or "tup," which works between guiding surfaces, and is connected by a piston-rod of relatively small diameter with the steam-piston in a cylinder situated above it. The other type, known as the Morrison from the name of its inventor, arranges the falling mass in the form of a large cylindrical bar, of which the piston is an integral part, and is situated near the centre of the length, so that the bar extends above the piston and passes through the upper cylinder head. Hammer bars of this type are guided in the upper and lower heads of the cylinder.

When, in 1861, we first began the manufacture of steam hammers, we selected the Morrison type because in our judgment it possessed marked advantages, and this view our experience has since confirmed. It seemed to us that a bar of such massive construction was better able to sustain the various shocks to which a steam hammer is subjected than the slender piston-rod employed in the other type of hammer, while the absence of guides gave unrestricted access to the anvil block from all sides; the strains being concentrated within the frame at the cylinder, instead of divided between the cylinder and the guides, as in the ordinary hammer. We have made many improvements in these hammers during the years that have

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PLATE NO. 146.

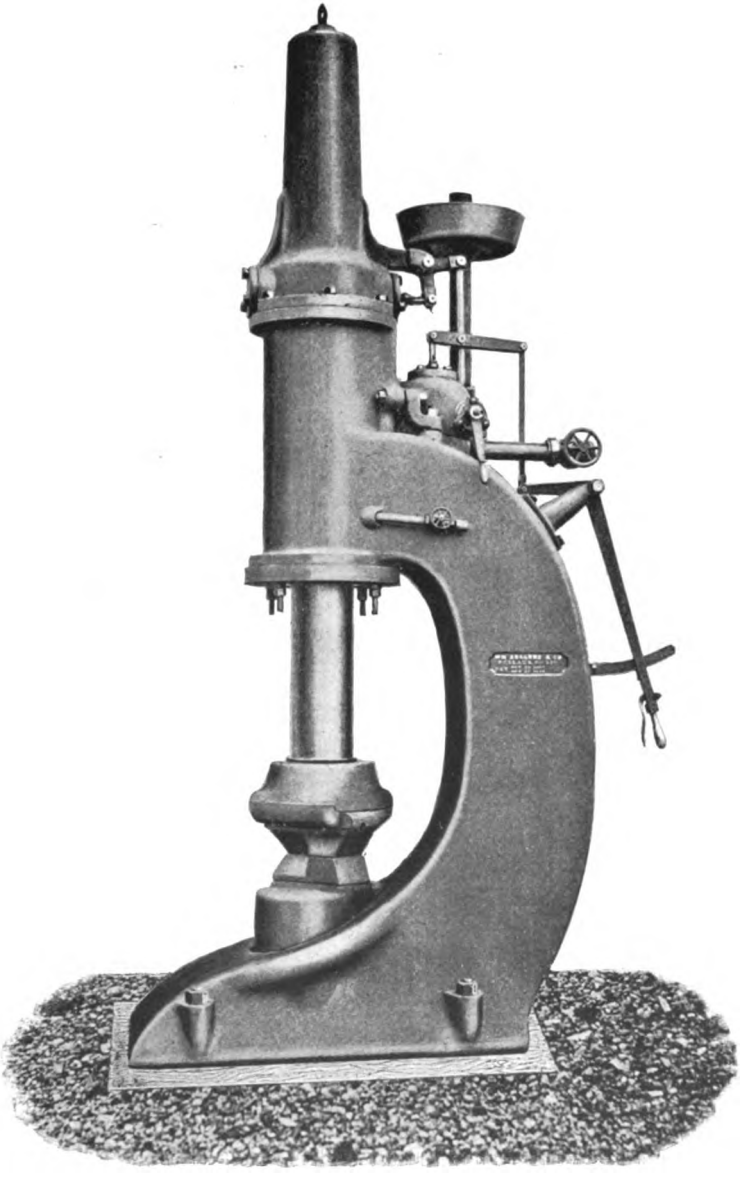


400-LB. HAND AND SELF-ACTING STEAM HAMMER.—10" CYLINDER, 15½" STROKE.

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elapsed since we first began their manufacture, all of which have tended to increase the efficiency and durability of the hammer. We early dispensed with the forged head, with which the English hammers were originally made, and which involved making the lower cylinder head in halves; we secure the hammer head by means of a circular taper wedge, which enables us to set the dovetail at any desired angle, and to renew the head in case the dovetail should be injured by careless keying or in other ways. We have adopted the box form of upright through the whole series of hammers, in place of the I-beam section formerly used, as we think the hollow box is particularly adapted for this purpose. We use an improved balanced piston-valve, packed with steel rings working in perforated bushing. The valve motion is exceedingly simple, and not likely to get out of adjustment. In order to insure a full exhaust, which is a very important matter, especially where the exhaust pipes are long, we have adopted the Collin's patent exhaust arrangement, and furnish with our hammers a suitable nozzle and exhaust pan with pipe connections. In setting up the hammer a thin sheet-iron exhaust pipe should be used, suspended directly over the pan, but not resting upon it. The exhaust pipe is thus relieved of the strain due to the shaking of the hammer, which is injurious to the pipe and tends to choke the exhaust, while at the same time the condensed steam falls down the sides of the pipe to the pan, whence it finds its way to the drain, and is not thrown in a shower upon the roof, as is usually the case. We furnish with our hammers, unless specially ordered, top and bottom dies of steel castings. For the smaller hammers these are made with peening faces at one end,—that is, for about half its length, the die is narrowed to about half its full width. If required, we can furnish plain dies, or those with parallel sides, in place of those described above. For large hammers, it is generally customary to use the plain dies only. For securing the dies to the anvil block, we recommend the use of crimped steel keys of uniform thickness, that is, without taper, which hold the dies by elastic pressure only. With such keys no injury can be done to the dovetail, but they require to be recrimped from time to time in order to retain their elasticity.

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1250-LB. HAND AND SELF-ACTING STEAM HAMMER.—11⅞" CYLINDER, 20" STROKE.

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In rating our hammers, we call them by the weight of the falling parts, and not, as is sometimes done, by the assumed value in pounds at which the blow of the hammer is estimated. For example, our 400-pound hammer has a bar which, together with the hammer-head and upper die, weighs 400 pounds. To this, of course, is added the pressure of the steam acting on the piston through the whole length of the stroke.

Single-Upright Steam Hammers.

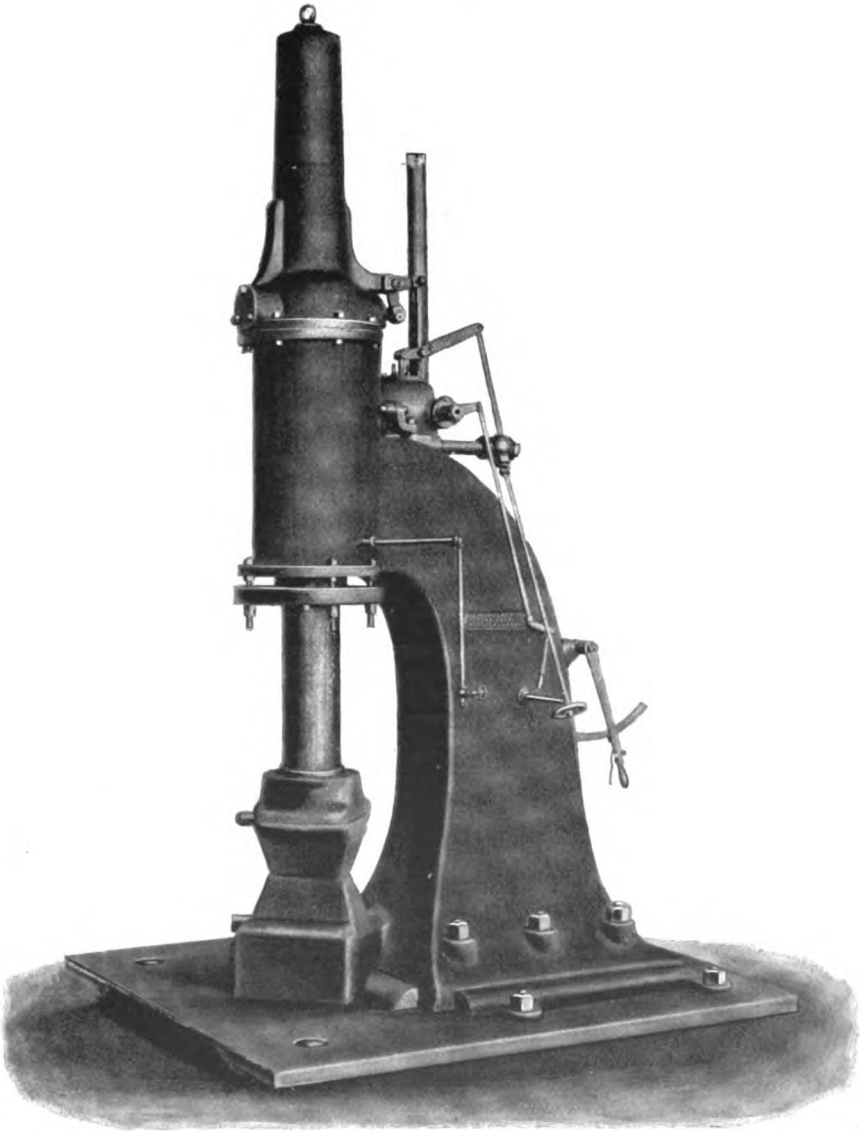
Our smaller hammers, from 400 pounds up to 3150 pounds weight of bar, are made with a single leg or upright and overhanging cylinder, and unless specially ordered they are provided with automatic valve-gear. The automatic motion in these hammers is obtained from two inclined grooves diametrically opposite each other in the upper part of the bar, which are made to work a brass yoke, whose line of movement passes through the axis of the bar. The horizontal movement of this yoke is transmitted through a bell-crank to the lever which operates the valve in the steam-chest. When the hand-lever is latched in a given position, the movement of the hammer up and down causes a corresponding movement of the valve in the steam-chest, and the hammer will continue to strike with a length of stroke depending upon the point at which the hand-lever is latched.

Double-Upright Steam Hammers.

Our hammers of more than 3150 pounds weight of bar are rated, for convenience, in tons of 2000 pounds each, and are made with two legs or uprights, the cylinder being a separate casting bolted between the uprights, which are arranged with flanges to enclose those on the cylinder. These flanges are secured together with short bolts, except at the bottom, where a long steel bolt is used, passing through both uprights and having a nut at each end. To keep this bolt cool and prevent undue expansion, we provide an air circulation around it through proper openings. The uprights are of hollow box construction, and each consists of a

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PLATE NO. 148.



1700-LB. HAND AND SELF-ACTING STEAM HAMMER.—13″ CYLINDER, 23″ STROKE.
SEPARATE BED-PLATE.

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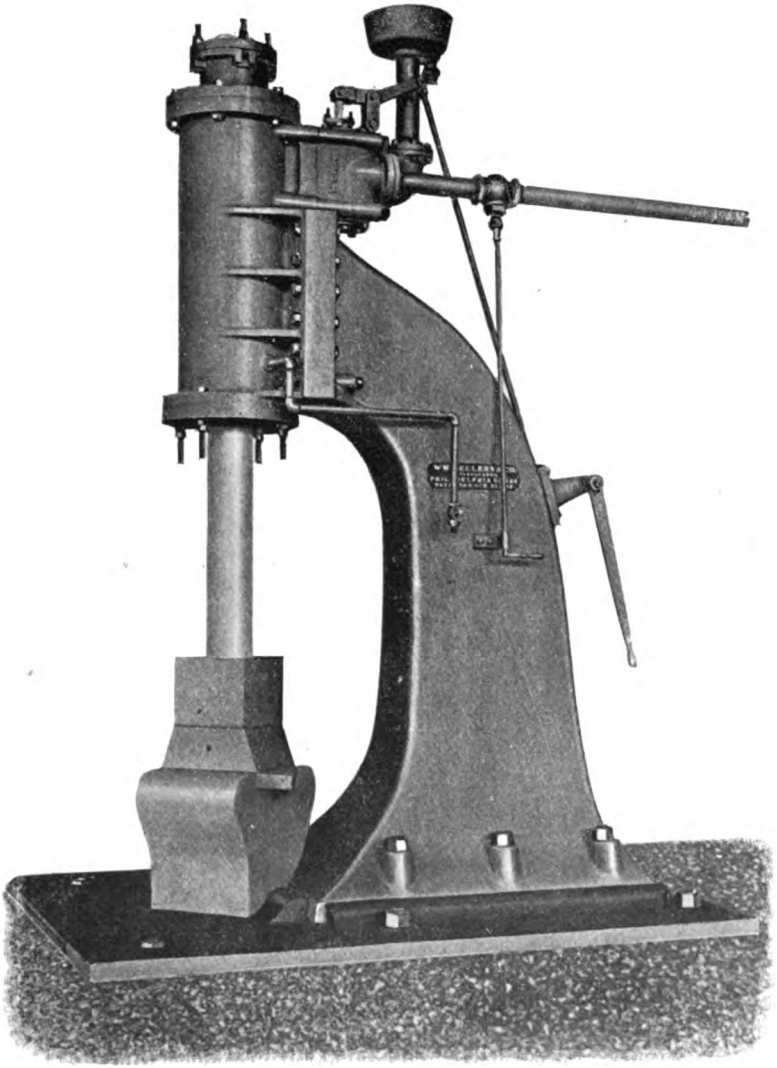
curved and a straight portion. The straight or lower part is bolted securely to the foundation plate, and is also connected to the upper or curved part by through-bolts. This separation into two parts strengthens the uprights and eliminates the danger of breakage by unequal expansion. The steam-chest in these hammers is situated over one of the uprights, so that the cranes for handling work may be brought up close to the cylinder on either side without interference. The upper portion of the bar has a flat face, which, fitting the top cylinder head, serves to guide the bar and prevent it from turning.

We would call especial attention to the ample room around the anvil block and under the cylinder, which allows free access and greatly facilitates handling large work. The loose head which holds the hammer die is secured to the bar by the taper wedge-ring used on the smaller sizes. If properly put on, this arrangement holds the head with great security, and will even carry special forging dies of great additional weight.

Sizes of Steam Hammers.

Size or Weight of Hammer Ram.	Length of Stroke.	Height under Frame.	Width between Frames.	Hammer Face.
400 lb.	15½″	SINGLE UPRIGHT.	SINGLE UPRIGHT.	6¾″ x 4½″
750 "	18″			8½″ x 5½″
1250 "	20″			9″ x 5¾″
1700 "	23″			10¼″ x 6″
2500 "	30″			13½″ x 8″
3150 "	30″			13½″ x 8″
1¾ ton.	3′ 2″	6′ 10″	7′ 6″	16½″ x 10″
2¼ "	3′ 6″	7′ 3¾″	8′ ½″	17¾″ x 11″
3 "	3′ 11½″	7′ 10¼″	9′ 2″	19½″ x 12″
4 "	4′ 6½″	8′ 5½″	9′ 8¼″	21¼″ x 13″
5 "	5′	9′ ½″	11′ 3″	22½″ x 14″
6 "	5′ 6″	9′ 8″	12′ 6″	24″ x 14¾″
7 "	5′ 10″	10′ 8¾″	13′	26″ x 16″
10 "	7′	11′ 9″	14′ 8″	29½″ x 18″

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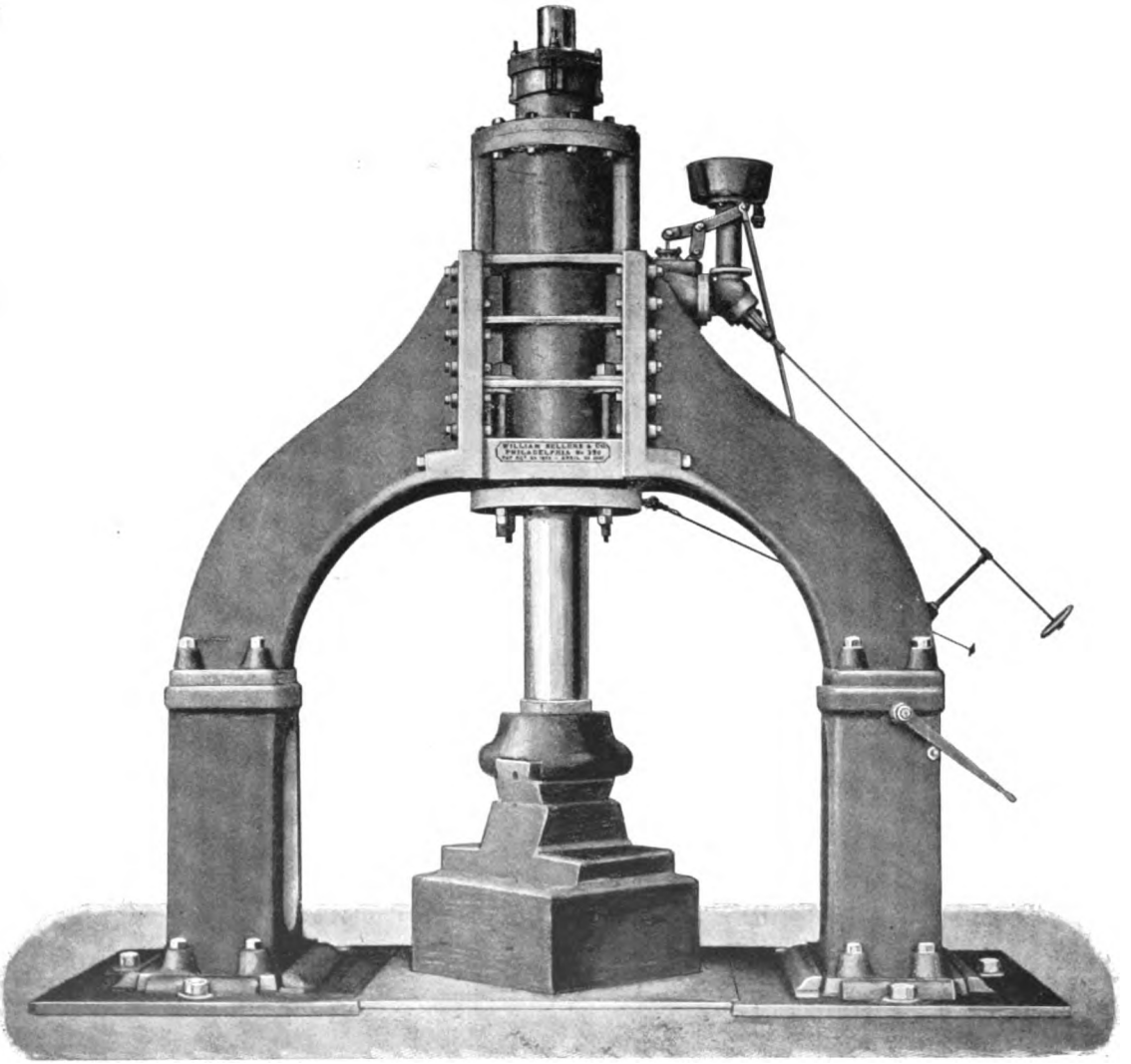


1100-LB. HAND-ACTING STEAM HAMMER—11⅞" CYLINDER, 30" STROKE.
WITH SEPARATE BED-PLATE.

Intended for welding locomotive side-frames and similar work requiring long stroke and considerable overreach.

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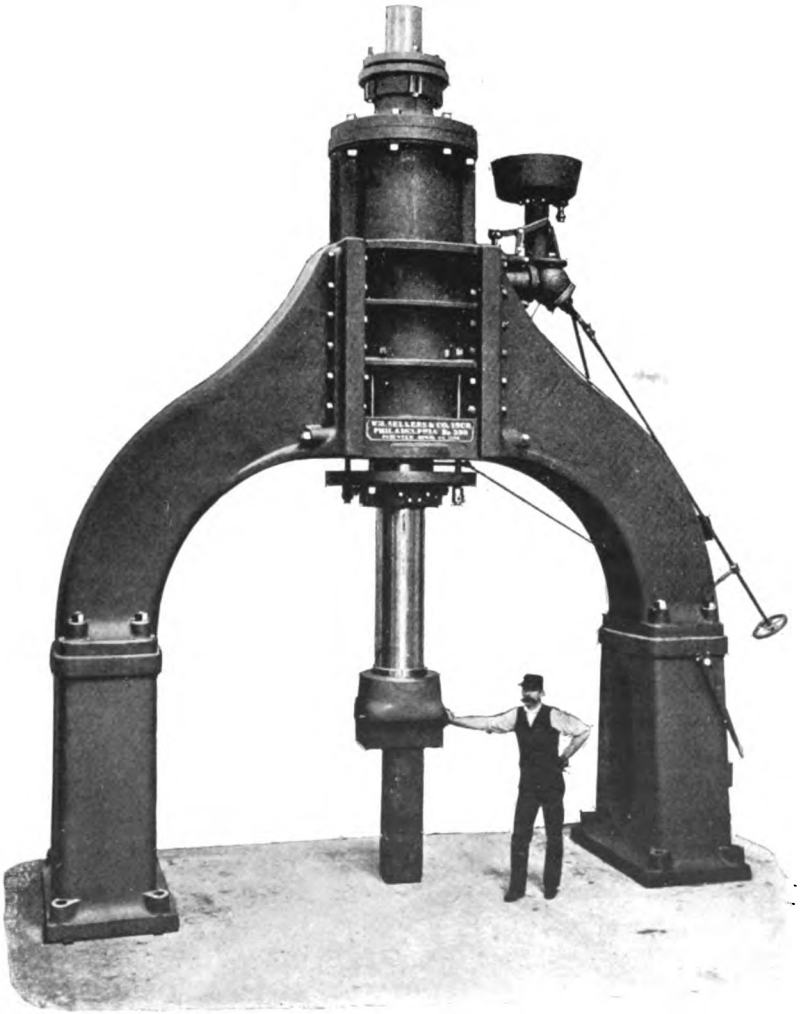
PLATE NO. 150.



2½-TON HAND-ACTING STEAM HAMMER.—20⅝" CYLINDER, 3' 6" STROKE.
BED AND ANVIL BLOCK IN POSITION.

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PLATE NO. 151.



7-TON HAND-ACTING STEAM HAMMER.—33" CYLINDER, 5' 10" STROKE.
BED-PLATE AND ANVIL BLOCK NOT SHOWN IN PLATE.

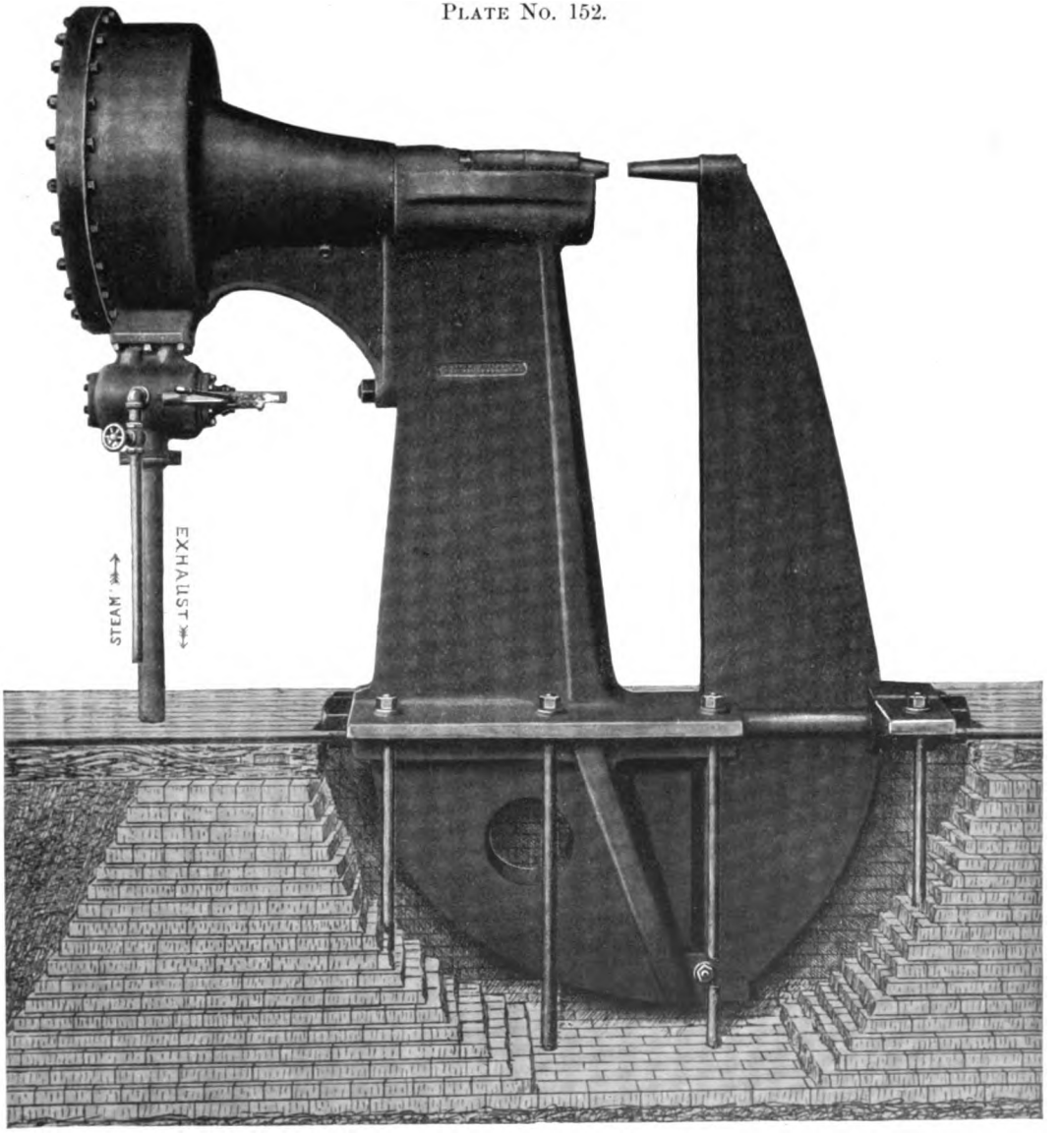
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Riveting Machines.

IN the various editions of our treatise on machine tools, we considered it wise to present very fully the arguments which, in our judgment, demonstrated the superiority of rivets driven by pressure over those driven by impact; but our view has been so fully sustained by general experience, and the superiority of the pressure-driven rivet is so universally acknowledged, that it does not seem necessary at this time to repeat the arguments formerly advanced, or to define our position on a question no longer in dispute. We desire, however, to point out the distinction which exists between driving a rivet by pressure only, and forming the head on such a rivet by a succession of blows applied either by a hand or power hammer. In one case the rivet is squeezed into shape and in the other it is hammered into the form required. In the squeezed rivet, the shank is upset so as to fill the hole completely before the head is formed, and the plates are brought in close contact; but in hammering, either by hand or power, the head is formed without necessarily upsetting the shank throughout its length; the rivet is almost certain to be loose in some part of the hole, especially if the punching does not match exactly, and the plates are not clamped together with the same solidity which is attained in pressure driving. A properly designed steam riveter will produce exactly the same quality of work as that made by the hydraulic riveter, it being only necessary to enlarge the cylinder in proportion to the lower pressure of fluid which is used, and to so proportion the valve and steam pipes that the movement of the ram will not be too quick.

In regard to the amount of pressure required for riveting, there seems to be a considerable difference of opinion, resulting from differences of requirements and of practice. The character of the work to be done, the size and form of the rivet-

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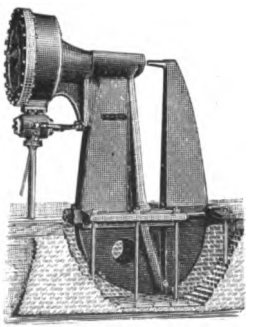


STEAM RIVETING MACHINE.—36" CYLINDER, 6 FEET GAP. WITH FORGED-STEEL STAKE.

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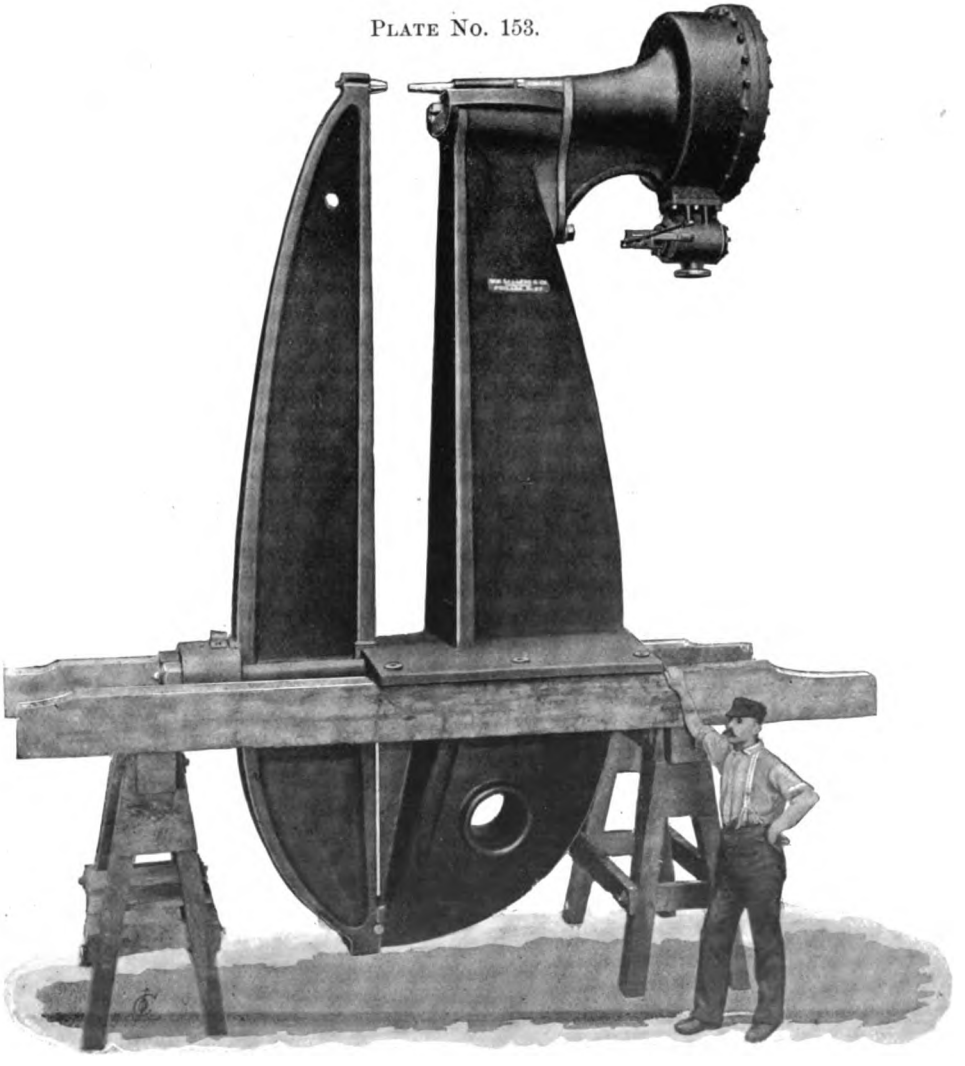
heads, and the temperature of the rivets used, all affect the amount of power required. Where the work requires to be steam-tight, more pressure is necessary than in bridge or girder work. Some experiments recently tried seemed to demonstrate that for boiler-work with rivets having very large heads, eighty tons per square inch of rivet section is amply sufficient to produce tight work, and an increase of pressure above this point was found to be injurious, and as much to be avoided as too little pressure.

Our regular stationary riveters are built with separate cylinders, arranged so that they may be converted from steam to hydraulic or the reverse. They are made of as few parts as possible, and all unnecessary complication is avoided. The greatest care is taken in the selection and testing of material, and extensive use is made of steel castings, which are made to our specifications and carefully annealed. Our usual sizes of stationary riveters vary from five feet to ten feet in gap, by differences of one foot; but our patterns are adapted for a variety of proportions, and we can meet almost any requirements as to depth of gap or width of space between uprights.



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PLATE No. 153.



STEAM RIVETING MACHINE.—36" CYLINDER, 10 FEET GAP. WITH CAST-STEEL STAKE.

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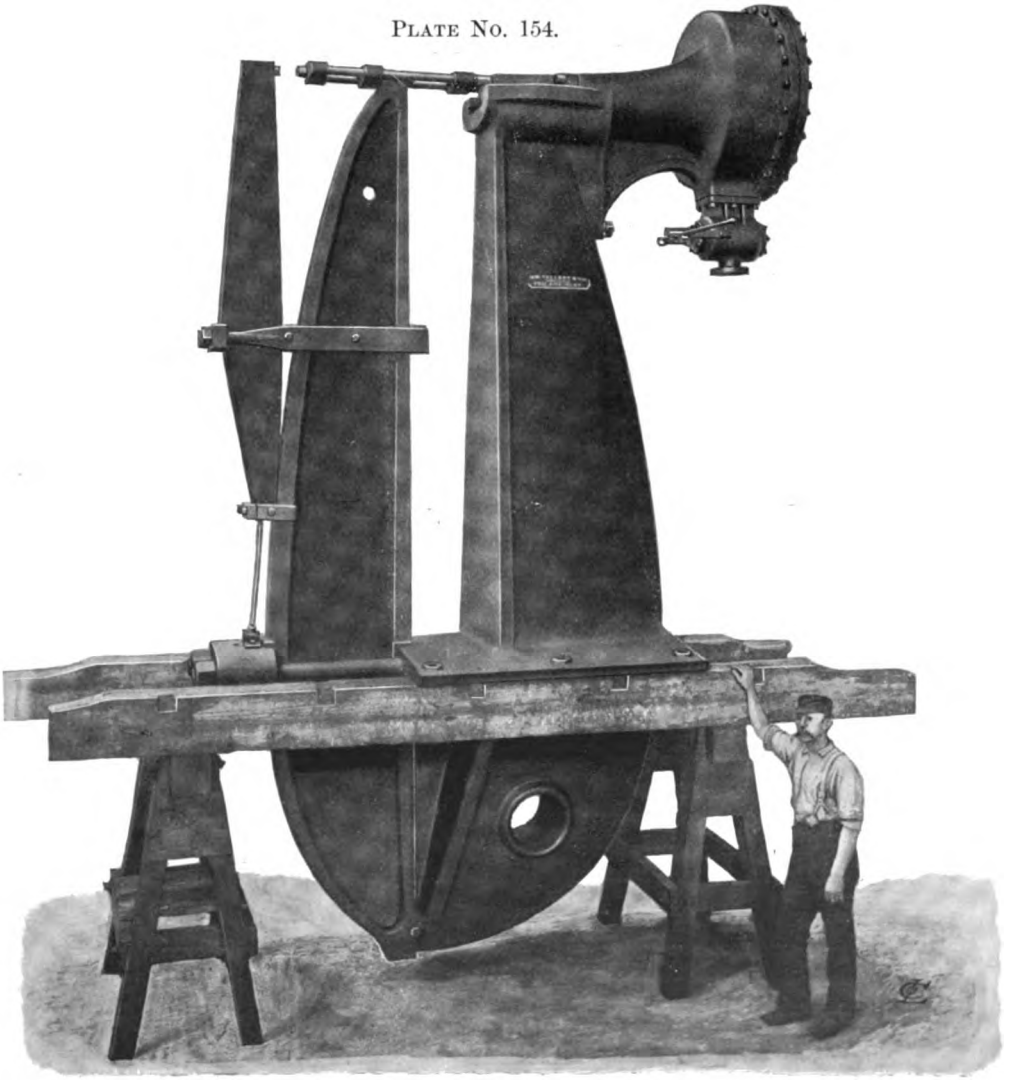
Steam Riveting Machines.

AS previously stated, a steam riveter, properly designed and constructed, will do as good work as any hydraulic machine, and in many establishments it is more advantageous to introduce a steam riveter than a hydraulic one. The construction and operation of the steam riveter are readily understood by any mechanic familiar with the steam-engine; but when hydraulic machinery is introduced into an establishment, the employees are obliged to use and care for a new type of machine, and must acquire a certain amount of experience and special training before the work will move smoothly. Adding a steam riveter to a boiler plant does not involve the introduction of the pumping machinery, accumulator, and piping required for a hydraulic machine, and there is no risk of freezing and breaking of cylinders in cold weather, which is a common experience when hydraulic machinery is intrusted to unskilled hands.

Our steam riveters are usually made with cylinders of 36″ or 42″ diameter. The steam chest is provided with a cylindrical piston-valve, perfectly balanced and packed with steel rings working in a perforated bushing. A by-pass through the valve permits the steam used for making a stroke to pass to the other side of the piston, and by expanding, draw back the die ready for the next stroke. Or, if it be desired to admit live steam for this purpose, a movement of the hand-lever beyond the ordinary end-stop admits the steam required to retract the piston. This, of course, is only necessary when the cylinder is cold, as in first starting. The steam riveters shown in the accompanying illustrations are each formed of a massive cast-iron upright, with a separate stake of forged or cast-steel. We, however, also build these machines with both parts of the frame made of steel castings; the construction being similar to that shown in Plate No. 156.

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PLATE NO. 154.



STEAM RIVETING MACHINE.—36" CYLINDER, 10 FEET GAP. WITH SUPPLEMENTAL STAKE FOR SMALL FLUES.

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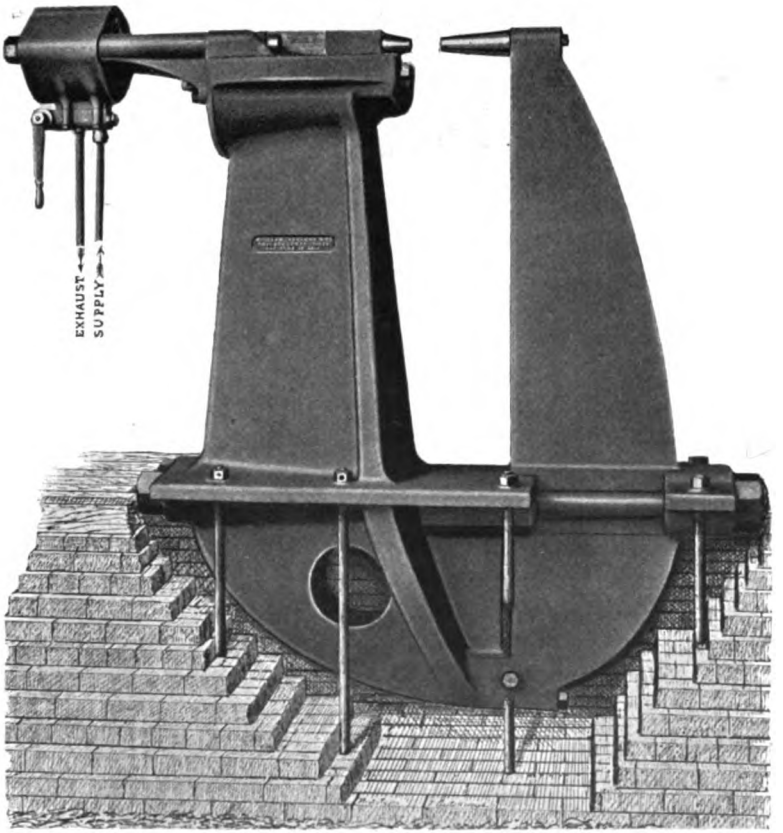
Hydraulic Riveting Machines.

IN establishments having hydraulic equipments or those employing a number of riveting machines, the objections mentioned do not prevail to the same extent. The cost of the pumping plant is not so large a factor in the total cost, as it is not likely that all of the machines will be used at their maximum capacity at the same time, and the capacity of the pumps and accumulators need not be equal to the combined requirement of all the machines they serve. Then, too, the size of the plant will permit the employment of a corps of men skilled in the use and maintenance of hydraulic machinery. Under such circumstances the hydraulic system has many advantages, and especially lends itself to relatively distant transmission and to a variety of uses. Probably the most important particular in hydraulic machinery is the packing, and its accessibility for repair and renewal is a great practical consideration in selecting machines of this character. The life of any form of packing is limited, and is governed by the speed, length of travel, and pressure at which it is worked. With the same stroke the life of a packing varies with the pressure used; at low pressures, such packings are far more durable than at very high ones; but in any event, packings must be frequently renewed, and, as they are liable to give out at critical times, it is essential that they should be quickly replaced; convenience of access is therefore essential. We have given great attention to this point, and in our latest forms of riveter every part can be reached at once without the removal of any other.

As to the utility of an auxiliary cylinder for clamping the plates together, there appears considerable diversity of opinion. In our own judgment there is no need for it in ordinary boiler and bridge work, and in these cases it complicates the machine, increases its cost and the cost of its maintenance, without adequate return;

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PLATE No. 155.



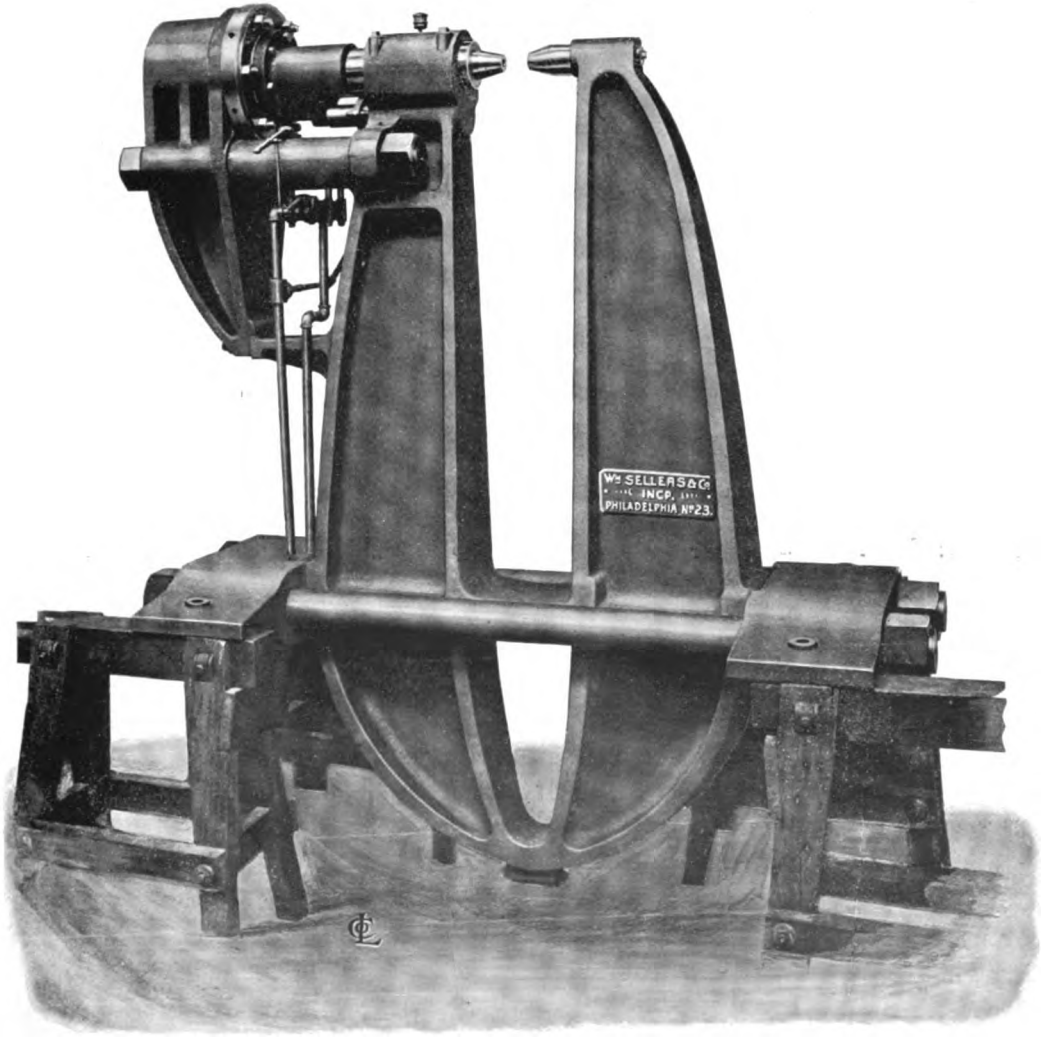
STATIONARY HYDRAULIC RIVETING MACHINE.—5 FEET GAP, 5" MAXIMUM STROKE.

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but we are not prepared to say that the plate-closer is not desirable in cases where the thickness of the plate used is excessive, as for example, in the manufacture of the heaviest class of marine boilers. In any event we are ready to meet the preferences of the purchaser, and can furnish our heavy riveters equipped with plate-closer or without, as may be required. We have adopted for this machine a closing device, which we think much superior to anything before attempted, especially in its accessibility for the renewal of packings. We can furnish the machines with this closing cylinder at a relatively slight additional cost, or they can be adapted for the addition of the plate-closing device at any subsequent period should experience demonstrate its necessity. All our packings are directly reached without removing any connections or any other parts. In the operation of our plate-closing device, pressure is admitted to the plate-closing cylinder, then to the riveting cylinder; the plate-closing cylinder is then connected to the exhaust, and, finally, the riveting plunger is withdrawn. The plate-closing cylinder being within the riveting plunger its release of pressure adds the whole of its force to the riveter plunger, which thus gives a final squeeze on the rivet with the plates pinched together. This feature is an important point in favor of our system which is not generally realized, and, further than this, our valve levers are arranged, when desired, to produce exactly the sequence in the action of the cylinders which we have described. It is often found, however, convenient to arrange the levers independently, so as to permit the plate-closing cylinder to be used as a riveter for light work. It is our practice to allow for the plate-closing cylinder one-half the full riveting pressure, thus giving the machine the advantage of two distinct riveting pressures with the same actual accumulator pressure.

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PLATE No. 156.



STATIONARY HYDRAULIC RIVETING MACHINE.—7 FEET GAP, 150 TONS PRESSURE ON DIE.
CAST-STEEL UPRIGHTS.

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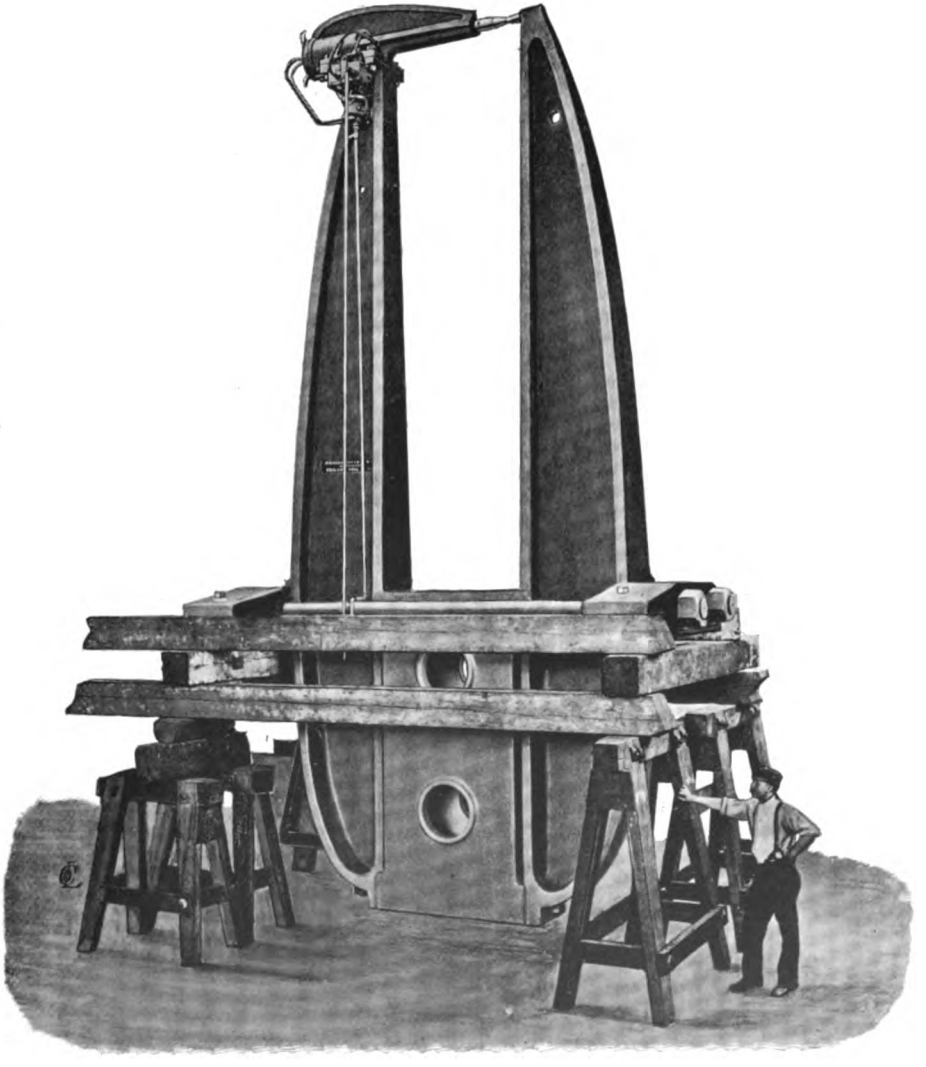
Special Hydraulic Riveting Machines.

THE hydraulic method of operating riveting machines lends itself readily to a variety of special applications to which steam is not adapted. We illustrate in the accompanying plates a few such machines, which are some of those which we have made for special work. Of these we would call particular attention to Plate No. 157, which shows an enormous riveter designed especially for work on locomotive boilers, and arranged with so wide a space between the uprights that the dome of the boiler and the corners of the fire-box will clear the uprights, thus enabling a locomotive boiler to be riveted up from one end without reversing. A novelty in this machine is the arrangement of concentric plungers, by means of which three different pressures can be given to the die with one accumulator pressure, thus covering the complete range of pressures required without the necessity of altering the load on the accumulator.

The operating valve in this machine is absolutely balanced, and the packing is accomplished through leather rings, which may be readily replaced when worn out. In addition to the operating valve, there is another by which the pressure is regulated, that is, the valve is set for the pressure desired. This valve has no packings subject to wear.

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PLATE NO. 157.

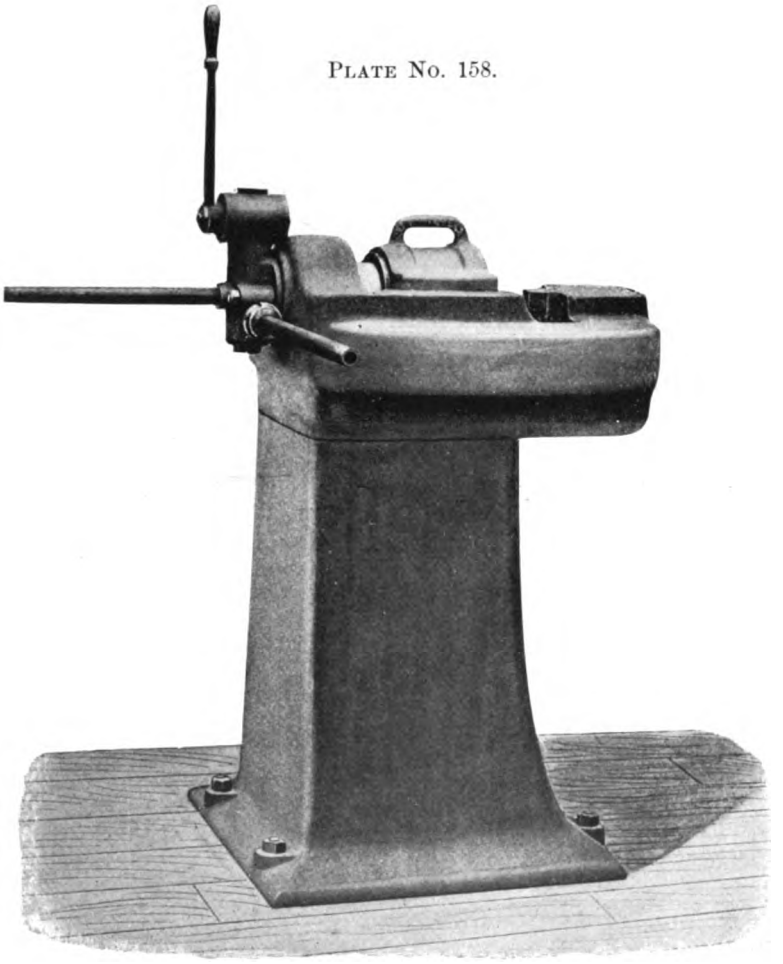


STATIONARY HYDRAULIC RIVETING MACHINE.—16½ FEET OVERREACH; STROKE, 5¼".
CAST-STEEL UPRIGHTS.

Pressure on dies adjustable for either 25, 50, or 75 tons. Especially intended for locomotive boilers.

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PLATE NO. 158.

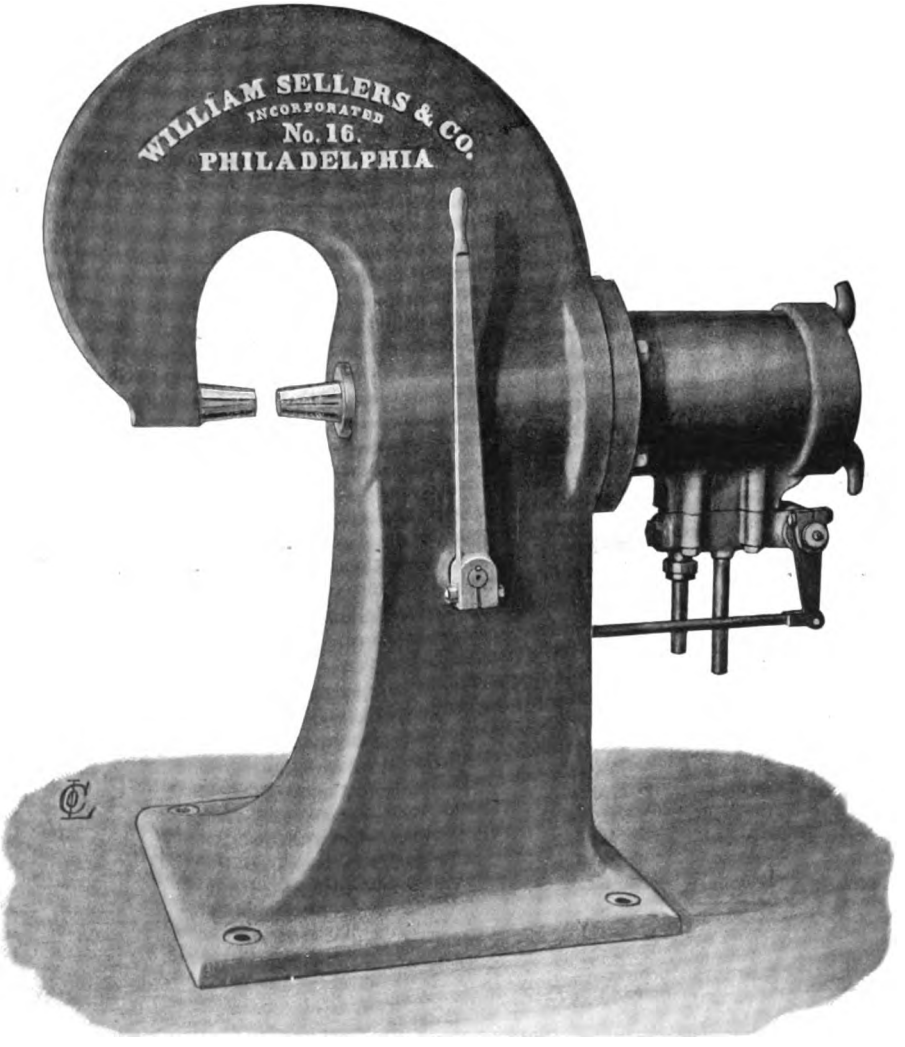


STATIONARY HYDRAULIC RIVETING MACHINE.—FOR ½" RIVETS. OVERREACH, 5".

Designed for riveting in the heads of small boilers. Will work down to 10" diameter of cylinder.

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PLATE NO. 159.



STATIONARY HYDRAULIC RIVETING MACHINE.—OVERREACH, 11″; GAP, 10″ WIDE; STROKE, 5″.

Originally built for work on iron car trucks. Packings easily accessible. Construction simple and efficient.

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Portable Riveting Machines.

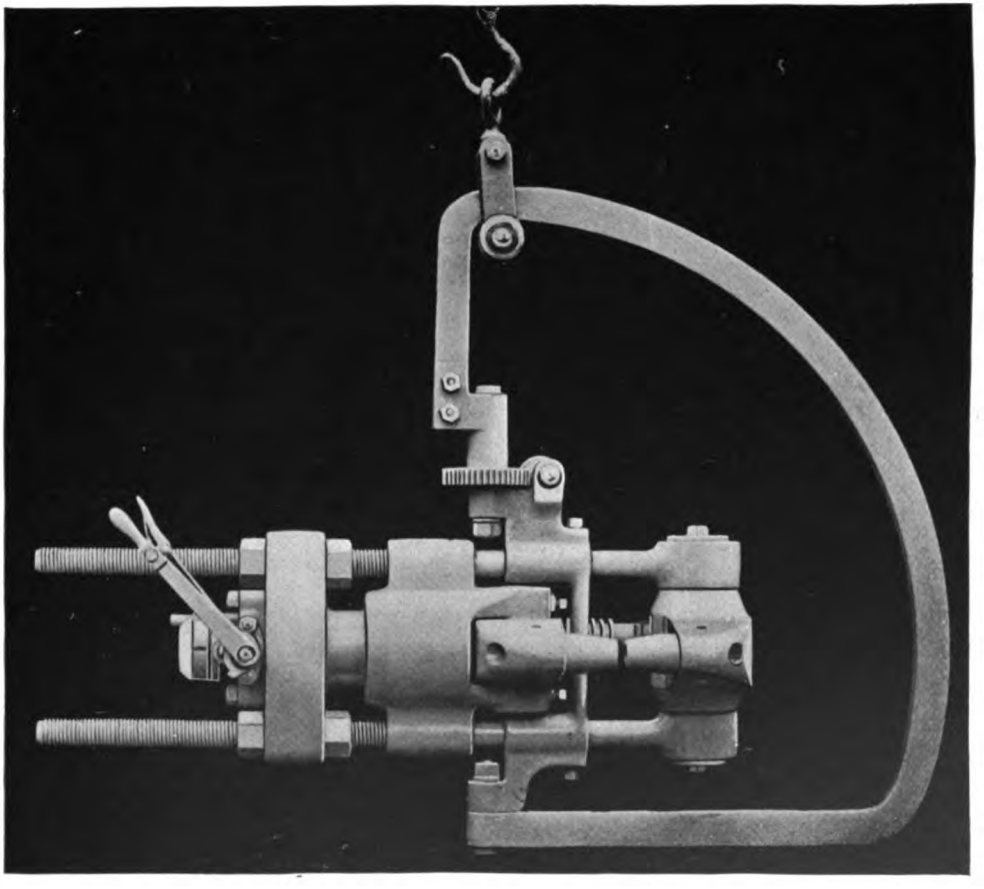
THE hydraulic system is particularly applicable to portable riveting machines, and a number of these have been made of various designs, and for many special purposes; they are either "direct-acting" or constructed with some form of jointed levers by which the dies are more conveniently arranged for working in contracted places. The machines illustrated in the accompanying plates are of the "lever type;" one lever being secured to the tension bolts and the other pivoted to the cylinder; the tension bolts being carried from the plunger by a cross-head and being guided by bearings in the sides of the cylinder.

Jam-nuts on the tension bolt permit the space between the dies to be increased or diminished to suit any given work, while the long arms of the lever are joined by a ball-and-socket connection, which is also adjustable to suit the gap required. The levers are made of different lengths in the proportion of two to one. They are thus: 6″ and 12″, 9″ and 18″, 12″ and 24″, etc.

Various arrangements are provided for suspending these machines and for bringing the high-pressure water from the accumulator. We prefer for the pressure system jointed pipes, such as are indicated in the plates, which are packed with simple leather rings, and are easily kept tight. For the exhaust, a rubber hose between points of attachment furnishes the necessary flexibility. We also make plain direct-acting portable riveting machines, especially designed for plate-girder work.

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PLATE No. 160.

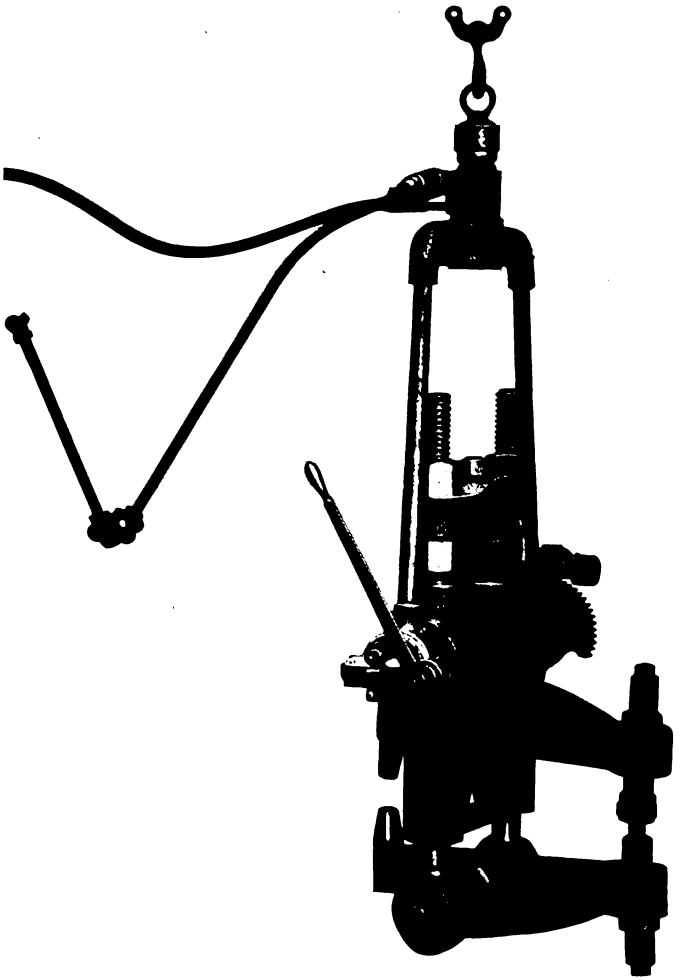


PORTABLE HYDRAULIC RIVETING MACHINE.

Arranged with Universal Hanging support, permitting riveter to be used in any direction.

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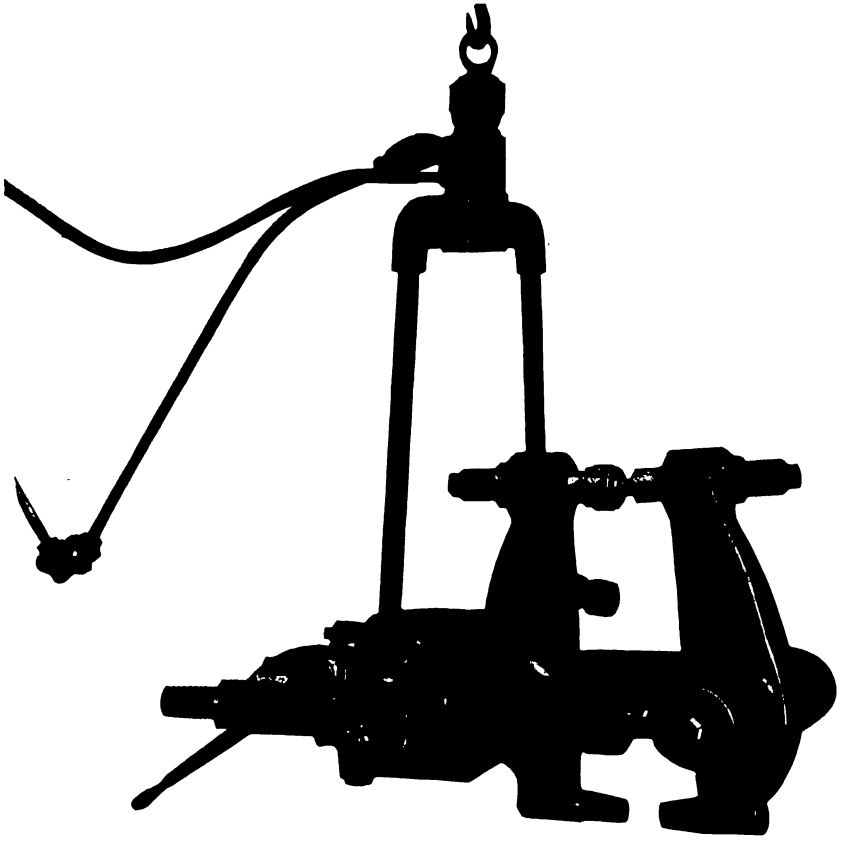
PLATE NO. 161.



PORTABLE HYDRAULIC RIVETING MACHINE.—WITH ADJUSTABLE JAWS. SHOWN WITH DIES VERTICAL.

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PLATE NO. 162.



PORTABLE HYDRAULIC RIVETING MACHINE.—WITH ADJUSTABLE JAWS.
SHOWN WITH DIES HORIZONTAL.

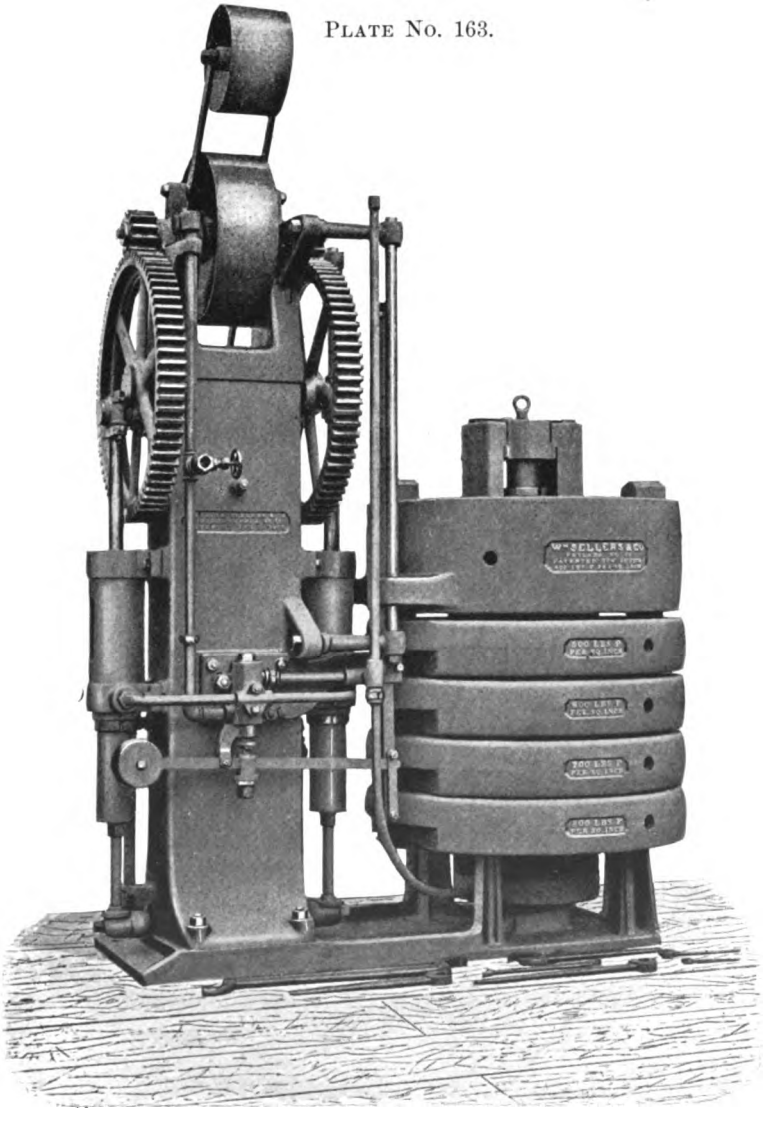
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Hydraulic Accumulator.

AN important factor of the hydraulic system is the accumulator, by which the pressure used is determined, and which should also furnish storage capacity enough to meet any sudden demand upon it. In its cheapest form it consists of a tank carrying iron ore or other heavy material, and suspended from a plunger moving in a vertical cylinder. The tank is sometimes replaced with cast-iron weights, so arranged that they may be removed in part to reduce the pressure of the system. In our patent accumulator the operation of adding or subtracting weights is readily accomplished, the weights being suspended upon cross-pins in vertical flat bars. The spacing of the pin-holes is such that upon lowering the accumulator the lowest weight is first lifted from its pins by striking the supports on the base-plate, the wood-bumper being removed to permit this, and the others follow in succession. As many weights as desired may be removed by pulling out the pins. A direct-acting steam-pressure pump is usually employed in connection with the accumulator, controlled by a valve which is moved by the accumulator, so that the fall of the accumulator starts the pump, which is stopped again by the accumulator when it reaches its highest position.

For portable work we have a special form of belt-driven pump combined with accumulator (Plate No. 163). The pump may be driven directly from the line-shaft, and is stopped and started by the belt-tightener indicated. The accumulator is carried upon the same bed-plate, and is provided with four removable weights. When the accumulator has reached its highest position, it trips a special valve attached to the side of the upright and permits the water delivered by the pump to flow directly into a tank in the top of the upright, whence it finds its way through a sponge filter to a reservoir in the base of the tank. When water is used, the accumulator falls, the deflecting valve is closed, and the pump delivers into the cylinder of the accumulator. These portable accumulators may be placed close to the riveters employing the pressure, and long lines of pipes for conveying the pressure and exhaust water may be avoided, and the exhaust lead directly back into the tank in the upper part of the upright.

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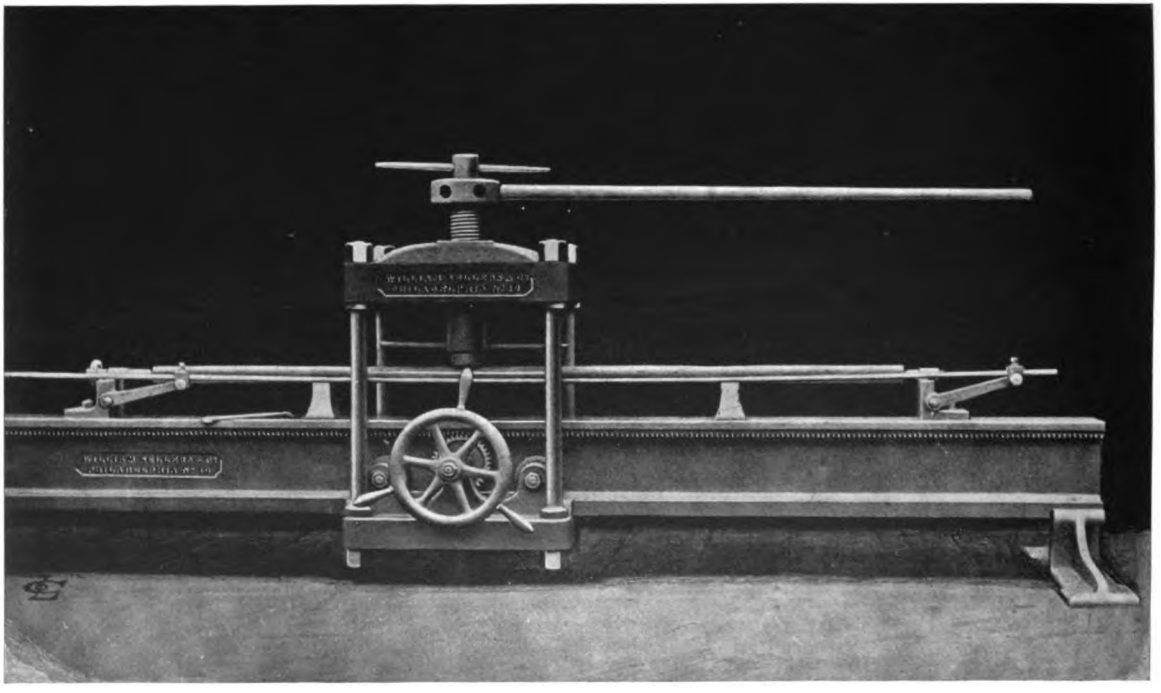


PATENT HYDRAULIC ACCUMULATOR AND PUMP.

Weights suspended so as to be readily released for adjusting pressure. Double-acting high-pressure pump carried on upright which forms tank, and is provided with sponge filter to remove all gritty matter before water enters the pump. Filter and tanks accessible by man-holes in side of upright. Improved relief-valve stopping flow of water to accumulator when it is full, but permitting the pumps to run full of water ready for action, but freed from pressure. Pumps readily accessible for changing packings.

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PLATE No. 164.

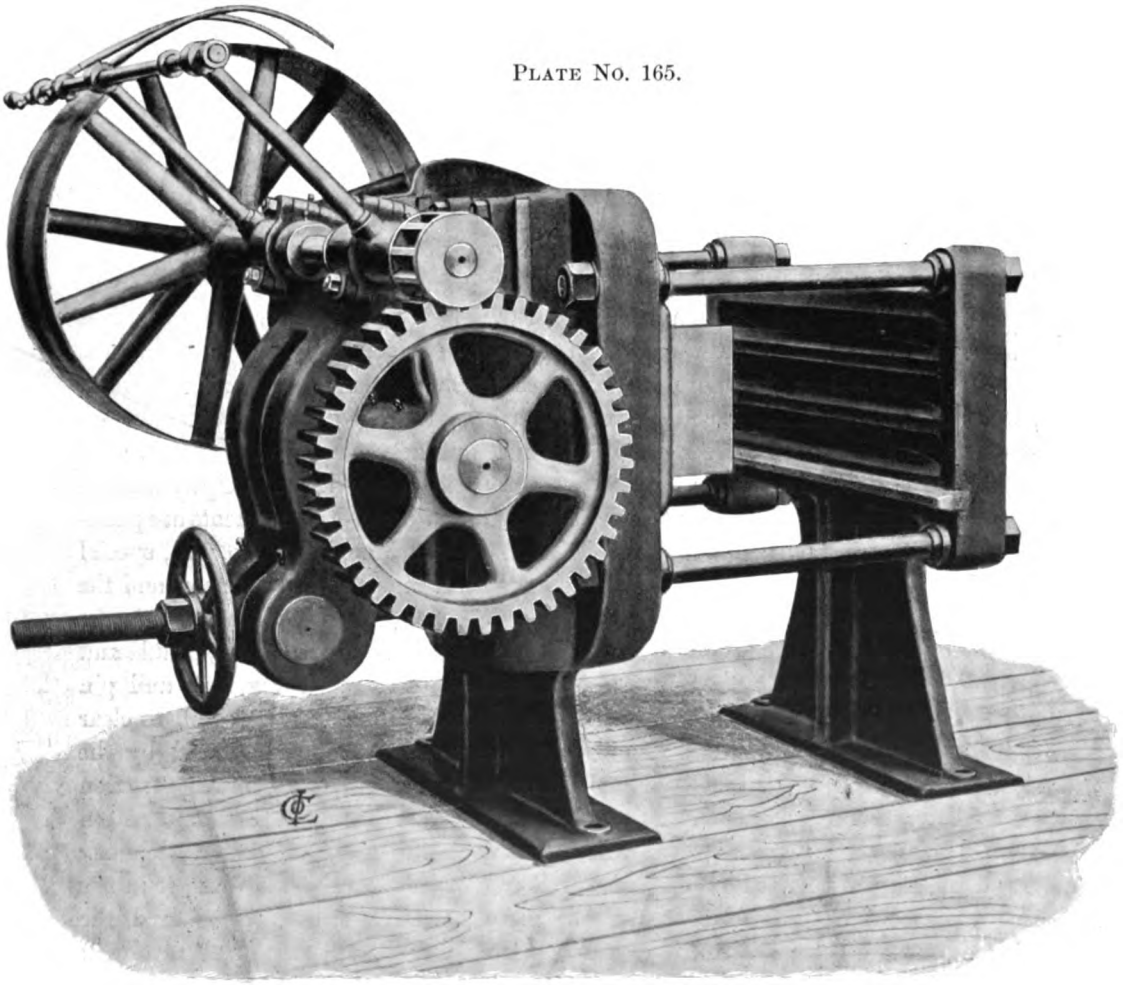


HAND STRAIGHTENING MACHINE.—FOR SHAFTS.

Bed 20′ long, with bending blocks for shafts up to and including 6″ diameter. Screw-press mounted upon rollers, running upon lower part of the bed, which is planed up for the purpose. Screw-press provided with pinion gearing into rack on the bed for rapid traverse back and forth. Shaft carried upon centres arranged to elevate and depress simultaneously. Capable of bending 6″ shaft, cold.

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PLATE NO. 165.



POWER STRAIGHTENING MACHINE.—FOR BEAMS.

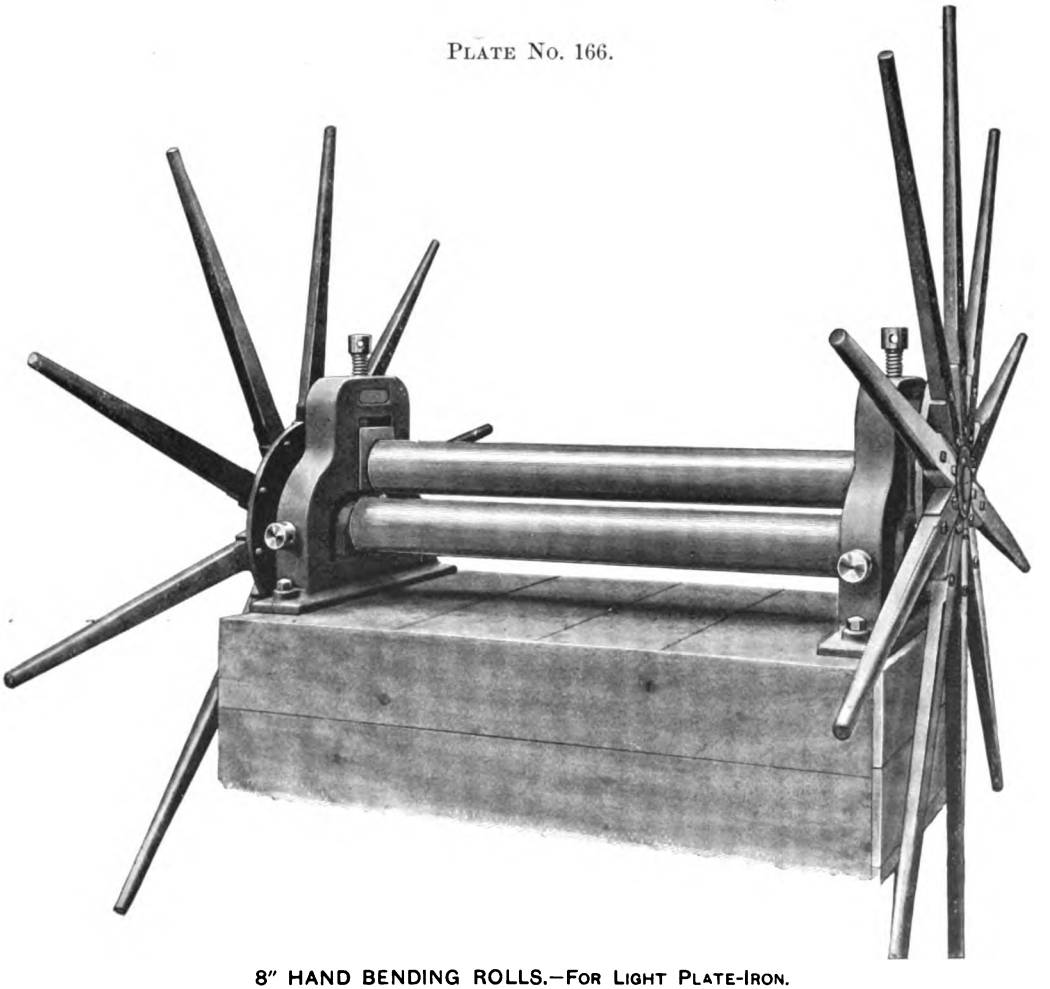
Bending plunger working horizontally. Operated by powerful crank with uniform length of stroke. Position of end of plunger adjustable. May be used for bars and other rolled shapes. Maximum capacity, 15″ I-beams. Fast and loose pulleys on machine, 36″ diameter, 7″ face. 150 revolutions per minute. Same machine arranged to operate by hand when required.

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Bending Rolls.

WE have recently made important changes in our power-bending machines, the marked advantage of which will be pointed out, but we are still prepared to build the earlier types, all of which have their distinct uses, as well as the more special types which have naturally arisen to meet particular requirements. Our experience has been large and varied, and our constant efforts to improve have resulted in a machine of unprecedented power, with new and original conveniences for accurate and rapid manipulation. Upon some of these features we have been granted letters-patent, and upon others patents are pending. In designing our standard three-roll bending machine, Plate No. 171, special attention has been given to the driving arrangement, the power adjustment, and the method of removing sheets bent to a full circle. In three-roll machines it is the common practice to drive the lower rolls only, making the upper roll adjustable and providing for the removal of flues by a tumbler-bearing or heavy link and pin manipulated by hand. In this construction the roll gears must be small to clear each other, and the power of this driving arrangement is thus limited by the strength of mere pinions but little larger than the rolls themselves, and the friction of the lower rolls only is available to carry the plate through. For this reason great difficulty has been experienced in causing plates to enter, and the clumsy expedient of grooving one of the lower rolls to catch the plate and drag it in has frequently been resorted to, but, after the plate has been successfully entered, the limited power available in the gearing or in friction on the plate makes it necessary to proceed with the work of bending by slow and easy stages. A number of passes may, therefore, be required to effect the desired curvature, and it is commonly necessary to run the plate out between passes in order to readjust the position

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8″ HAND BENDING ROLLS.—FOR LIGHT PLATE-IRON.

Used for tanks and light boilers. Top roll adjustable and self-supporting. Side rolls adjustable by screws. Arranged to bolt to foundation. Pits required in floor for the operating spiders. Made 6′ 1″ and 8′ 1″ between housings, with 8″ and 9″ rolls respectively. Strong and substantial machine. To remove flues, top roll may be partly withdrawn.

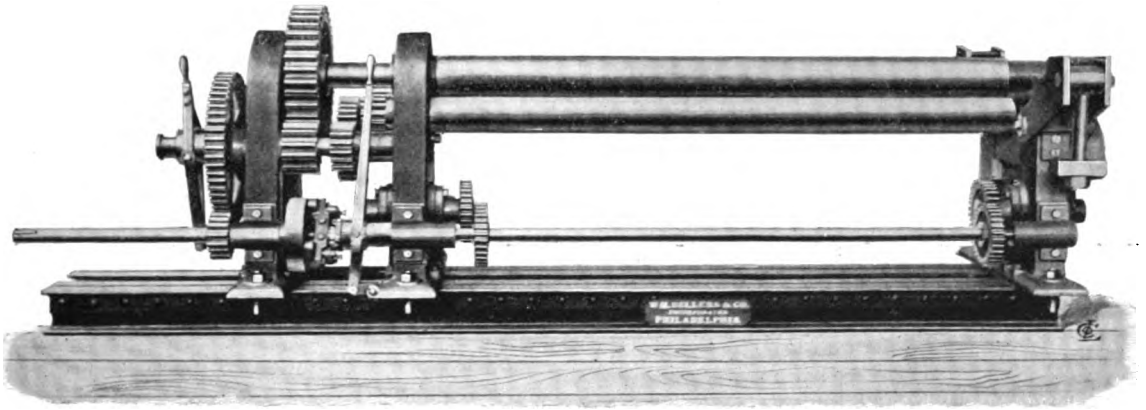
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of the top roll. When the work is completed and the plate bent to a full circle, its removal from the rolls is often an operation involving considerable labor and time. All of these objections to the usual type of rolls have received our careful consideration, and our most approved machines are now offered to bend plate to the proper radius at one pass, to adjust the rolls under the full pressure required for bending, and to remove without delay plates bent to a full circle.

To increase the driving power, we have adopted the novel expedient of driving all of the rolls in a three-roll machine, adding a large wheel to the top roll, and augmenting the traction to such an extent that plates can be easily entered and carried through to any desired curvature at a single pass. In this arrangement the top roll, to which abundant power can be transmitted, is the main driver, while the lower rolls, which act in a secondary manner, receive power through a lost-motion clutch, so that whenever their assistance in driving is not required they may be carried ahead by the plate. The rolls are all driven at the same peripheral speed and all act together in entering a plate; but, if the top roll has sufficient traction to do the work of bending, the lost-motion clutch referred to avoids the calendering due to the difference between the outside and the inside circumference of the sheet, and saves the loss in friction which would otherwise occur. Should the top roll slip, however, the bottom rolls are always in readiness to assist in driving and carrying the plate through. Unlike other machines for the same purpose, the top roll is fixed at one end in a horizontal position, while the lower rolls are adjustable by power. This adjustment can be made at either end independently, or at both ends together, and against the full resistance of a plate between the rolls. The lower roll bearings are mounted on cross-pins to insure a perfect distribution of pressure under these conditions, and the main bearings for the top roll are mounted in the same way, so that the natural spring of the roll in service will not impair the surface exposed to pressure. These rolls are arranged in the usual pyramidal form, and the pressure required for bending is carried directly between the top and bottom rolls by heavy adjusting screws, on which all of the rolls are supported when in action.

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PLATE NO. 167.



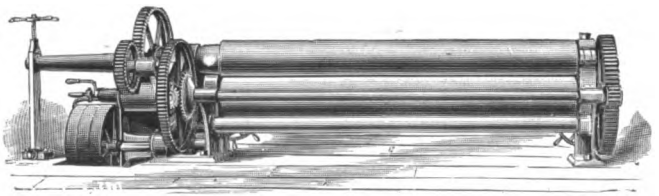
6″ POWER BENDING ROLLS.—FOR LIGHT PLATES.

Top roll, 6″ diameter; side rolls, 5″ diameter; all forged steel. Tumbler bearing permits work rolled to a full circle to be readily removed. Housings attached to beams and extended to carry motor for driving rolls. Rolls adjustable by power through friction clutches. Arranged to drive by fast and loose pulleys when required.

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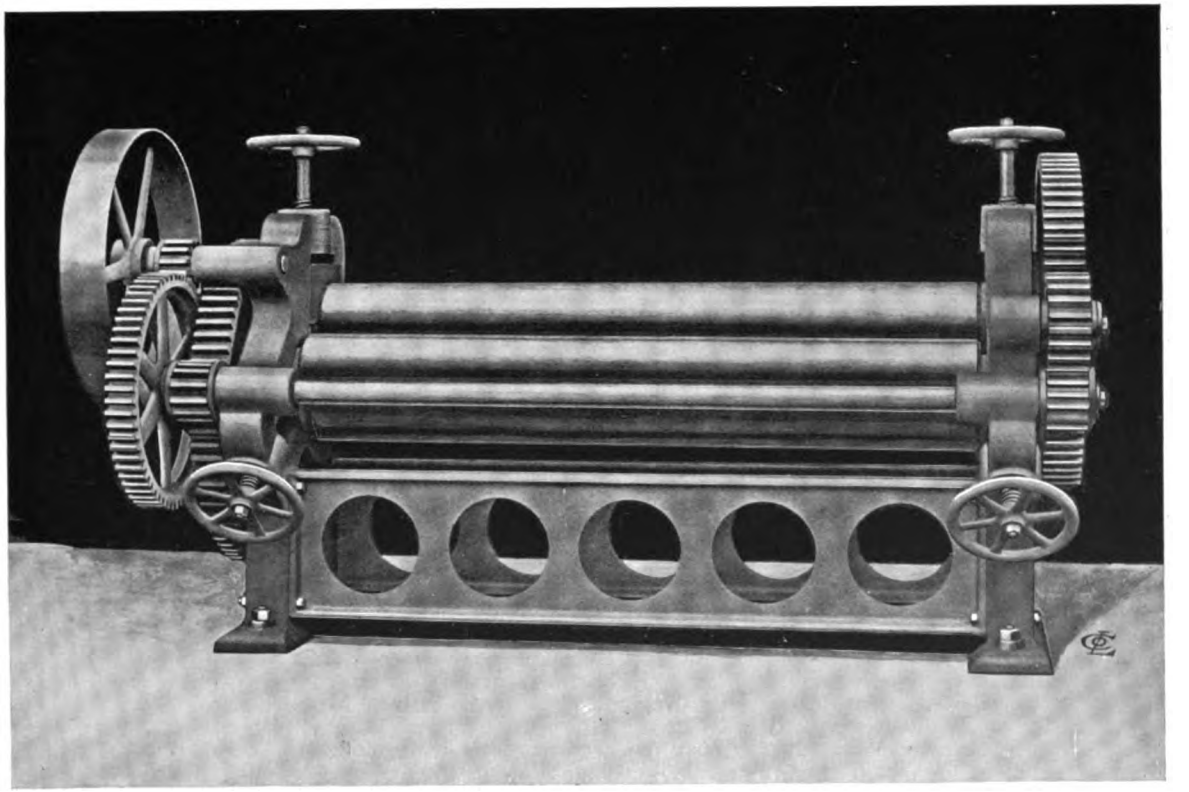
These screws are attached to the bearing yokes on the top roll, but for the removal of flues, provision is made to revolve the outer one by power and unscrew it at once from its yoke, leaving the top roll supported at one end and without any obstruction at the free end. When the flue is withdrawn the screw may be connected again by power, putting the rolls in readiness to repeat their work.

These rolls may be driven by straight and crossed belts from a single counter-shaft, and controlled by friction clutches on the machine, or, by using a reversing engine or electric motor, the belts may be dispensed with, the same machine being easily adapted to any mode of driving which may be preferred. The rolls are of forged iron or steel, and all the parts are carefully proportioned for the heaviest duty. On this account the gearing may appear abnormally heavy and strong, but the capacity of the machine is correspondingly great, and, although the cost of construction may be higher than that of some other types, we have no hesitation in claiming this machine to be by far the cheapest in the market when the output of work in a given time is considered.



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PLATE NO. 168.

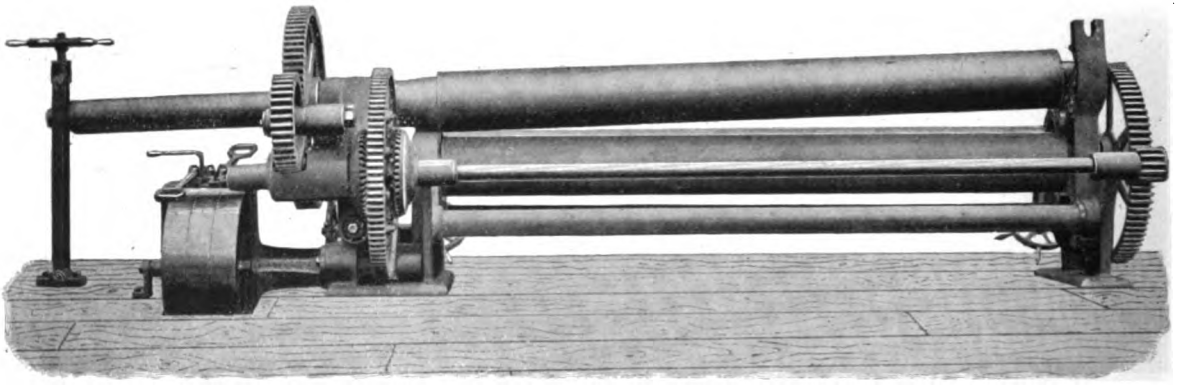


8″ POWER BENDING ROLLS.

Arranged with two pinching rolls in same vertical plane, and bending roll moved at an angle to same. Pinching rolls geared at opposite ends. Top roll removable through housings to permit work to be removed. Rolls, 8″ and 9″ diameter; 6′ long. Driven by open and cross belts on countershaft. Countershaft pulleys, 26″ diameter for 3″ belt. Speed, 180 revolutions per minute. Bending rolls adjustable by hand.

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PLATE NO. 169.

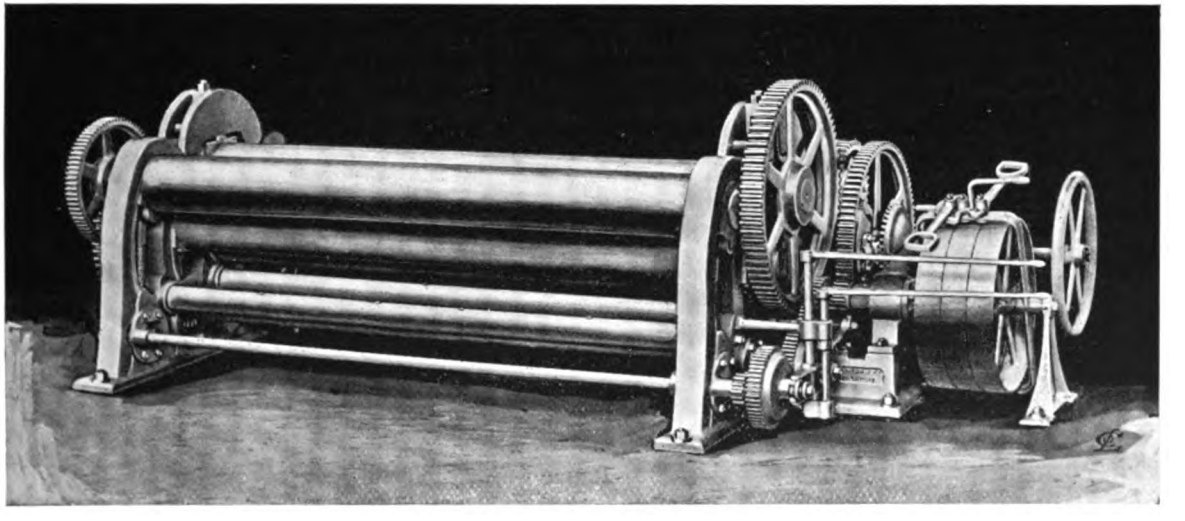


12″ POWER BENDING ROLLS.—FOR PLATES TEN FEET WIDE.

Top roll tilting. Pinching rolls, 12″ diameter, in same vertical plane. Bending roll 10″ diameter, arranged at angle to same. Pinching rolls geared at opposite ends with large wheels, and power transmitted through equalizing gearing to prevent calendering action on the curving plates. Top roll arranged to tilt for ready removal of plates rolled to full circle. Improved belt-shifting device for operating open and cross belts from line-shaft. Pulleys, 30″ diameter for 4″ belt. Should make 180 revolutions per minute. Bending roll adjustable by hand The equalizing gearing is an important feature of this machine, as it enables both rolls to be driven with less power than would be required if one had to slip on the plate. This is a simple and efficient machine, well adapted for lighter classes of work, especially where bending close to the edge of the sheet is an object.

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PLATE NO. 170.



12" BENDING AND STRAIGHTENING MACHINE.—FOR PLATES NINE FEET WIDE.

Driven by gearing similar to that of machine in Plate No. 169. Extra top roll to be used for straightening only. Is adjustable to height required and may be lowered to clear plates when bending. Rolls adjustable by power from the main driving gear through friction clutches. Rolls, 12″ diameter, cast-iron

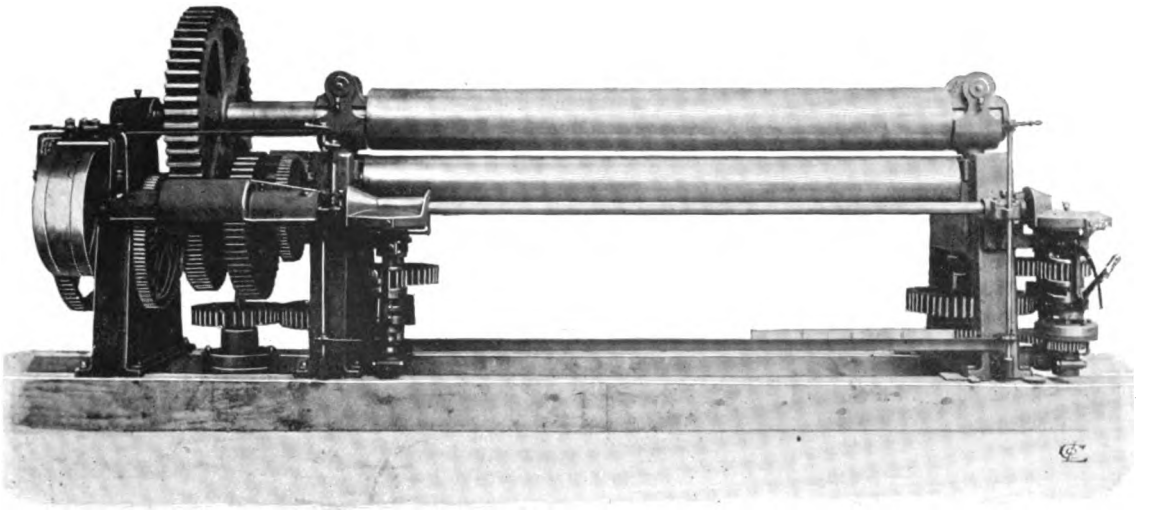
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Patent Plate Bending Machine.

THE machine shown on the opposite page represents a specimen of our latest type of plate bending machines, and possesses the special features described on a previous page. All three of the rolls are driven. The driving of the two lower rolls being simply for the purpose of insuring that the plate shall be started, while the main driving is accomplished through the top roll, which is provided with powerful gearing for the purpose. Our lost-motion clutch enables the plate to control the speed of the lower rolls without calendering or straining of gears. The rolls all act together, causing the plate to enter readily and to keep it moving at all times. The bottom rolls do not slide on the plate or retard its progress, but are always ready to help it along if the traction of the top roll is insufficient. The top roll is fixed in vertical height, and is provided with two bearings at one end, capable of sustaining it when the outboard bearing is unsupported. The lower rolls are adjustable vertically by power at either end independently, or both ends together, against the full resistance of the plate between the rolls. When removing a flue or circular work, the screw supporting the outer bearing of the top roll can be run down by power, leaving the roll supported at one end and free from any obstruction to the removal of the plate. After the flue is removed, the screw carrying the bearing is connected again by power, and the rolls are ready for the next job. It will be seen that this arrangement is much easier and quicker than the usual plan of removal or opening bearings. We have made these machines of great strength, with a view of doing the maximum amount of work in a minimum time, and with the least necessity for hand labor.

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PLATE No. 171.



16″ PLATE BENDING ROLLS.

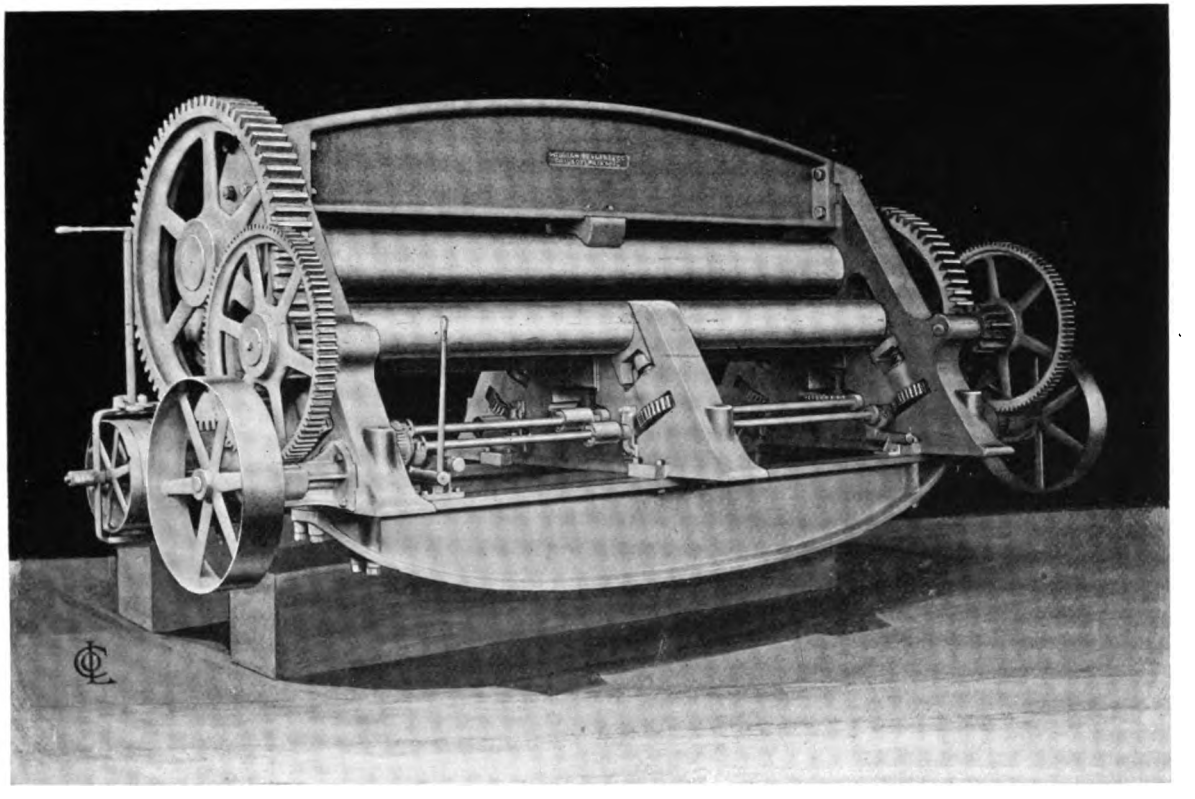
Top rolls, 16″ diameter; bottom rolls, 13″ diameter. All forged steel. Capacity, ¾″ steel plate 12′ wide, bent to circle of 64″ in one pass. Latest type of machine. All three rolls driven. Fast and loose pulleys, 16″ diameter, 6″ face. 1500 revolutions per minute.

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16″ Ship-Plate Rolls, 14 Feet between Housings.

THE machine shown in Plate No. 172 was designed for bending ship-plates 14 feet wide, and is of the most substantial construction. It has four cast-iron rolls, two pinching rolls 16″ diameter, and two bending rolls of 12″ diameter, and all provided with centre supports, making the machine unusually stiff and strong. The pinching rolls are driven from independent trains of gearing by pulleys at each end from a reversible countershaft, and all of the three lower rolls are adjustable by power by reversing pulleys on the machine, and by means of clutches in the adjusting mechanism, any bearing can be manipulated independently of the rest, or all bearings can be moved simultaneously. This machine, is especially useful in bending warped surfaces such as are required in ship-building and similar work. It may also be used to straighten plates, curved or buckled; the bending rolls being so set as to take the plate level without bending and the parts of the plate to be stretched to free it from the buckle have shims of sheet-iron placed upon them, and passing through the pinching rolls, these parts being submitted to greater pressure will be stretched in such places. This is a common expedient in bending to irregular shapes.

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16″ SHIP PLATE ROLLS.—14 FEET BETWEEN HOUSINGS.

Two pinching rolls, one over the other, 16″ diameter, 14′ long; two bending rolls, 12″ diameter, arranged to move diagonally towards top pinching rolls. All rolls supported at ends and at the middle. Top roll fixed; other three rolls adjustable by power. Rolls may be set parallel to one another, or side rolls may be inclined for irregular or conical work as required. Pinching rolls driven by large wheels at opposite ends by independent pulleys and separate belts. Driving pulleys, 40″ diameter, 8″ face. 120 revolutions per minute. Open and cross belts operated by our improved shifting motion, used for adjusting rolls. Convenient arrangement of clutches for coupling elevating gear.

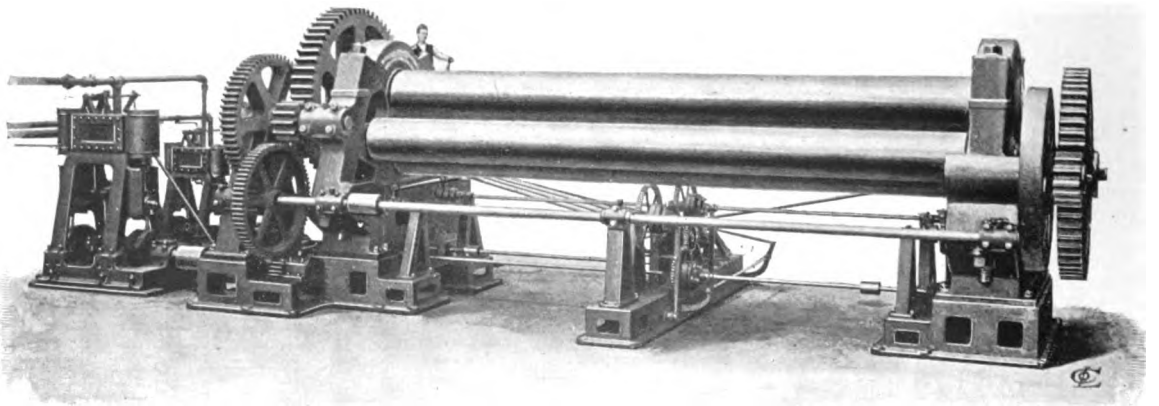
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24″ Ship-Plate Rolls, 22′ 6″ between Housings.

THIS machine represents our latest and most approved design for ship-plate bending rolls. Special attention has been given to accessibility of parts, and, when possible, bearings have been capped for ease in assembling the various parts, and for ready examination and repairs in case of carelessness in oiling, accumulation of scale and dirt. The pinching rolls are 24″ diameter, and the side rolls 20″ diameter, all of forged steel. The gearing is very heavy, and provision is made in the driving arrangement to avoid calendering when the traction of the top roll is sufficient to carry the plate.

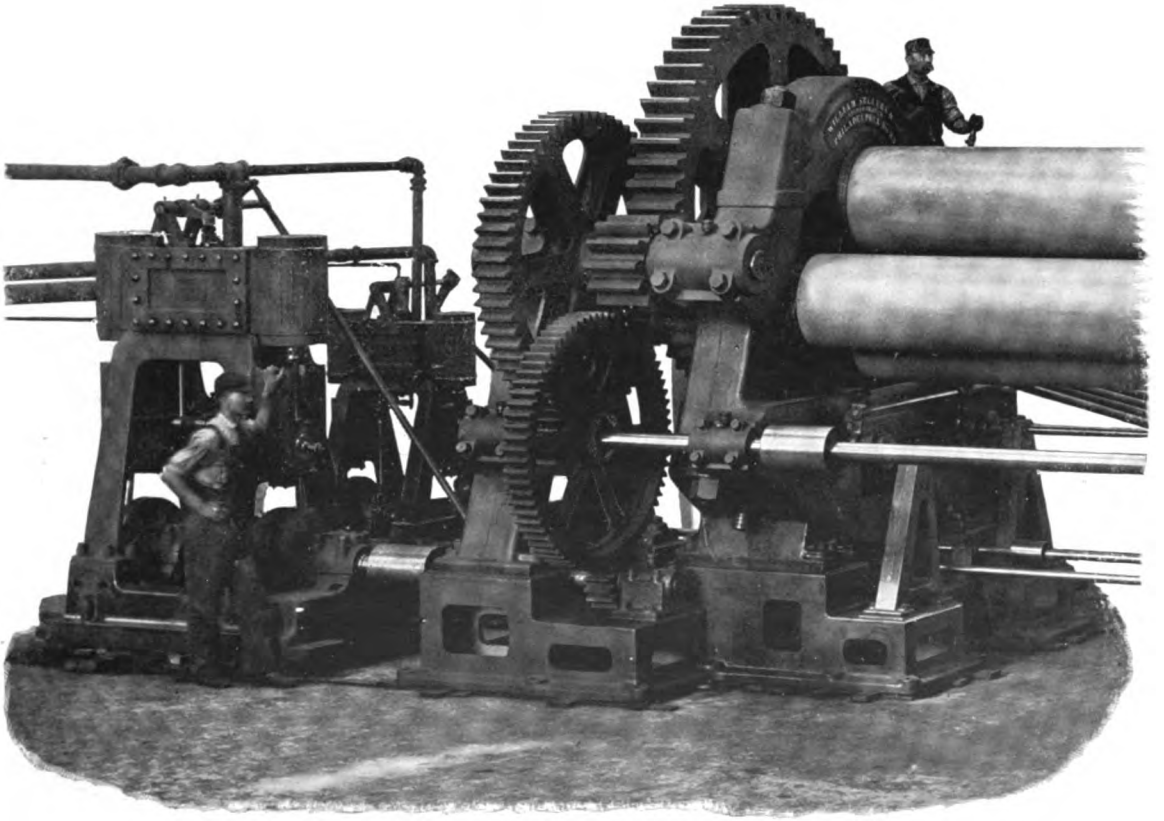
The machine is driven by two reversing engines, one of which turns the rolls while the other is used to adjust them. The pinching rolls will take in plates 2″ or less in thickness and the side rolls have an adjustment of 18″. By means of cut-off clutches either end of a roll may be adjusted independently, or both ends of all the rolls may be moved together when desired.

PLATE NO. 173.



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PLATE NO. 174.



24″ PLATE BENDING ROLLS.—22 FEET 6″ BETWEEN HOUSINGS.

Top and bottom rolls, 24″ diameter; side or bending rolls, 20″. Independent engines for driving rolls and adjusting them to height. Ends of rolls adjustable simultaneously or separately, as required for the work.

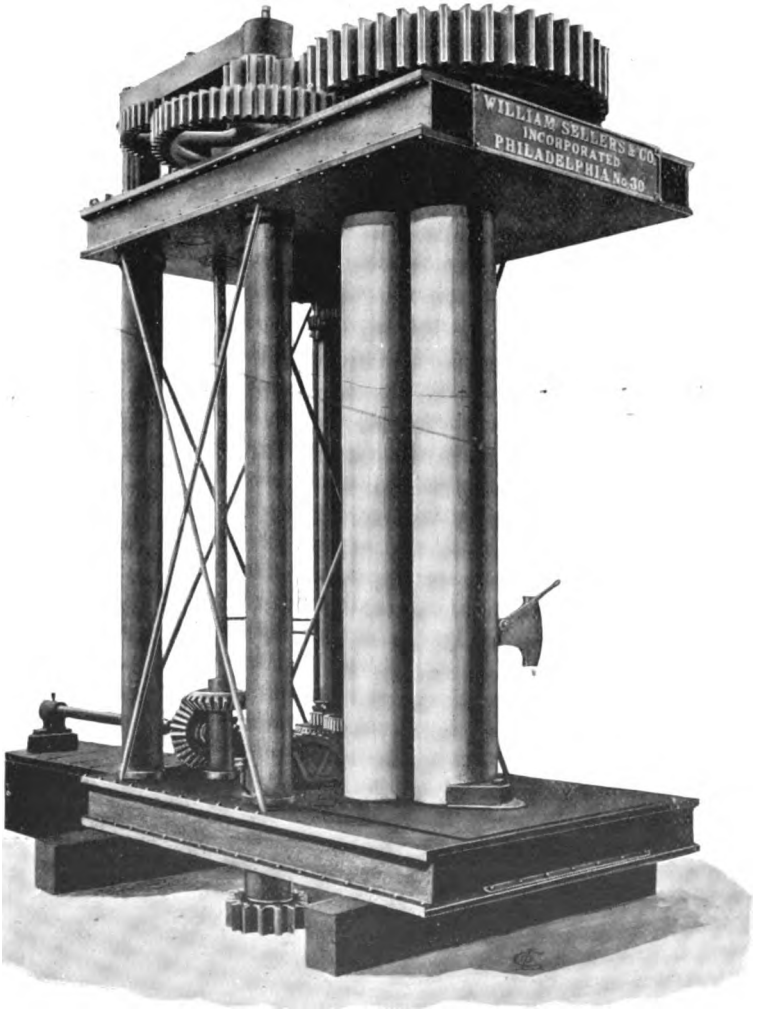
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Vertical Bending Rolls.

FOR a great variety of work, especially on very heavy plates, the vertical system of bending rolls has many advantages. As the plate to be bent rests upon its lower edge upon the floor, it requires only a slight curvature to enable it to stand alone, thus permitting all hoisting tackle to be dispensed with for the time being, and the plate can be passed back and forth between the rolls until the desired curvature is obtained. In our type of this machine, the housings are built up from steel plates and rolled beams; they are tied together by bolts and struts so as to make a rigid structure. All three rolls are driven. The side rolls are adjustable by power, and the centre roll with its driving gear may be readily removed when it is required to take out cylindrical work. For this purpose it should be situated under a suitable overhead crane. We use independent reversing engines for driving and for adjusting the rolls, but if it be desired, one pair of engines can be applied to both purposes through a suitable arrangement of clutches. All the main gearing is placed out of the way above the top housing, leaving only the secondary gears for the side rolls to be placed below the floor line. The floor-plate is of steel, one inch and a quarter thick, and is reinforced by a thinner plate to carry the work, which may be replaced readily when it becomes worn.

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PLATE NO. 175.



VERTICAL BENDING ROLLS.

Centre roll, 18″ diameter; side rolls, 15″ diameter. All forged steel. Distance between housings, 10′ 4″. Housings of steel plates and beams. Capacity, 1½″ steel plate, 10′ wide. Centre roll removable to take out work. Independent engines for driving and setting the rolls.

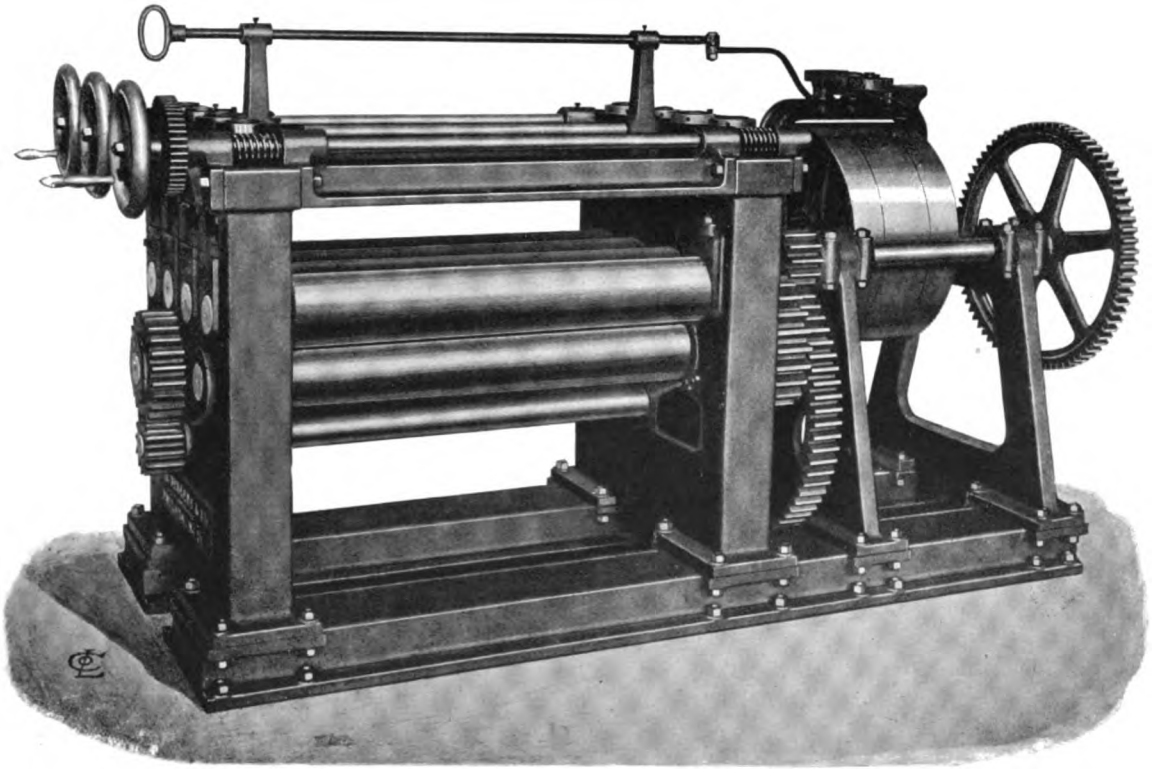
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Plate Straightening Machine.

THIS machine is designed for straightening plate-iron for various purposes, and for tank- and safe-work such a machine is quite indispensable. There are seven rolls, four above and three below,—the upper rolls being adjustable independently or together, while the lower rolls run in fixed bearings, and are driven in a novel and superior manner from a common driving shaft across the machine. Each roll, therefore, receives its power direct from the same source, and wheels of ample size are used in driving. The efficiency and durability of the driving machinery are thus vastly increased over the common practice of driving one roll direct and the others through small idle pinions. Three hand wheels are used for adjusting the upper rolls, the middle hand wheel controlling the two middle rolls, while the others adjust the outer rolls. By means of sliding gears between these hand wheels, they may be coupled to act in unison or disconnected for independent action. The machine is driven by straight and crossed belts for reversing the direction of motion, and controlled by a belt shifter, which may be operated from either side. The rolls are of forged steel, proportioned in size to the work required. The whole machine is very compact and stands on a base plate requiring but little foundation. We are prepared to build machines of this type of any capacity, and illustrate in Plate No. 176 a small narrow machine originally built for safe-makers, and intended to straighten composite steel plates.

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PLATE NO. 176.



STRAIGHTENING ROLLS FOR THIN PLATES.

Forged steel rolls, 6″ diameter, 38″ long. Three bottom rolls driven directly from same shaft. Four top rolls adjustable vertically, separately or together. Fast and loose pulleys on countershaft, 18″ diameter, 7″ belt. Should make 280 revolutions per minute.

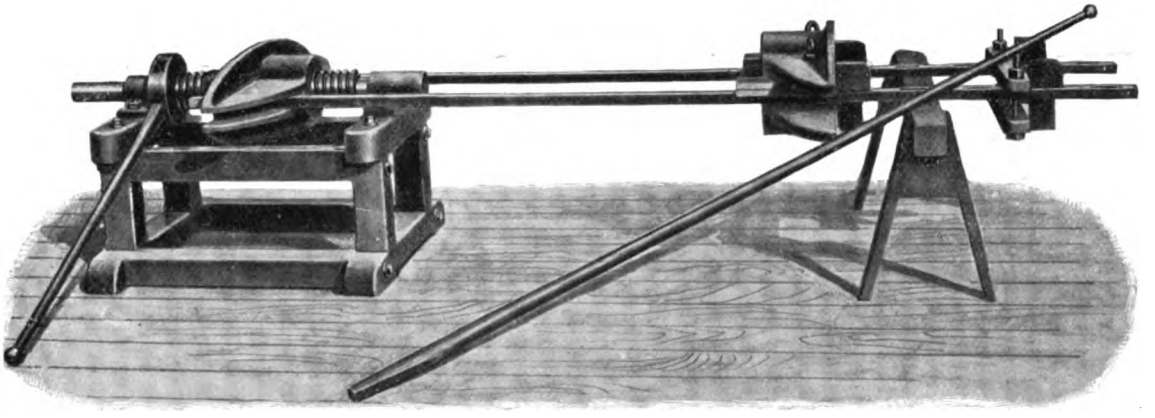
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Forcing Machines or Presses for Shafts, Mandrels, Wheels, etc.

NO progressive modern machine shop is without convenient appliances for forcing mandrels into work to be turned, or pressing wheels and other tight-fitting parts upon their shafts. All mandrels that are too large to be conveniently driven by a lead or copper hand-hammer require some form of forcing press, screw or hydraulic, and the practice of sledging mandrels to place is, or ought to be, prohibited in every good shop. The machine used for the purpose will depend on the size and character of the work and the amount of work that is to be done. For ordinary lathe work up to 20″ diameter, the mandrel presses illustrated in Plate No. 178 will answer an admirable purpose. For larger work, up to say four feet in diameter, the type of machine illustrated on the succeeding page, Plate No. 179, will meet a large variety of cases. These machines are placed in convenient positions in the machine shop, regard being had to their accessibility by all the workmen likely to use them. Each group of lathes, for example, should have conveniently placed a suitable mandrel press covering the entire range of work for which the lathes are competent. For miscellaneous work of large size, and for work done away from the shop, the portable hand-forcing machine in Plate No. 177 is a very convenient tool. Where there is much work of this kind to be done, a power wheel-press of suitable size becomes a necessity.

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PLATE NO. 177.



HAND FORCING MACHINE.—FOR PULLEYS, WHEELS, ENGINE CRANKS, ETC.

5¼″ screw, thread 26″ long, mounted in bearings on convenient wooden frame. End thrust of screw taken upon steel step-bearings. Cross-head, carried upon screw, about 4′ long, with slots for tension bars. Outer cross-head same size, made in halves for convenience. Machine complete with cross-heads, one pair of clamps, 26″ long, one set of tension bars, 7′ long, one set 19′ long; one set of keys, one forged hand-lever, 5′ long, and one 9′ long. A convenient machine for heavy miscellaneous work. Its portability is an important feature, and enables the machine to be used in a variety of locations.

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PLATE No. 178.

FIG. A.

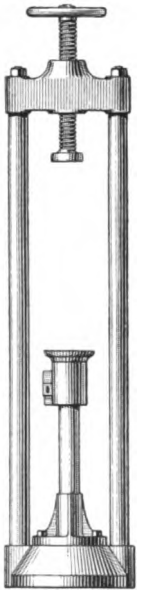
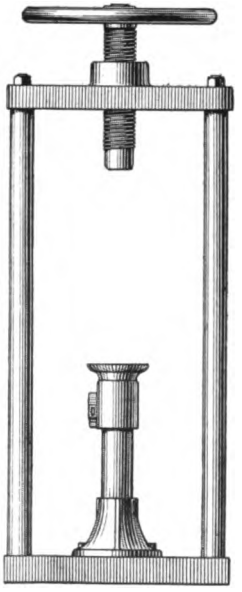


FIG. B.

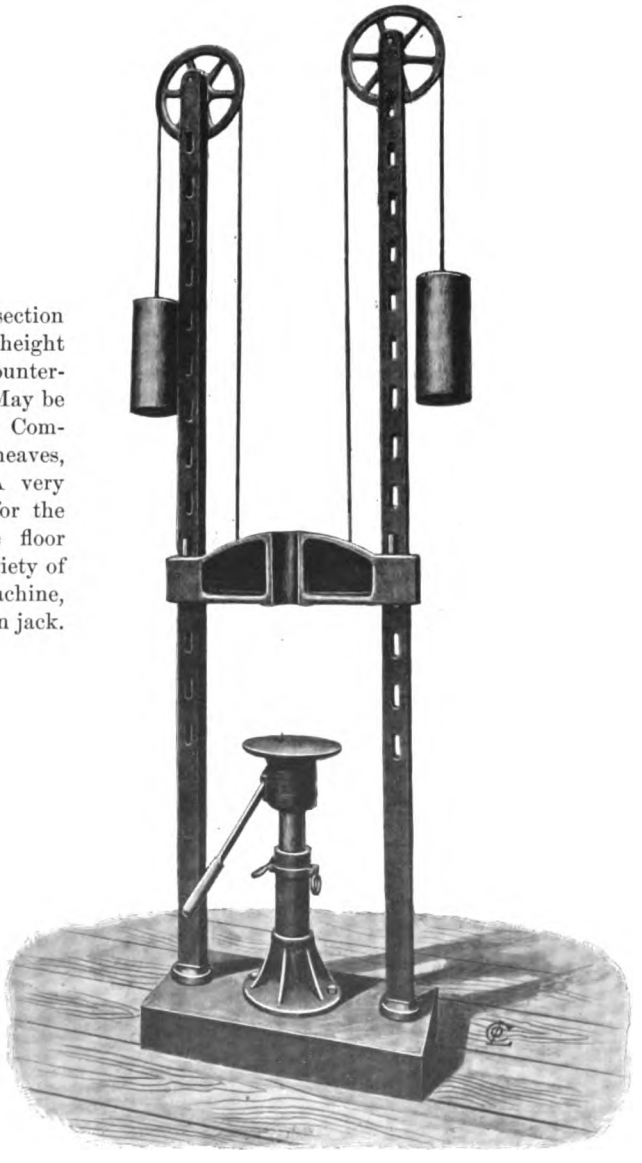


HYDRAULIC MANDREL PRESSES.

Having screw adjustment for length of mandrel. Fig. A, 10¼″ between tension bars; 2″ screw, 4′ 6″ under cross-head, 4-ton jack. Fig. B, 21″ between tension bars; 5′ under cross-head, 4″ screw, 10-ton jack.

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PLATE NO. 179.



36″ MANDREL PRESS.

Distance between bars, 36″; section of bars, 3″ square. Greatest height from base to underside of counter-weighted cross-head, 7′ 3″. May be used with 10-ton or 20-ton jack. Complete with counterweights, sheaves, keys, wire rope, and jack. A very handy and complete machine for the purpose, occupying but little floor room and covering a great variety of work. We also make a similar machine, 50″ between uprights, for 30-ton jack.

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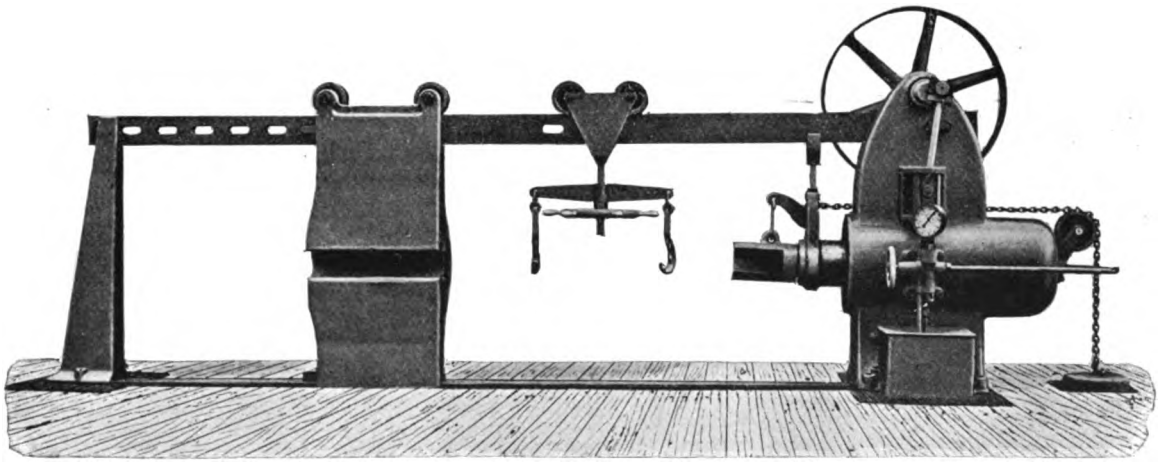
Hydrostatic Wheel-Presses.

WE were the patentees of what has since become the usual form of hydrostatic wheel-press, that is, the machine having a movable abutment, adjustable along the tension bars, hollowed out in the centre to permit the shaft or axle to pass into the line of pressure. We also patented the hinged blocking piece carried upon the end of the plunger; and, later, we patented a method of lining the cylinder with copper without joint or possibility of leak; which we have found greatly increases the durability of the wheel-press.

We use in all of our wheel-presses double-acting pumps, producing a smooth and approximately uniform motion. The pump is sufficiently large to move the plunger at a reasonable rate of speed. Our wheel-presses are rated by the size, measured on the tread, of the largest flanged wheel which they will take. They are thus: 36″, 42″, 54″, 72″, 84″. The actual distance between the tension bars in each case is at least 4″ greater than the nominal size. We make a line of these machines up to 72″, with a maximum pressure of 150 tons on the plunger; another set from 54″ to 84″ inclusive, with a maximum pressure of 200 tons. We are also prepared to build machines of larger capacity and greater pressure. An important feature of our pump is in the arrangement of the safety-valve, the spring of which is not subject to pressure except when the press is in action, thus giving it ample time for rest and insuring its constant accuracy. The safety-valve is locked to prevent tampering, and the overflow is discharged into the oil tank on the side of the upright, from which it is again drawn to the pump when required. There are no openings through the side walls of the main cylinder, the oil being forced through a centre-block in the back end. When the machine is running, the oil raised by the pump passes back through an overflow passage to the tank until this passage is closed by the hand-wheel, when delivery takes place into the cylinder. Movement of the hand-wheel in the opposite direction opens the valve, permits the cylinder to exhaust and the plunger to be retracted, all without stopping the pump.

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PLATE NO. 180.

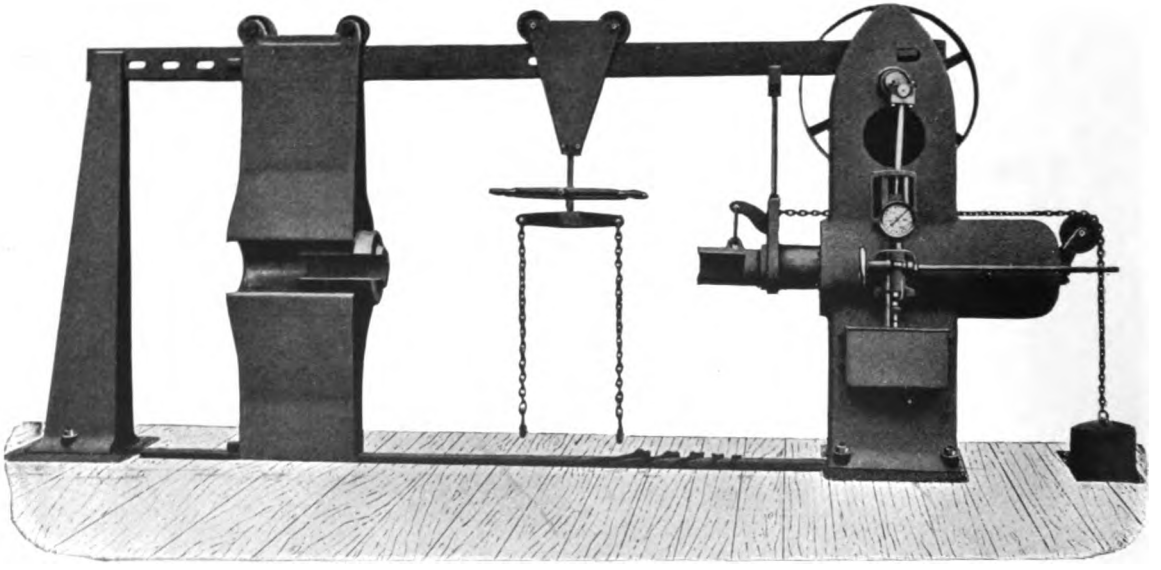


42″ HYDROSTATIC WHEEL-PRESS.—150 TONS CAPACITY.

Distance between tension bars, 3′ 10″; capable of putting two wheels on axle at the same time. Cylinder lined with copper in improved manner. Double-acting bronze pump, arranged with pressure gauge and stop-valve and improved safety-valve to prevent overloading. Hooks and elevating screws for wheels and axles, travelling on tension bar. Resistance beam or post carried upon wheels on the tension bar, movable to any position, thus acting equally well for pulling off and pushing on. Complete with countershaft, pressure blocks, and full set of wrenches.

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PLATE No. 181.

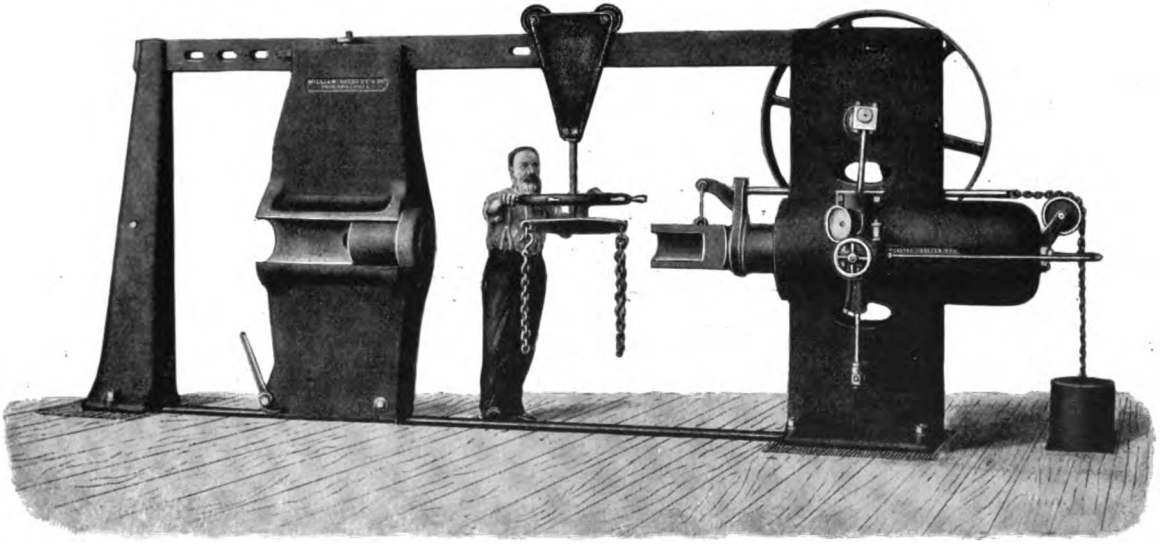


72″ HYDROSTATIC WHEEL-PRESS.—150 TONS CAPACITY.

Distance between tension bars, 3′ 10″; capable of putting two driving-wheels on axle at the same time. Cylinder lined with copper in improved manner. Double-acting bronze pump, arranged with pressure-gauge and stop-valve and improved safety-valve to prevent overloading. Chain-slings and elevating screws for wheels and axles, travelling on top tension bar. Resistance beam or post carried upon wheels on the tension bar, movable to any position, thus acting equally well for pulling off and pushing on. Complete with countershaft, pressure blocks, and full set of wrenches.

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PLATE NO. 182.



84″ HYDROSTATIC WHEEL-PRESS.—200 TONS PRESSURE.

Distance between tension bars, 3′ 10″; capable of putting two driving-wheels on axle at the same time. Cylinder lined with copper in improved manner. Double-acting bronze pump, arranged with pressure-gauge and stop-valve and improved safety-valve to prevent overloading. Chain-slings and elevating screws for wheels and axles, travelling on top tension bar. Resistance beam or post, carried upon wheels on the tension bar, movable to any position, thus acting equally well for pulling off and pushing on. Complete with countershaft, pressure blocks, and full set of wrenches.

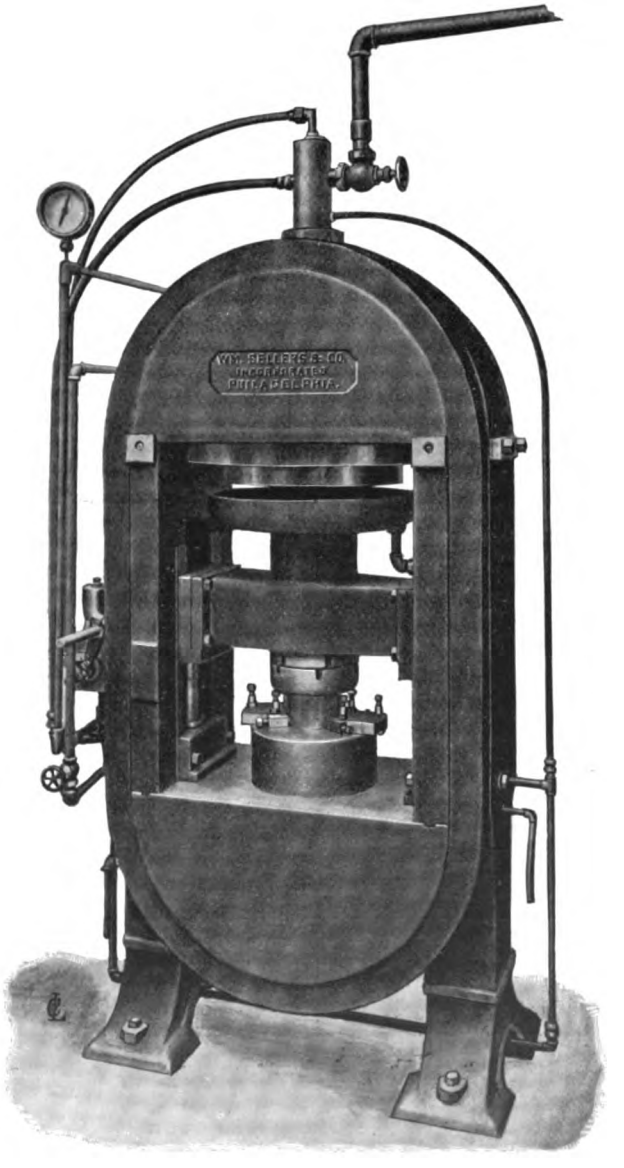
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Hydraulic Medal Press.

THE machine illustrated on the opposite page was designed and built for the U. S. Mint at Philadelphia, to stamp medals of various sizes, using any desired pressure up to 2,000,000 pounds upon the dies. It consists of two semicircular heads, separated by strong columns and united by heavy steel bands, between which is a cross-head operated by a large steel cylinder in the upper head and small return cylinders in the lower head. Power is supplied by a direct acting plunger pump, which maintains a constant flow of oil, to be deflected as desired from an idle circulation through a supply tank overhead into the large or small cylinders. The movement of the coining-head is controlled by a lever conveniently located on the side of the machine. In its middle position the head remains stationary, and as the lever is moved up or down the coining-head follows in the direction indicated by the lever movement. The pressure applied is determined by an adjustable safety-valve. This is easily and quickly adjusted, the pressure being regulated to suit the strength of the hardened steel dies used. Although the pressures employed are very great, the power required to run the press is quite small, and a rapid movement of the coining-head in both directions, toward and from its work, is accomplished by automatically putting the large coining cylinder in direct communication with the supply tank. This communication is established by a large valve on top, which automatically closes again as soon as the coining-head is arrested by the work, after which the movement continues slowly under pump pressure, allowing time for the metal to flow between the dies: the head is made to move at the rate of an inch a minute under pressure, and three feet a minute toward and from its work. As the movement under pressure is very short, the operation of coining is rapid and applicable to a variety of work, such as punching and stripping, for which it is also used. Such a press may be used to supersede the drop or the fly-press for many operations.

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PLATE No. 183.



HYDRAULIC MEDAL PRESS.—2,000,000 POUNDS PRESSURE.

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Hoisting Machines.

WE make three sizes of worm hoisting machines for freight elevators, all of the same general type; they are strong, simple, and efficient. The worm-wheels and worms are made from iron patterns, and the latter are so moulded that the thread is without "parting" marks. The worms in all cases run immersed in oil, which is prevented from escaping at the end of the worm-box by a suitable packing. The thrust of the worm is taken upon hard steel steps, well lubricated.

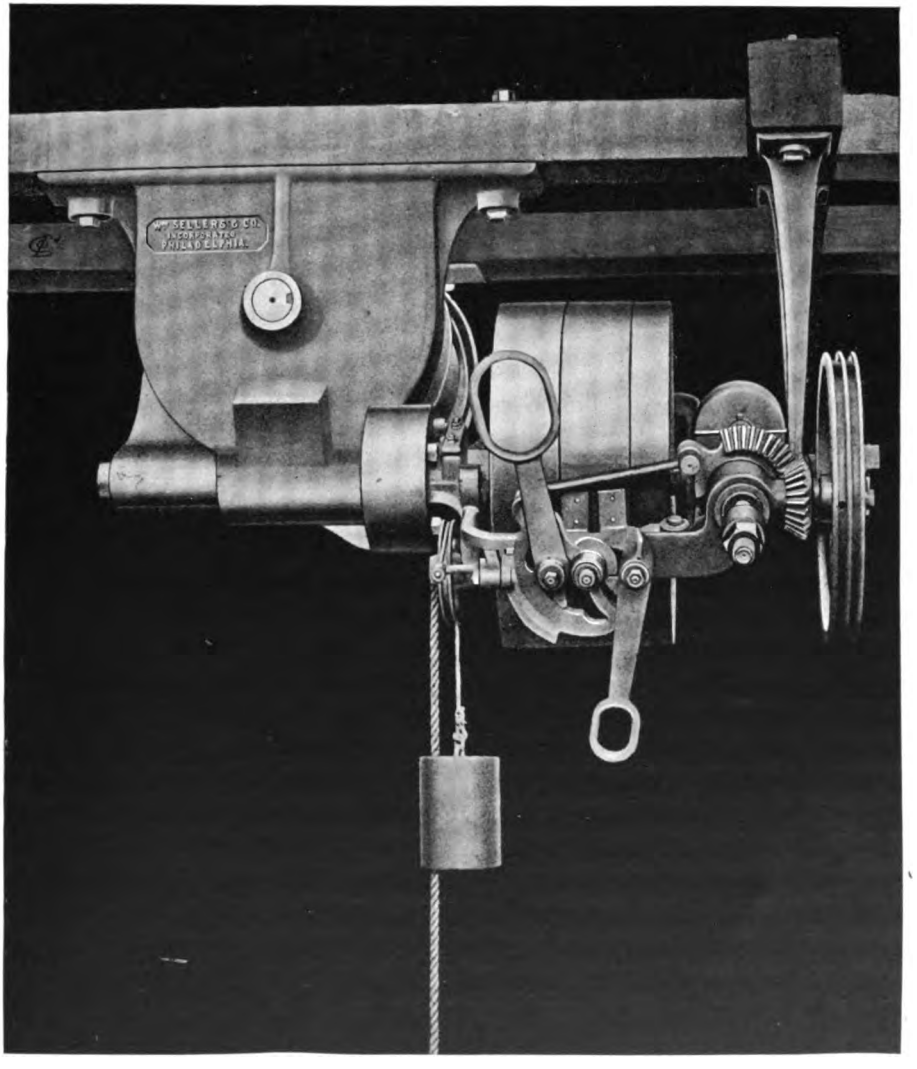
These machines have our improved interlocked belt shifter, carried upon an adjustable frame, which may be set to suit the angle of the driving-belts. When both belts are off, a brake is automatically applied and remains on the driving-pulley until one of the belts is shifted. These machines are provided with an automatic adjustable stopping device, which causes the hoisting cage to stop at top and bottom of hoistway, regardless of whether or not the shifting-rod is moved; that is, the machine stops when the drum has made the desired number of rotations. This arrangement is certain in its action, and is a valuable addition to the ordinary stops on the shifting-rod.

WORM HOISTING MACHINES.

Nominal Rating.	Diameter of Worm-Wheel.	Usual Diameter of Drum.	Diameter of Pulleys.	Usual Speed. Revs. per Minute.
1000 lbs.	10″	14″	16″	212
2000 "	18″	18″	24″	275
4000 "	30″	36″	30″	225

Other drums can be furnished in each case when required.

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2000-LB. WORM HOISTING MACHINE.

Worm-wheel, 18″ diameter. 24″ pulleys; 4″ belt to hoist; 2″ belt to lower. Complete with 18″ drum, turned and grooved for wire rope; belt shifter; automatic brake; automatic stop-motion; counterweight for brake, and outboard supports for drum-shaft and pulley-frame.

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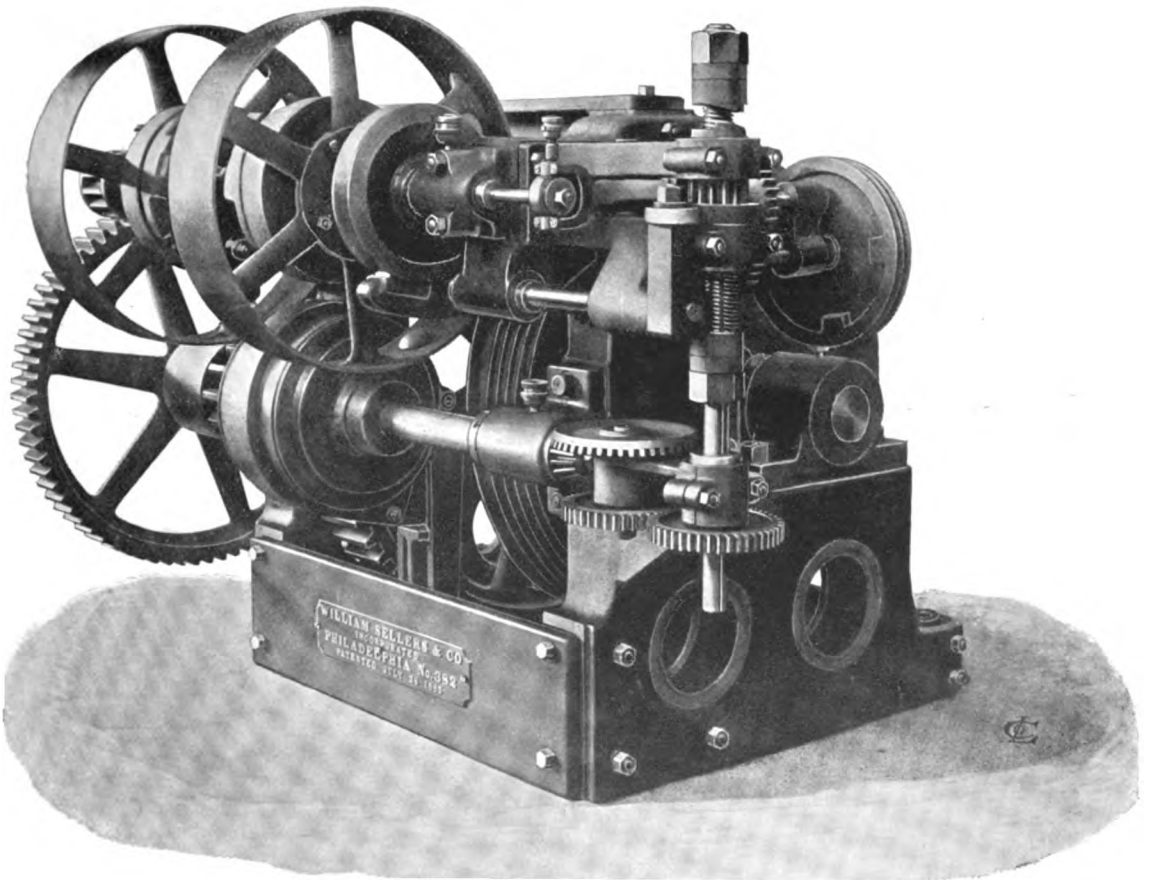
We make cages or platforms for elevators to order, as well as all the iron-work for the guides, etc., and are prepared to supply safety catches, operated by spring or counterweights, as well as the "Tatham and Britton" safety arrangement, in which a pendulum suspended below the car vibrates in grooves in the guide-irons. In this device, as long as the proper speed is maintained, the pendulum vibrates freely, but should the motion of the cage be unduly accelerated, the pendulum at once jams and throws into operation a pair of toothed clutches which lock the cage absolutely and prevent further movement until the car is raised to disengage them. This is an absolutely certain safety device, and provides not only against accident from breakage of the rope, but from the running away of the hoist, due to any other cause.

Spur-Geared Hoisting Machines.

We show in Plate No. 185 a spur-geared hoisting machine, driven by open and cross-belts through our improved friction clutches, in which the load is sustained by our improved self-acting retaining device. This machine has a 36″ drum, turned and grooved for 1″ wire rope. It is provided with an automatic brake and automatic stop-motion, similar to that used on our worm-geared machines. It may be readily used to hoist the full load at least 60 feet a minute. It is a strong and substantial machine, arranged to bolt upon the floor or upon a foundation at base of elevator shaft. This machine is also used for a riveter hoist, as shown in Plate No. 186. For this purpose a chain drum is substituted for the wire rope drum, and the automatic brake and stop-motion are omitted, a suitable hand-lever being provided for operating the clutches. This machine is admirably adapted for the purpose, as it can be controlled with the utmost nicety, so that the hoist may be stopped at exactly the point required for driving the rivet. This machine is used for loads up to fifteen tons on four parts of chain.

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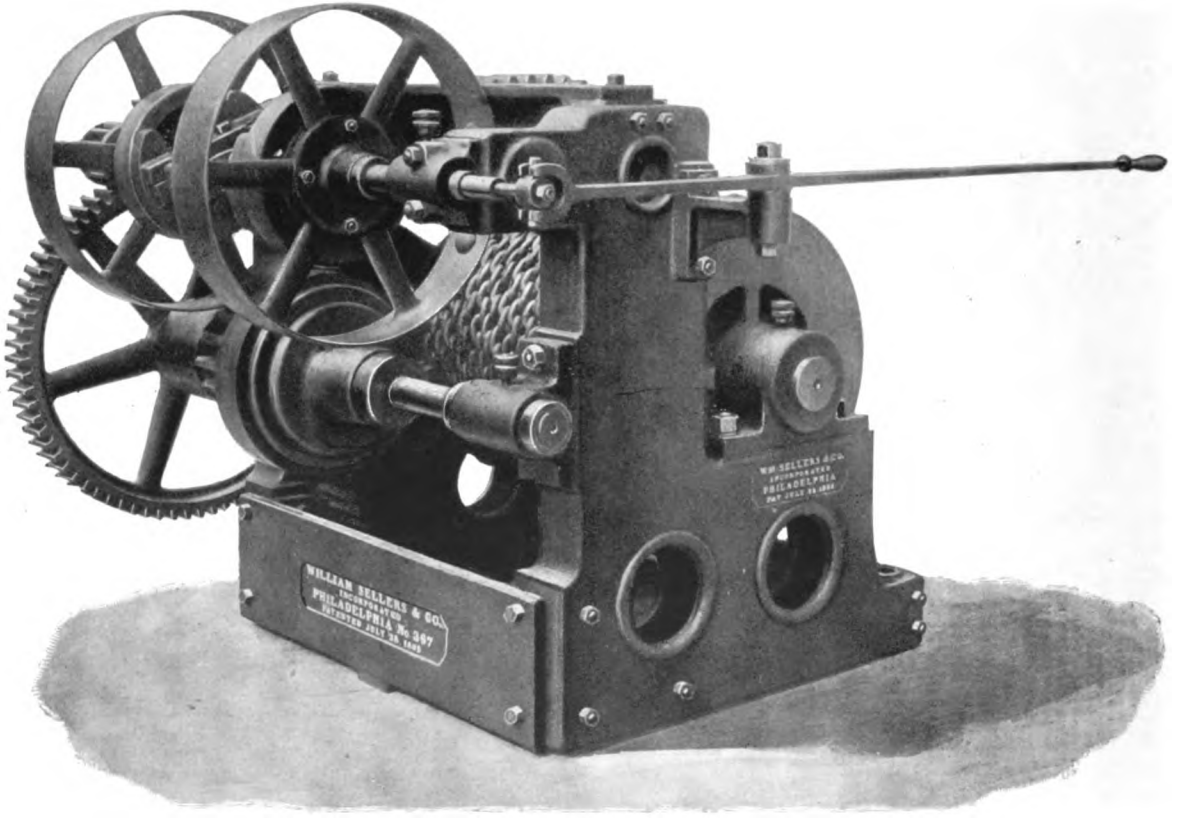
PLATE NO. 185.



5000-LB. SPUR-GEARED HOISTING MACHINE.—WITH PATENT FRICTIONAL RETAINING CLUTCH.

86″ drum, turned and grooved for 1″ wire rope. Pulleys 24″ diameter, 5½″ face. Should make 250 revolutions per minute, to hoist at a rate of 62′.

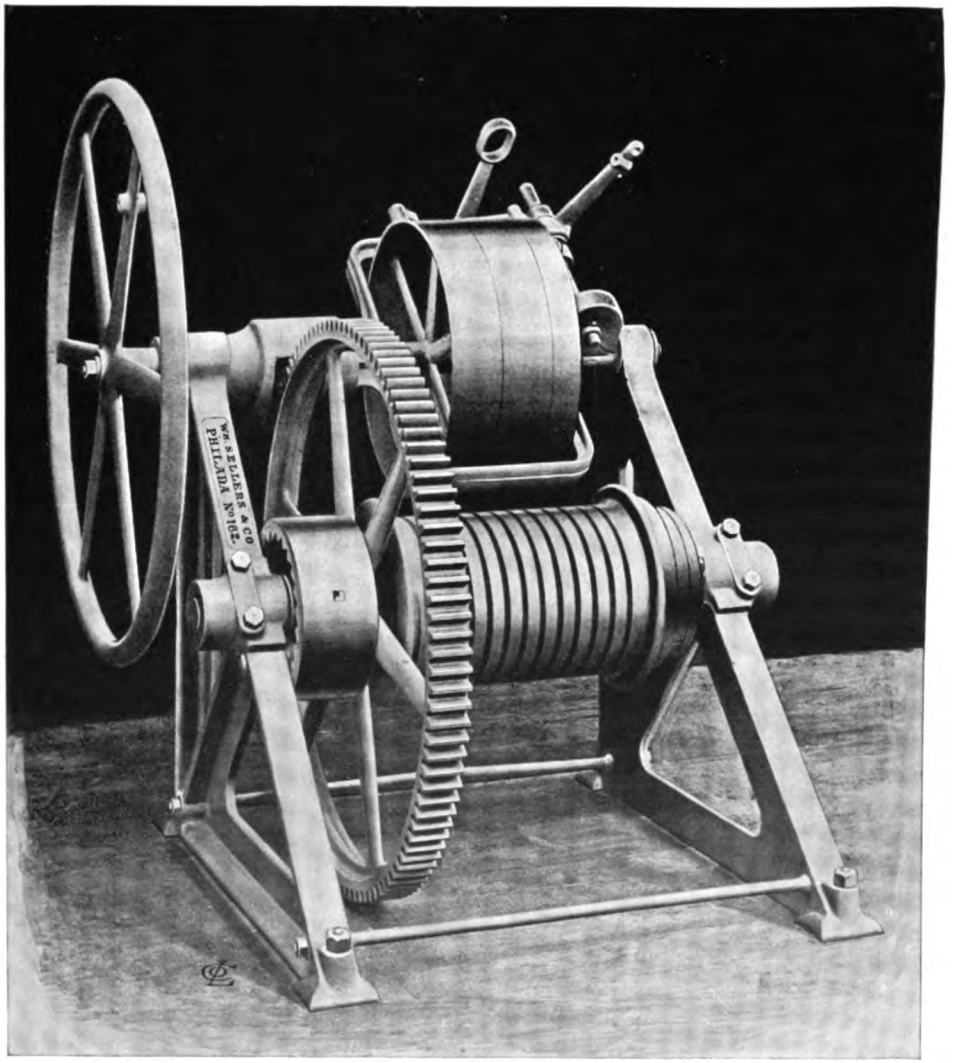
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SPUR-GEARED HOISTING CRAB.—SPECIAL DESIGN FOR USE WITH OVERHEAD HOIST FOR RIVETING MACHINES.

24″ x 4½″ pulleys. Should make 300 revolutions per minute. Drum, 18″ diameter. Load sustained by patent frictional retaining device.

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SPUR-GEARED HOISTING CRAB.—WITH WESTON RETAINING CLUTCH.

This machine was designed for use with light overhead hoist for riveting machines, up to five tons capacity. It is driven by open and cross belts. Is provided with a hand adjustment through 4′ hand-wheel, enabling fine adjustments to be readily made. The pulleys are 24″ diameter. Made also to work by hand only.

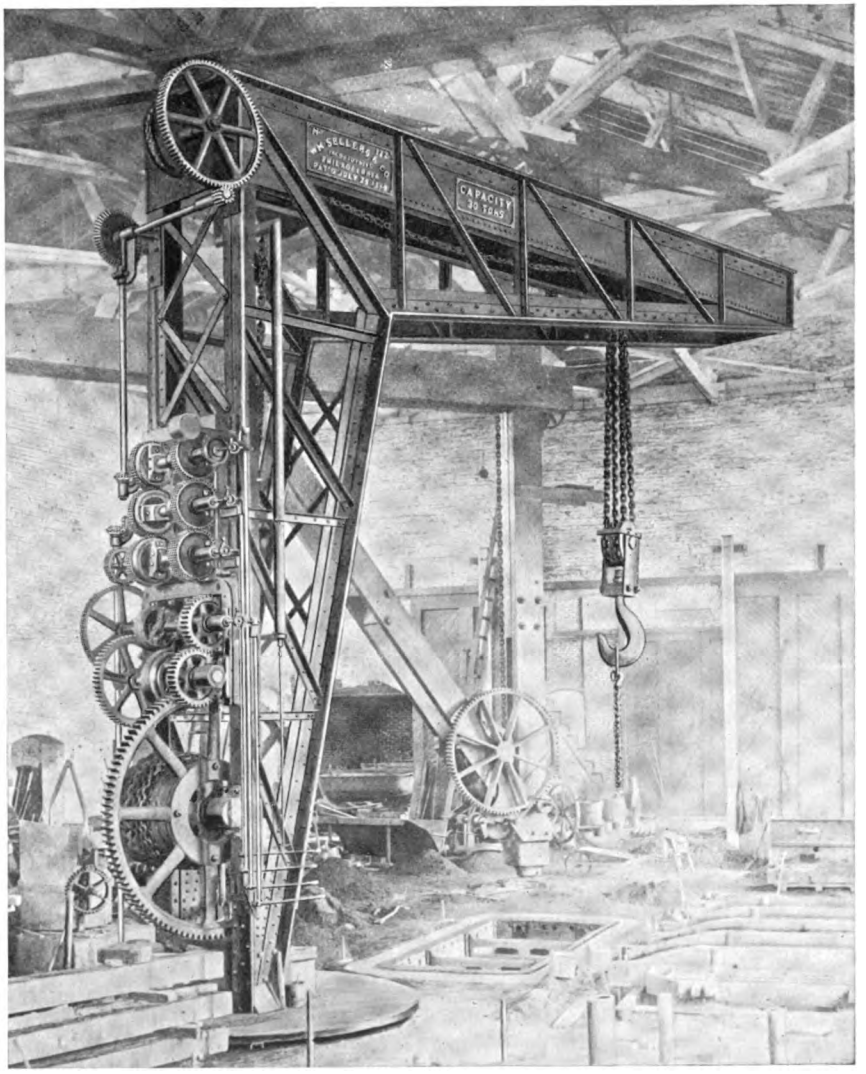
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Cranes.

UNTIL a recent period, very little attention was paid in this country to the improvement of cranes for heavy work. Any appliance that would lift the required load was considered by most people good enough, and economy of labor and time was neglected. In fact, our manufacturers were often as much behind their foreign competitors in facilities for lifting large machinery as our railroads and steamship terminals are now behind those of other civilized countries in appliances for rapidly handling the heaviest kinds of freight. New economic conditions, closer competition, and, above all, the remarkable improvements recently accomplished in cranes themselves, have produced an entire change of practice, and every progressive foundry and machine shop in the country has been improving its cranes, while an efficient system of handling its plant and product is now recognized as of prime importance in the arrangement of every new enterprise projected.

In this mechanical revolution we were among the pioneers. Early recognizing that the hand-crane must be superseded by something quicker and cheaper, we applied power to our jib-cranes. Then becoming convinced that a proper travelling crane would enable us to dispense with a number of jib-cranes, thus gaining largely in available floor space and rapidity of work, we sought among the leading makers of such appliances, then all in England, without finding a crane which realized our ideas as to speed and design. We were thus led to devise and build our own travelling cranes, which proved so successful that we were encouraged to take up the manufacture of such machines as a regular part of our business, and we do not hesitate to say that our cranes have proved eminently successful and satisfactory to our customers. We attribute our success chiefly to our careful designing and

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30-TON STEAM JIB-CRANE.—IN FOUNDRY OF THE J. MORTON POOLE CO., WILMINGTON, DEL.

Height of post, 26′; effective radius of hook, 23′. All movements by power. Driven by independent 8″ x 8″ engines, bolted to frame carrying machinery, receiving steam through upper pintle and discharging exhaust through step in foundation plate.

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thoroughly good workmanship. Realizing the vital importance of the crane and the amount of responsibility put upon it, we have allowed no detail in its mechanism to be neglected, and have calculated with care the strength of every part, allowing invariably a large factor of safety. In fact, our cranes are always designed to carry the full rated load for continuous working. Great care is taken to make all parts accessible for examination, to provide ample bearing surfaces, and the best facilities for lubrication. We avoid the use of worm-wheels, and as far as possible of bevels and very small spur-wheels. We reduce the chain friction to a minimum, and neglect no detail calculated to increase the efficiency of the operating mechanism. In all these respects we solicit examination and a comparison with competing cranes of the same rated capacity.

We pay particular attention to the hooks of our cranes, which are carefully designed, of correct mathematical proportions, and made of the best iron, forged and bent to shape. They are not steel castings. Our hooks are suspended upon ball-and-socket swivels, and in the larger sizes are provided in addition with anti-friction ball bearings for easy rotation.

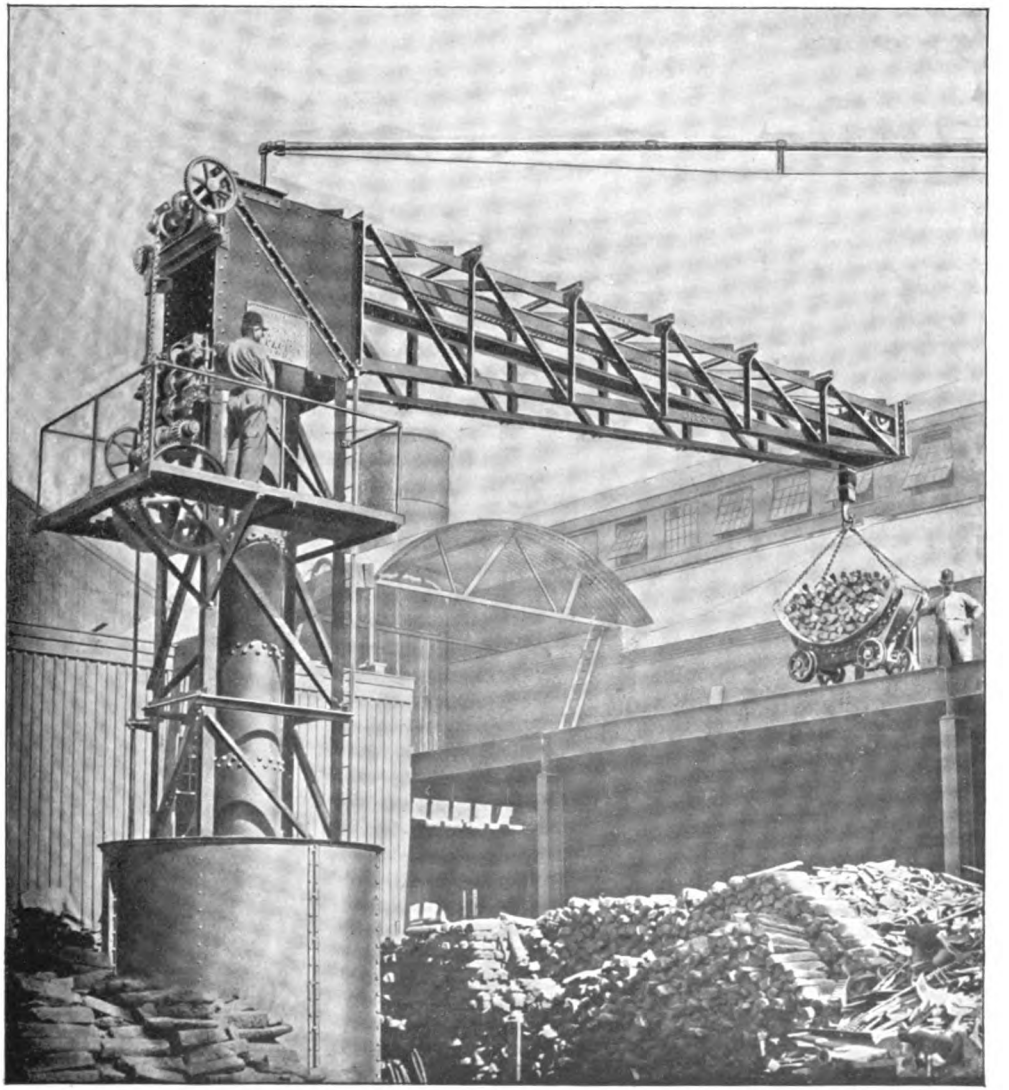
In general, we claim for our crane machinery that it is simple and accessible, efficient, and strong; and for our clutches and the method of operating them, that we are able to put any motion into action without shock, to stop and start the load without risk of injury to it, and to make small movements with ease and certainty.

We have drawings and patterns for a great variety of cranes not illustrated in these pages, and are always prepared to consider cranes for special purposes.

Swing-Cranes.

Cranes may be divided broadly into two general classes; the first, including the swing or jib-cranes, derricks, etc.; and the second, the various types of bridge-cranes, gantries, and overhead travelling cranes. Until recently, overhead travelling cranes, even when driven by power, were slow in action, and capable therefore of a

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5-TON STEAM PILLAR JIB-CRANE.

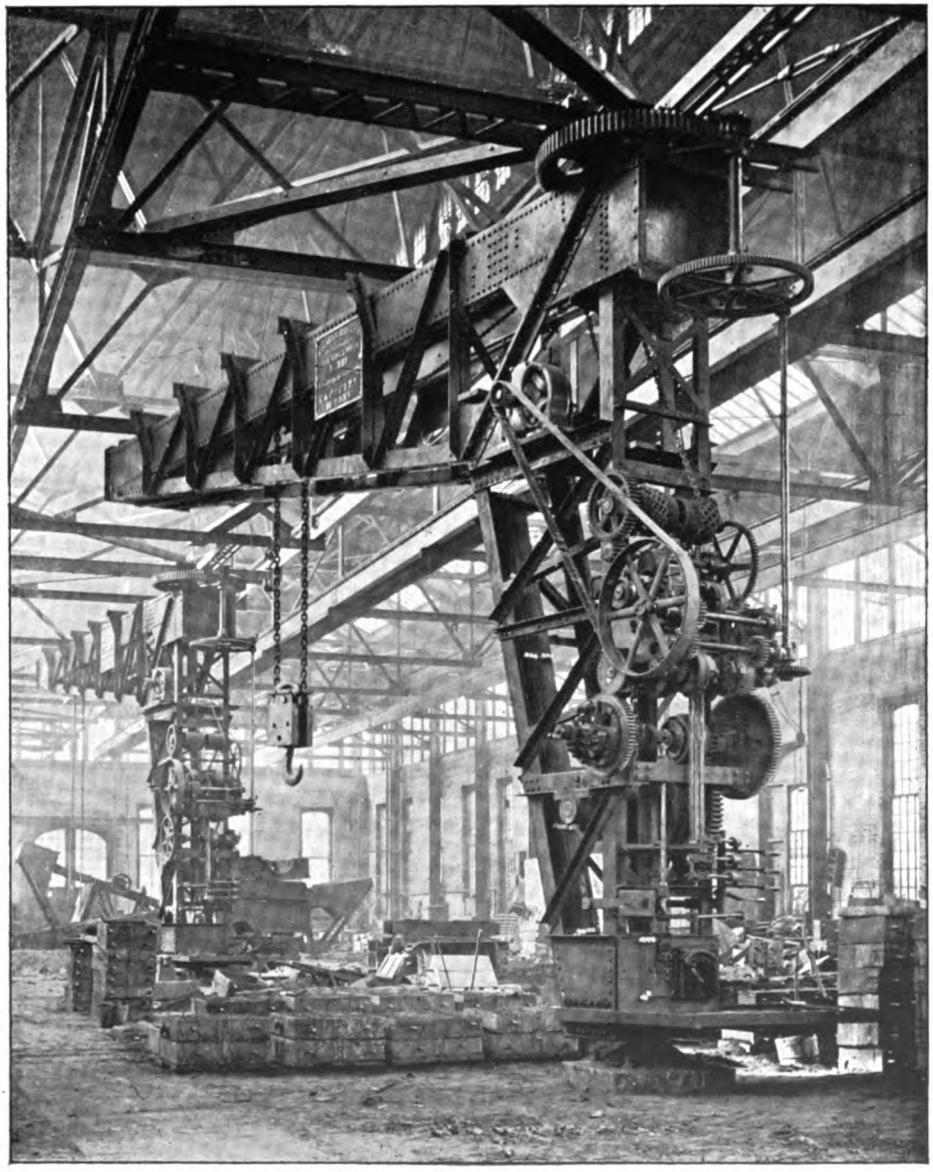
Carried upon riveted steel pillar, bolted to foundation, driven by independent steam-engine, and receiving steam from stationary boiler through top pintle bearing. Post of crane protected by cylindrical guard. Operating platform elevated. Maximum height of hook, 25 feet. Effective radius of the hook, 30 feet.

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very limited amount of work. In establishments requiring much lifting, the travelling cranes were supplemented by numerous jib-cranes, situated at points where frequent hoisting was most required. By greatly increasing the speed of travelling cranes—and in this effort we believe ourselves to have taken the initiative—the conditions have been greatly modified, and one efficient travelling crane will now do the work which formerly required a number of cranes. For general purposes, especially where a large area of floor surface is to be covered, the travelling crane is usually the better form; but there are many special purposes and many locations which require some form of swing-crane. In developing the travelling crane, therefore, we have at the same time improved the jib-crane type. In fact, the development of the two forms has proceeded side by side, and the contrast between the high-speed travelling crane of to-day and the old wooden hand traveller made by us forty years ago, is no more marked than is the difference between the wooden swing-cranes of those days and their modern successors with power driving-gear and iron frames.

The usual framing for the wooden jib-crane consisted of a post, a jib, and a diagonal strut from the base of the post to a point near the centre of the jib, and the earlier iron cranes followed closely the same form of construction; rolled beams took the place of the wooden ones, and the method of joining them was modified; but the general form remained the same. As the post and jib were each composed of two beams, united only at their ends and of little value laterally, it was difficult to make such cranes strong enough without the use of an excessive amount of material. We early discovered that this form of frame was not adapted for quick-acting power cranes, and introduced the improved type of frame, shown in the accompanying illustrations, which combines lightness and strength in a marked degree. In this form the trolley or carriage travels within the jib, which is cross-braced from side to side above the carriage. The post in the same manner is cross-braced and latticed on all four sides, while at the top and bottom of the post wide plates are used to thoroughly unite the parts of the frame. Cranes can be built in

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10-TON ELECTRIC JIB-CRANE.—IN FOUNDRY OF THE BALDWIN LOCOMOTIVE WORKS.

With two hoisting speeds. Effective radius of jib, 30 feet. Operated by single constant speed motor. Arranged to lower by power or brake, as may be required.

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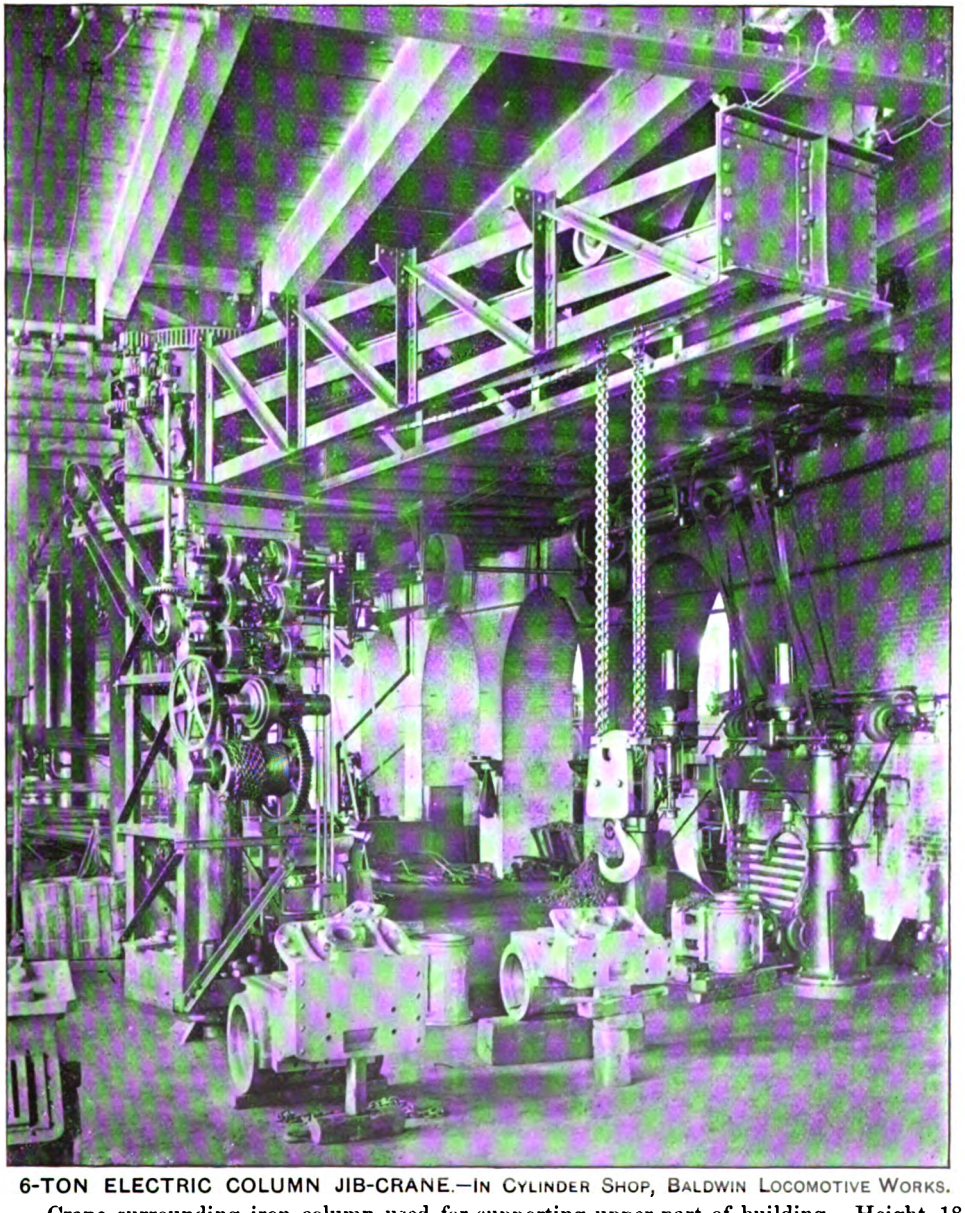
this form of great torsional strength, and able to stand the strain produced by rapid rotation of the loaded crane and its sudden stoppage, while the omission of the separate strut permits work to be moved much nearer to the axis of rotation than is possible with the old form of construction.

Jib-cranes may be supported on the top by bearings attached to the roof-girders or by struts from walls or columns, or they may be made to embrace columns which support the upper floor of a building, as in Plate No. 191, or the column may be a pillar like that of the crane shown in Plate No. 189, secured to a sufficient foundation and requiring no support from roof or wall; or the pillar may be bolted to the platform of a car of sufficient weight and size for use in various locations. Besides the jib-cranes described, in which the carriage supporting the load is arranged to travel radially along the jib, there are a number of swing-cranes having a fixed radius of action or a limited variation, by raising or lowering the end of the frame, which, vibrating about an axis near the centre of rotation, will move the load in and out through a limited distance. Such cranes are shown in Plates No. 193 and No. 197.

There is still some demand for cranes operated by hand only, and for swing-cranes of this kind we usually provide a crank-motion for the hoisting train, while the travel of the carriage is produced by a hand-chain operating the traversing gearing.

Jib-cranes—not including those operated by direct-acting air or water cylinders—may be driven in various ways: by independent steam-engines attached to the crane, by power obtained from the line shafting, by electric motor, etc. We use essentially the same machinery in all these cases, making only such changes as are required for the application of the particular motive power required. Our machinery consists primarily of a suitable framework carrying a pair of our improved friction clutches for each of the movements which it is desired to produce. The two clutches comprising each pair run in opposite directions, and thus the various movements of the crane can be made in either direction without reversing

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6-TON ELECTRIC COLUMN JIB-CRANE.—IN CYLINDER SHOP, BALDWIN LOCOMOTIVE WORKS.

Crane surrounding iron column used for supporting upper part of building. Height, 18 feet. Radius of jib, 20 feet. Driven by single motor.

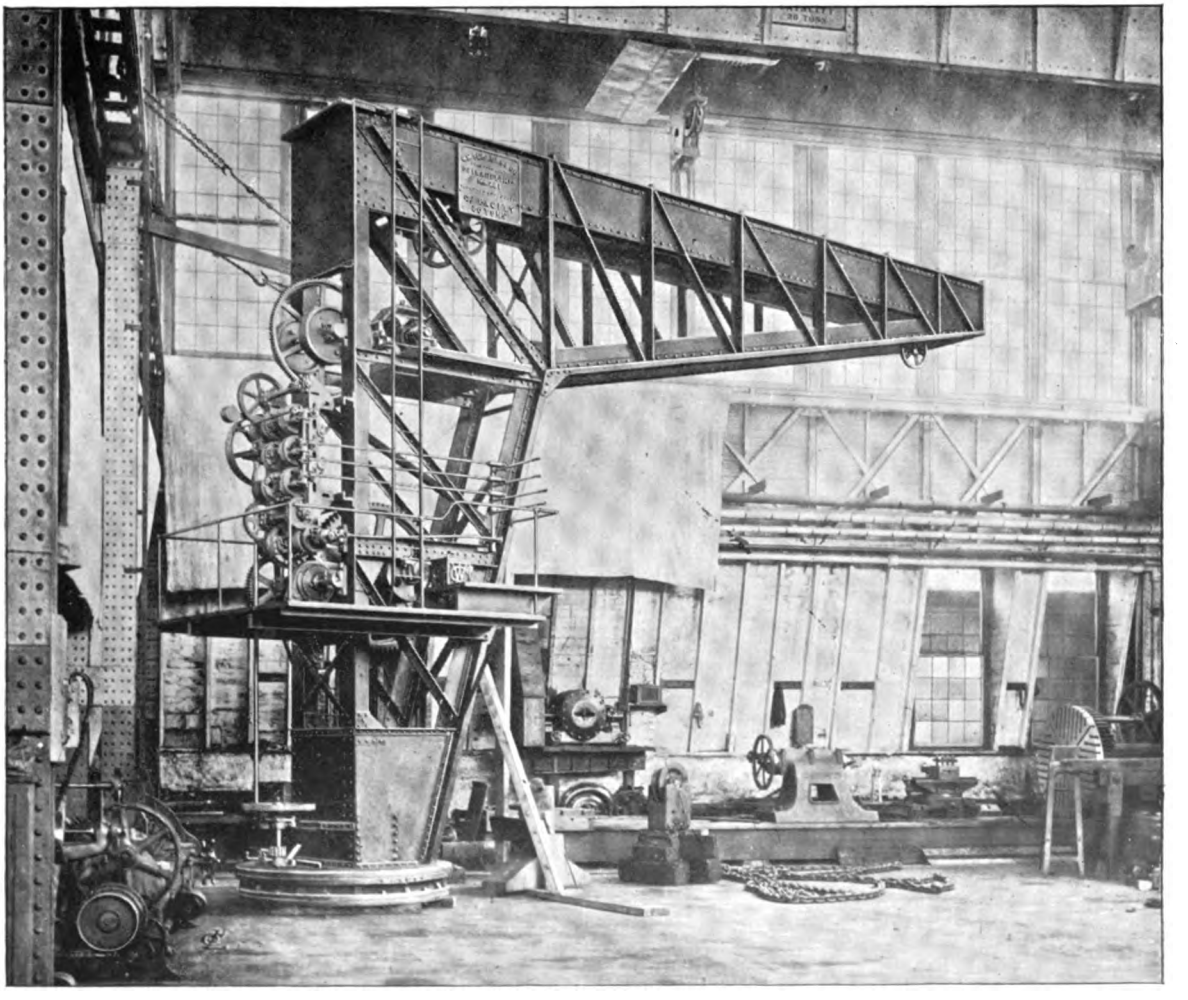
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the prime mover. The drum is usually arranged to carry all of the chain in one course without overlapping, and the load is held in any position by our patent automatic sustaining clutch, so that it is impossible for it to overhaul or run down; and the load must be lowered by power. In special cases, when it is required to lower by brake, we make a suitable arrangement for the purpose. The mechanism we use in our cranes, while compact and neat in appearance, is carefully designed to facilitate examination and repairs, and great attention is paid to proper lubrication of every part. Small cranes are generally made of one speed only; the larger sizes are provided with clutches for changing the speeds of the hoisting train; but it is usually found that one speed is sufficient for trolley travel. We have paid great attention to the elimination of unnecessary chain friction, and design our carriages to avoid the twisting tendency which is so objectionable in many jib-cranes.

Very little modification is required to apply power of any kind to cranes of this type. If it be desired to drive from line shafting, we usually put a vertical shaft through the upper pintle, connected by bevels with the operating mechanism at its lower end, and provided at its upper end either with bevel wheels operated by horizontal countershaft, or with a pulley driven directly from the line. When driven by independent engines, they are secured to the housings which carry the operating clutches; steam is supplied through a stuffing-box in the top pintle, and the exhaust passes through a similar stuffing-box in the lower step. If electricity is used, the motor is carried upon the crane frame in any convenient place and connected by belt or gearing to the driving shaft of the operating machinery. In our direct driven steam-cranes we do not reverse the engines; in our electric jib-cranes we do not usually reverse the motors. We prefer the prime mover to run at a constant speed in one direction only, and to make our changes in speed and direction through the operating mechanism. The requirements of users of cranes, however, are so varied that it is impossible to provide any general construction that will be available in all situations. We are constantly making special adaptations to meet peculiar cases, and are always ready to work up such designs.

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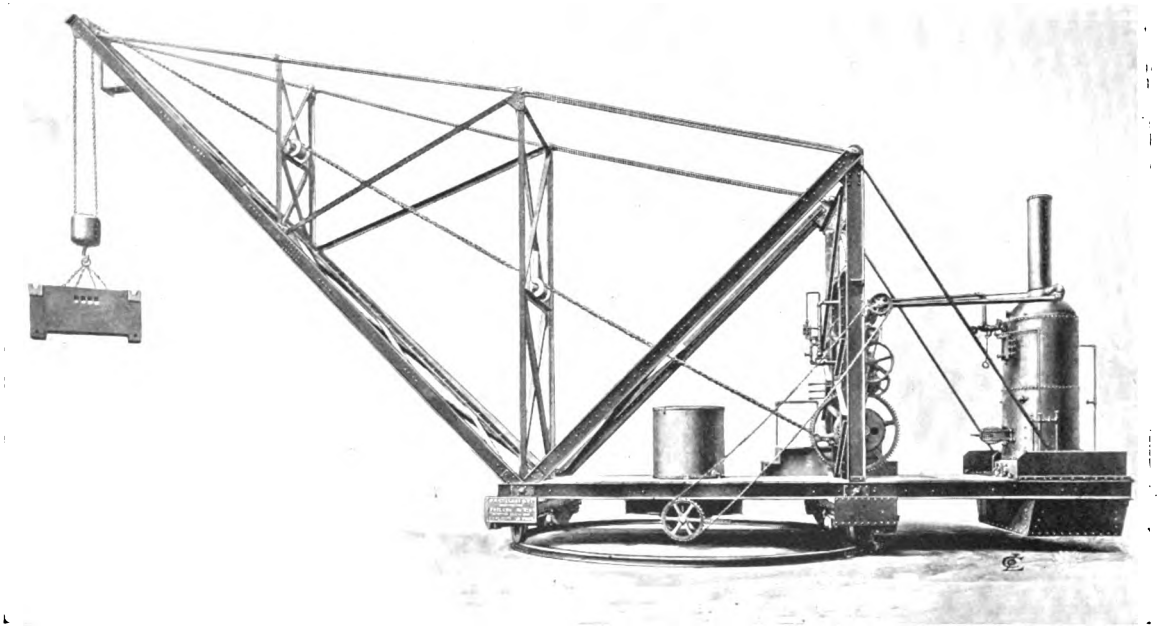
PLATE No. 192.



20-TON ELECTRIC JIB-CRANE.

Effective radius of hook, 31′ 9″. Post, 28 feet high. Elevated platform for operator. Turning-gear at base of post. Driven by single electric motor.

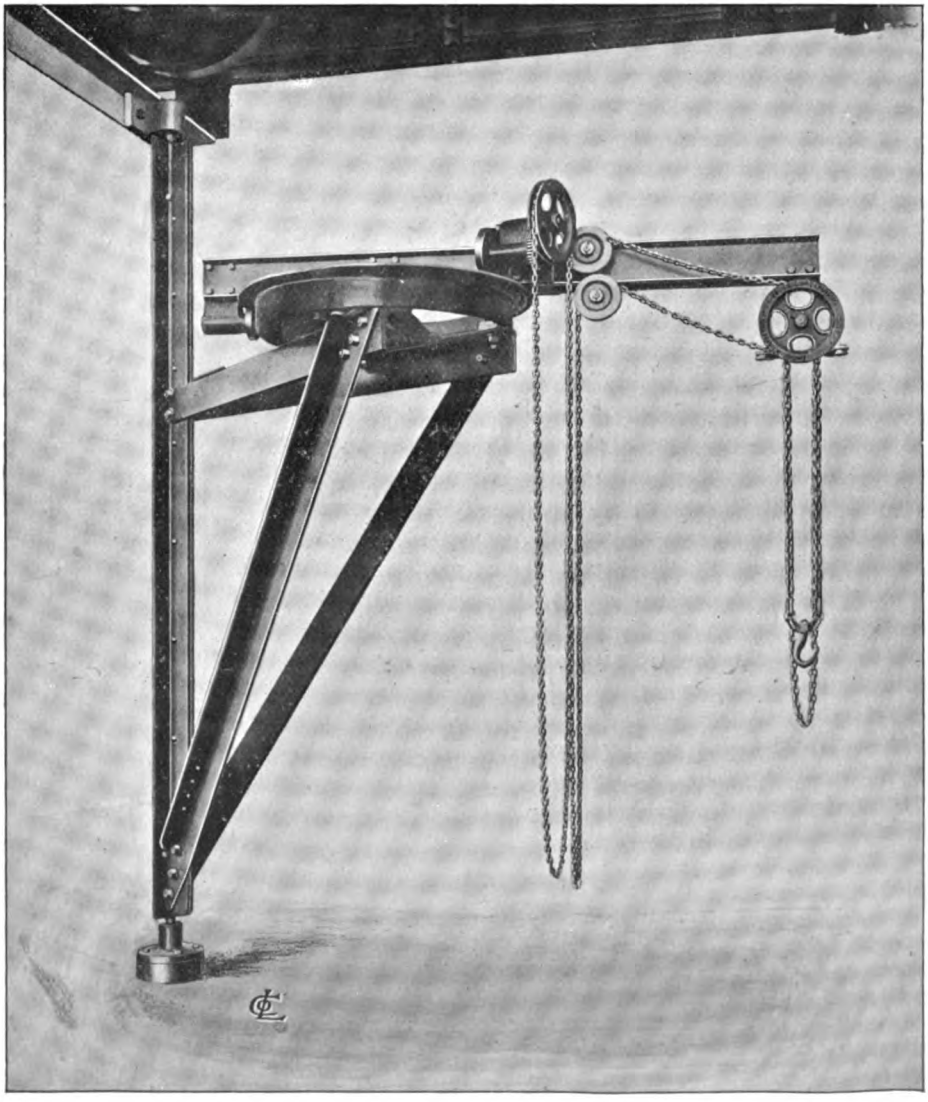
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10-TON SWING-CRANE.—WITH FIXED RADIUS OF ACTION.

Centre of rotation to centre of hook, 40 feet. Maximum hoist, 40 feet. Crane frame and machinery carried upon rotating platform, which also supports water-tank, boilers, and counter-weight. A useful crane for wharf purposes. Is carried on circular track 20 feet in diameter. Requires no masonry foundation. Is quick and handy.

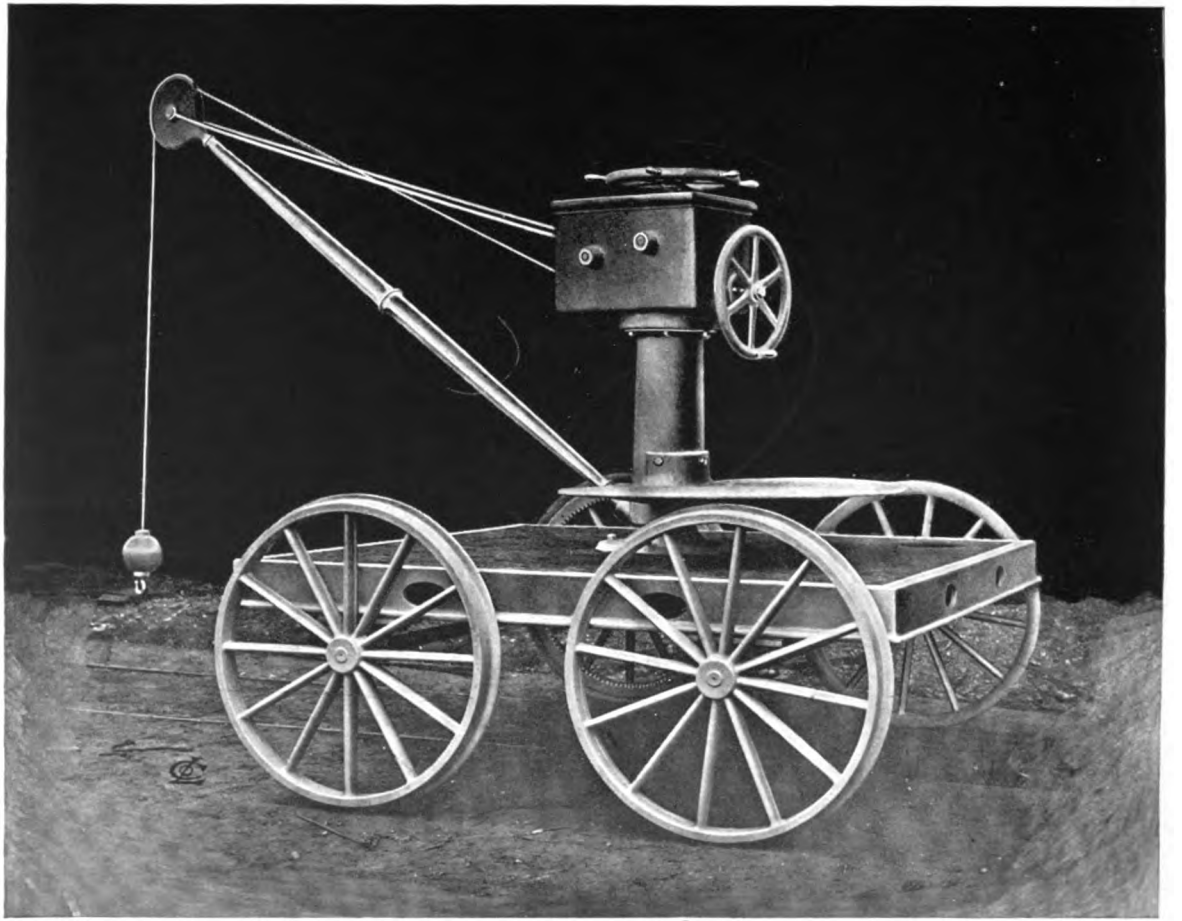
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2000 LB. HAND SWING-CRANE.
With supplemental jib, arranged to rotate about independent axis.

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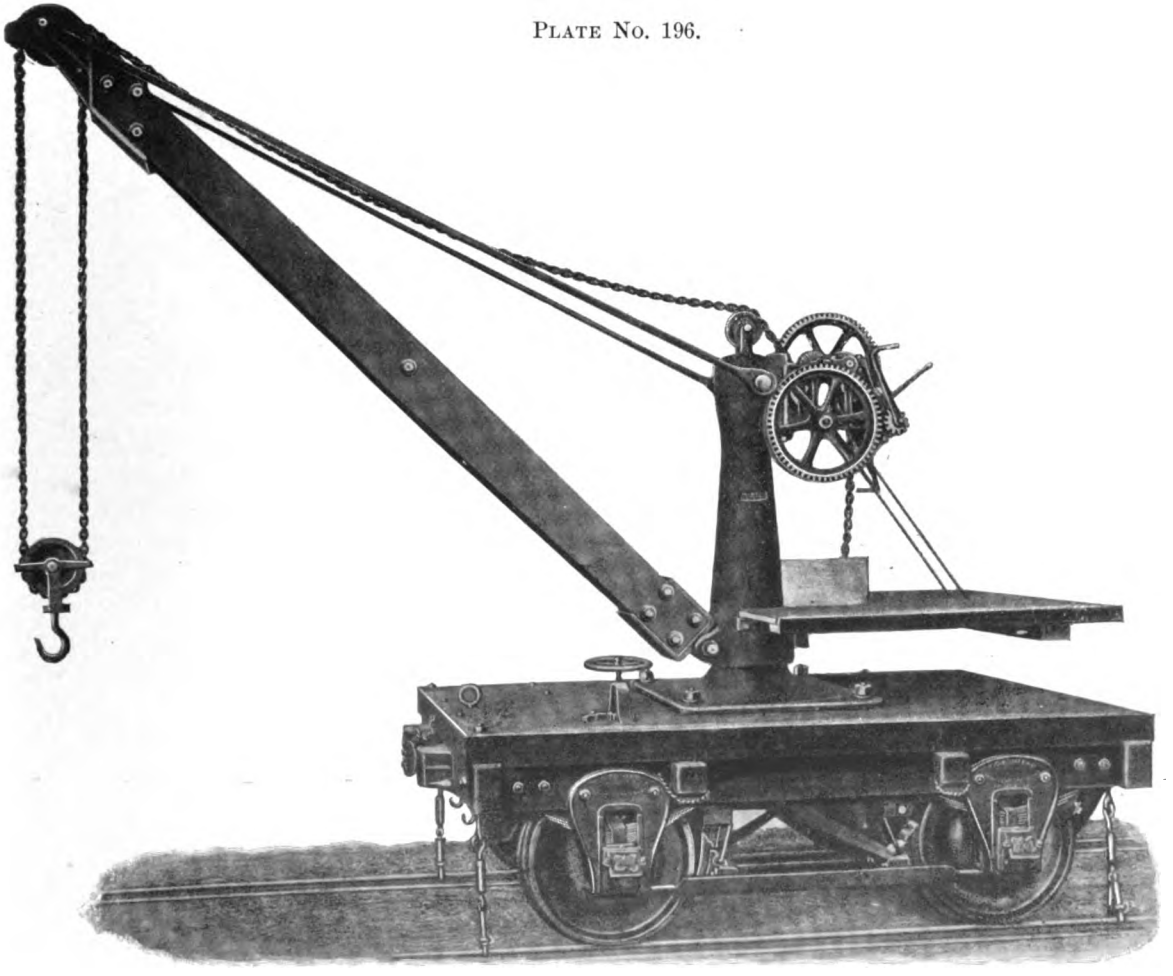
PLATE No. 195.



2000 LB. HAND-CAR CRANE.

Especially designed for use in wheel foundries. Crane is carried upon a car 9′ 3″ square, supported by four 48″ wheels, 9′ 10″ gauge. Hoisting and traversing operated from elevated platform attached to crane.

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5-TON CAR CRANE.

With cast-iron post mounted on railroad car, with any required gauge of track. Gearing for fast and slow motions. Strap-brake on large gear-wheel. Provided with clamps and bracket for securing car when hoisting. Usual radius of hook, 12 feet. Made with wood or iron jib, as required. Simple, quick, and efficient.

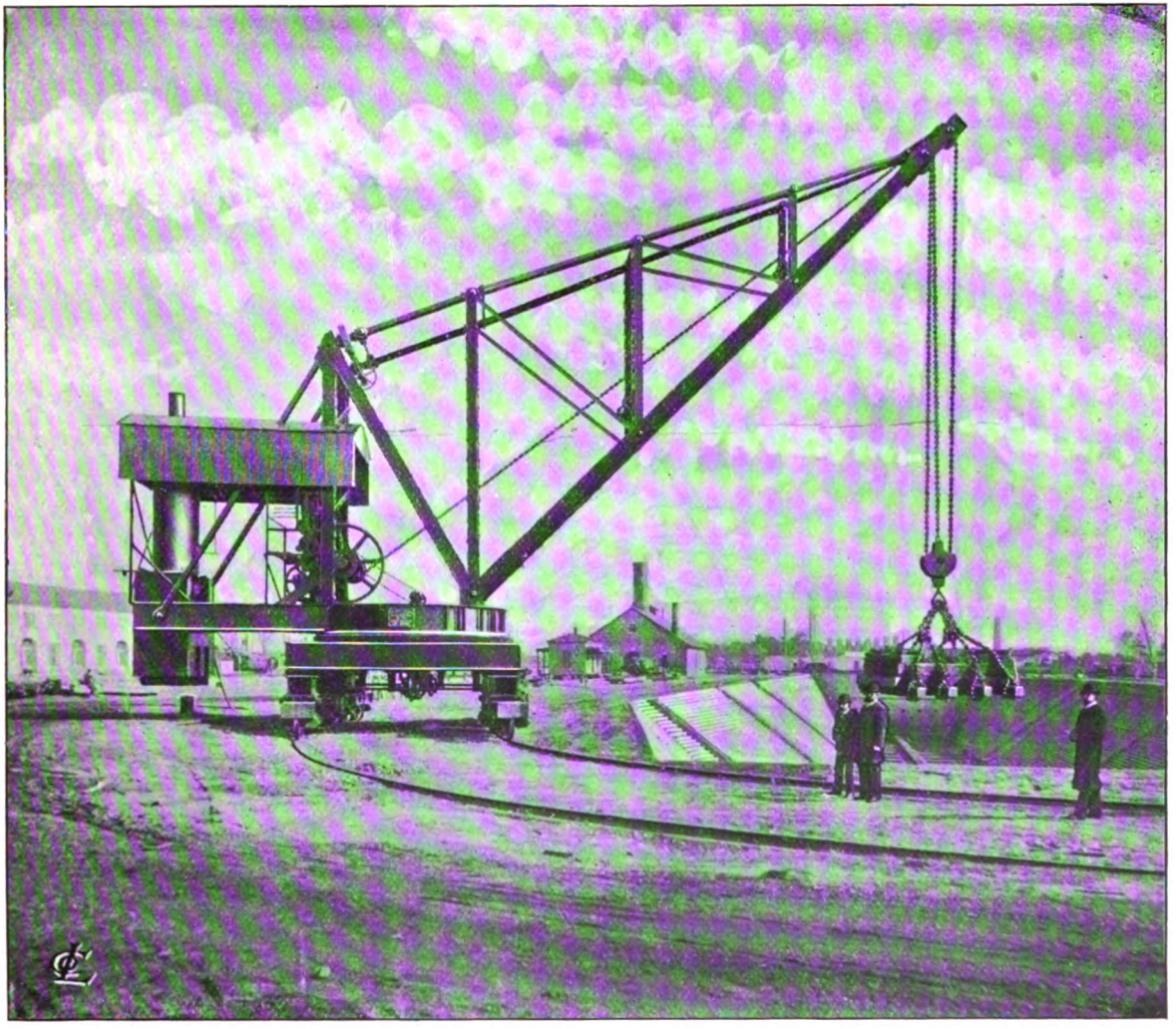
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40-Ton Locomotive Car Crane.

THE car crane illustrated on the opposite page is one of those built by us for the U. S. Government for placing the heavy armor plates upon the new war ships. They are arranged to run upon a track of 18 feet gauge, and are able to travel around the end of the dry dock, so as to command both sides of the ship. The car upon which the crane is mounted is supported by sixteen 37″ steel-tired wheels with double flanges, the trucks being so arranged as to equalize the load on the wheels and to permit the car to travel on curved tracks. Mounted upon the car is a rotating platform or drum which carries the machinery and crane-jib, and upon a projection opposite the jib supports the boiler and the necessary counterweights.

The drum is centred to the car by a heavy steel pin, and the weight is taken upon steel rollers running in turned steel tracks. The jib is pivoted close to the platform, and is arranged to vibrate so as to change the radius of the hook from 56 feet to 70 feet. The load is carried by three parts of $1\frac{3}{8}$″ chain, which is wound on a large drum; the hoisting train being provided with our improved sustaining clutch, and operated through friction clutches from a pair of engines with cylinders 10″ diameter and 12″ stroke. The engines run without reversing, and the various movements are operated through suitable gearing and friction clutches. The crane is fully counterbalanced, and is therefore able to pick up its load and travel with it to any desired point. As shown in the plate, the jib is reduced to its shortest overreach, and the crane is loaded with the full test load of forty gross tons.

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40-TON LOCOMOTIVE CAR CRANE.—IN PLACE ALONGSIDE OF DRY-DOCK, PORTSMOUTH NAVY YARD, VA.

Capacity of hoist, 90,000 pounds at 56 feet radius of hook; 64,000 pounds at 70 feet radius. Highest position of hook above rails, 56 feet. Gauge of track, 18 feet. Trucks arranged to equalize load on wheels and permit crane to travel around curves of 66 feet radius. Duplicate cranes have also been supplied to the U. S. Navy Department for other locations.

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Hydraulic Cranes.

THERE are many locations where cranes are most conveniently operated by water under pressure or by compressed air, especially where the cranes are simple in construction and designed for one or two movements only. Direct-acting hoists are the simplest and most efficient, and where establishments are already provided with hydraulic accumulator and pumps or with a compressed air plant, such machines can be introduced to great advantage. We have built a number of various types for many special purposes, and are prepared to submit prices and designs for hydraulic cranes of all kinds. We illustrate on the opposite page a simple form of hydraulic pillar crane particularly adapted for certain classes of foundry work, or for putting work on machine tools, since the arrangement of levers is such that the operator can control the movement of the hoist while standing at the load. The cylinder is brass-lined and is double-acting, and a heavy counterweight is not required to overhaul the load.

The crane may be bolted directly to floor or foundation, and no portion extends below the floor line excepting the pipe connections. The capacity of the crane in Plate No. 198 is 2240 pounds. Radius of hook, 9′ 6″. Height of hook in highest position above floor, 8″. Actual lift, 7 feet. We also manufacture a similar crane of 4000 pounds capacity, with a hook radius 9′ 8″, and a similar stroke of 7′ 8″. These machines are part of a series of special hydraulic machines that we designed for the equipment of the wheel foundry of the Pennsylvania Railroad Company at Altoona, Pa.; the equipment included, also, hydraulic ladle tilting machinery, iron breakers, pitting crane, platform elevators, etc.

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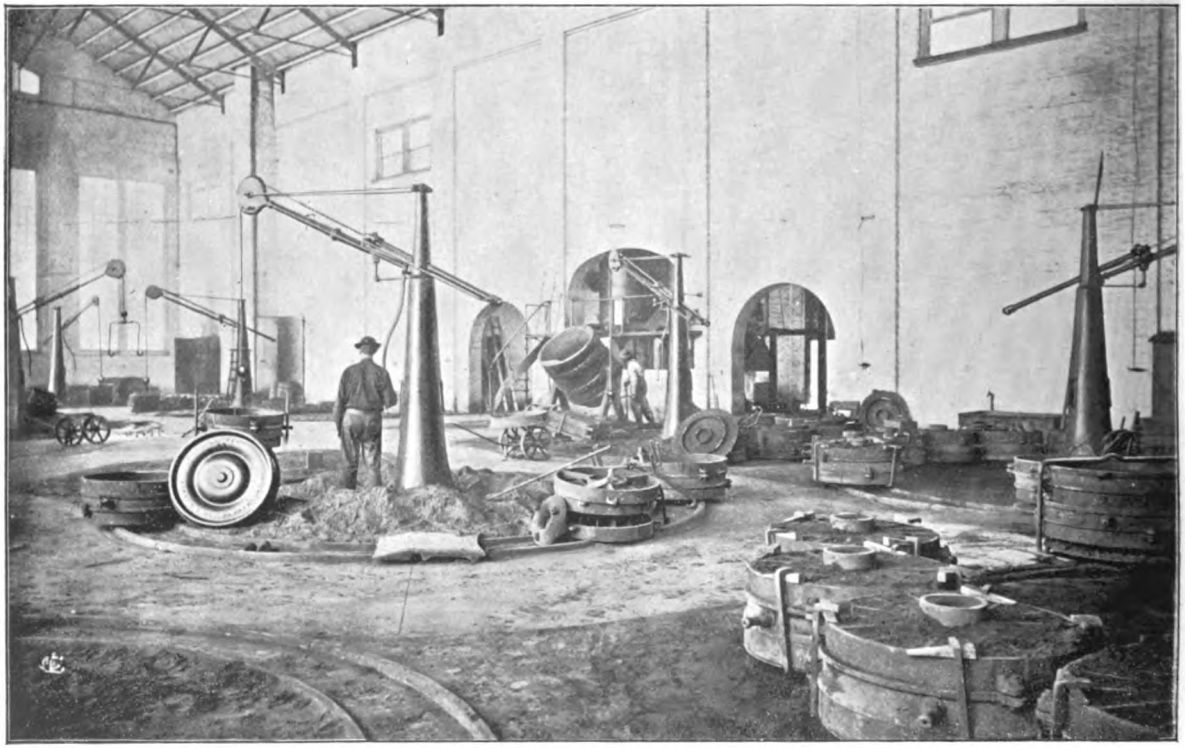


1-TON HYDRAULIC PILLAR CRANE.

(For description, see page 318.)

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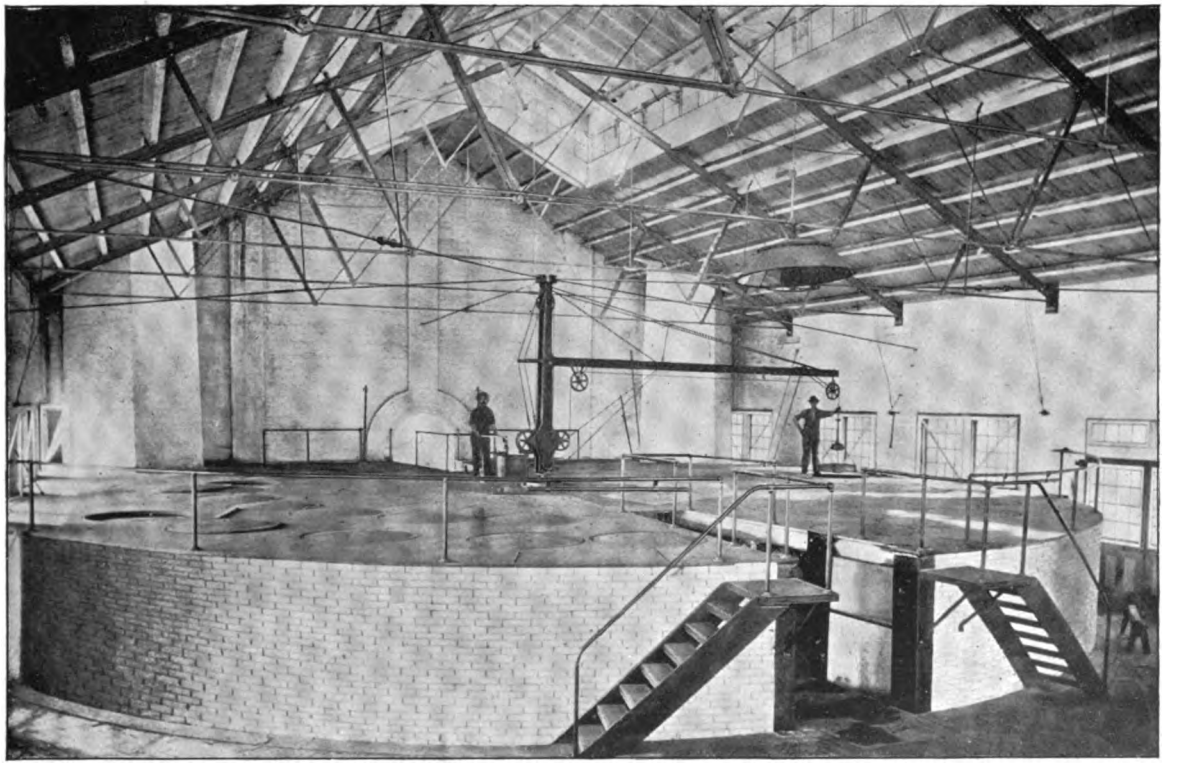
PLATE NO. 199.



VIEW IN CAR-WHEEL FOUNDRY OF PENNSYLVANIA RAILROAD, SHOWING HYDRAULIC MOULDING CRANES AND LADLE-TILTING DEVICE.

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PLATE NO. 200.



HYDRAULIC CRANE.—FOR THE ANNEALING FURNACE OF THE WHEEL FOUNDRY OF THE PENNSYLVANIA RAILROAD.

Rotates and hoists by power. Automatic hooks for holding the wheels.

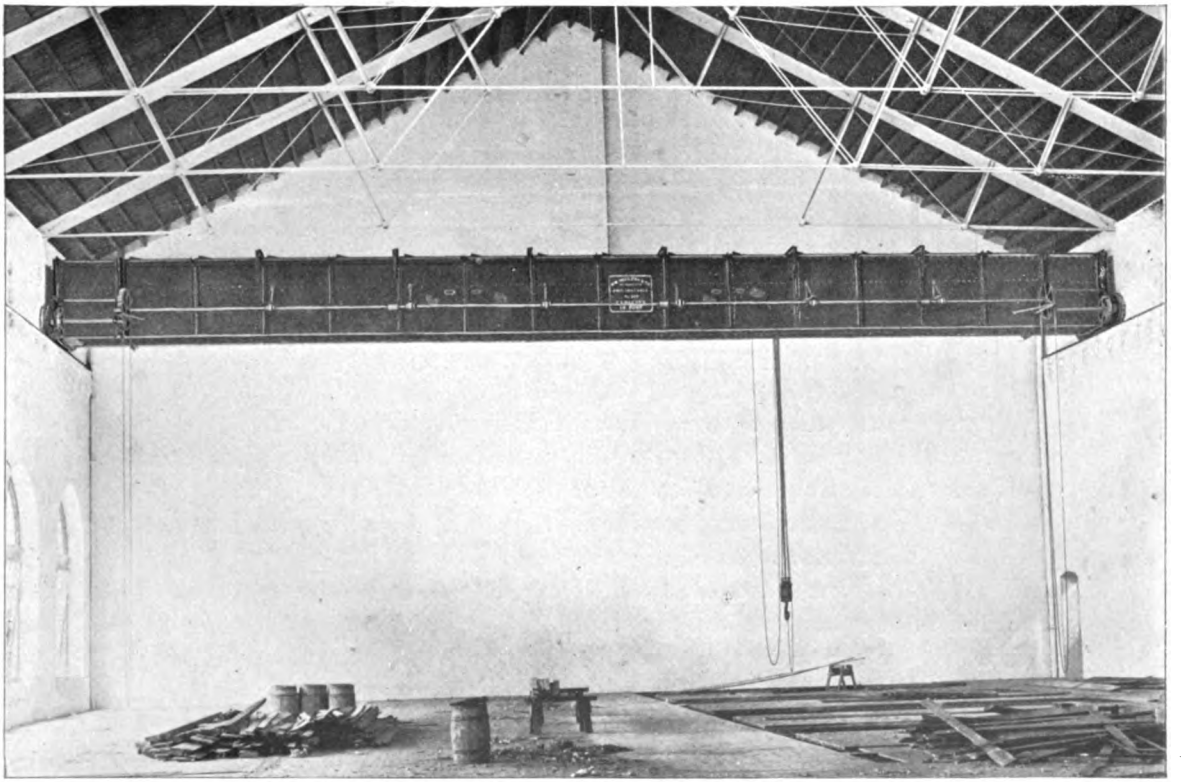
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Travelling Cranes.

IT has become general practice to designate by the name *travelling crane* that type which consists of a bridge mounted upon wheels, supported upon an elevated track and having two motions in a horizontal plane, namely: a longitudinal motion along the runway rails, and a transverse motion within or upon the bridge itself. Such cranes were early employed, first operated by hand only, then by independent steam-engines, and to a large extent by a rope, and later by a square shaft supported on movable bearings along the runway. Until within a few years all such cranes were very slow in action, and, as far as we know, the first cranes approximating in speed of bridge travel the practice of to-day, were built by ourselves. We were led to consider the subject from the fact that we could not get from the then leading makers travelling cranes approaching in speed the velocity which we considered essential for our own business. The speeds which we produced were considered phenomenal, and by our competitors were condemned as useless. We were interested, however, to observe that, as soon as they learned how to build rapid running cranes, they changed their views as to the utility of quick speeds. Our earlier power-travelling cranes were usually driven by square shafting, and for this purpose we invented a movable bearing, provided with a cap, which, being locked in place, enabled us to drive the shaft at a velocity not practicable while the shaft was carried in open bearings, as had previously been the practice, and at the same time the cap protected the bearing from dirt; more than this, the movement of our square shaft-bearings is so correct, and they are so well supported, that we were enabled to increase the length of the bearing, and by thus reducing the pressure per square inch, increase the durability of the shaft and bearing. A crane driven in this way is shown in Plate No. 206, and we have many other examples of such cranes which have been running successfully for years. The electric motor, how-

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PLATE NO. 201.



10-TON HAND-TRAVELLING CRANE.—IN THE MARKET STREET POWER-HOUSE OF THE PHILADELPHIA TRACTION COMPANY.

Span, 80 feet. Hoist, 22 feet. Operated by hand chains from floor. Spur-geared machinery of high efficiency. Retaining device to prevent load from running down. Sometimes we arrange our cranes with small electric motor for traversing bridge only. This is a handy type of crane for use in the power stations of electric railways and similar locations where a crane may be required to handle heavy parts of engines and dynamos during erection and repairs.

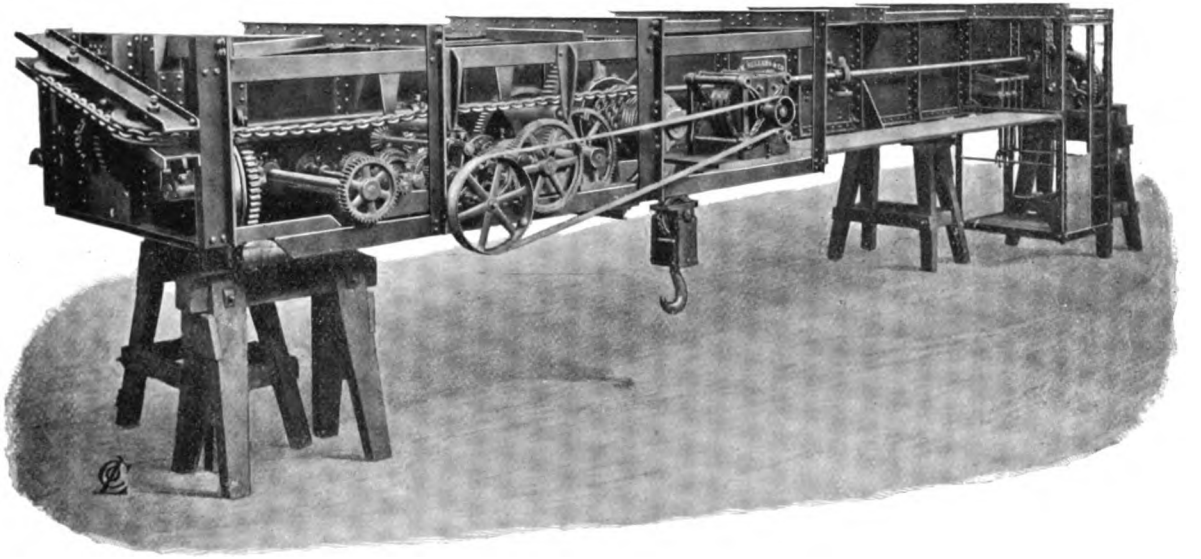
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ever, furnishes by far the most convenient means yet devised of communicating power from a stationary source to the operating mechanism of a travelling crane. There are two methods of employing the electric motor upon the crane. The first, which was the earlier application, merely substitutes for the square shaft, rope, or other prime mover, an electric motor carried upon the crane itself. The distribution of the power to the various parts of the machinery, the stopping and starting of the different movements, are effected by mechanical means. In the other type, called for convenience the "all electric," a motor is provided for each movement which it is desired to make; thus, there is one for travelling the bridge and another for hoisting the load, while a third is required for traversing the carriage within the bridge. In this type of crane the various movements are controlled by stopping, starting, or reversing the motors governing these movements, and changes of speed are commonly produced by changing the speed of the motor by Rheostat or otherwise.

There is a popular idea that this second type of crane, the "all electric," dispenses with much machinery necessary for the former type; but, in point of fact, it is only the machinery of transmission and the clutches which can be avoided. The reduction of gearing necessary between the motor and the work remains practically the same, while for the mechanical parts omitted, electrical equivalents are introduced, and with them a certain amount of mystery which is beyond the ken of the untrained mechanic. For ordinary establishments not employing skilled electricians, we are convinced that the single motor type of crane is in every respect preferable, and for any location this type of crane possesses one important advantage over the "all electric" crane which is not usually recognized; in the latter type, the motor, the machinery, and the load are put in motion at the same time, requiring a very large amount of power at the moment of starting, and an appreciable interval of time to get up the normal velocity. In the single-motor crane the motor and a portion of the machinery are running at speed before the work is added. The inertia of these moving parts acts as a fly-wheel to assist in overcoming the resistance of the load when the latter is applied; as a consequence, the

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PLATE NO. 202.



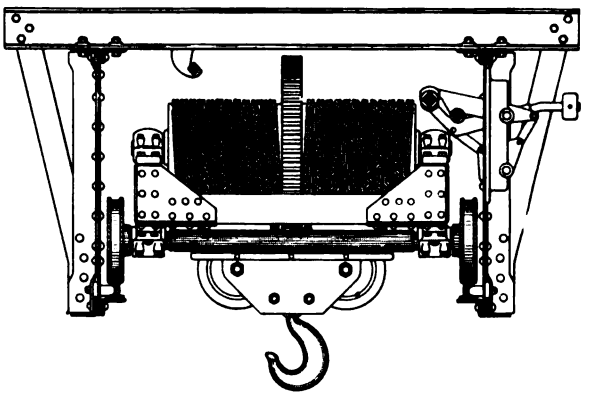
10-TON ELECTRIC TRAVELLING CRANE.

Fixed drum type. Operated by single motor. Span, 33 feet. A very handy machine-shop crane, as it requires but little head-room, and the hook works very close to the ends of the bridge.

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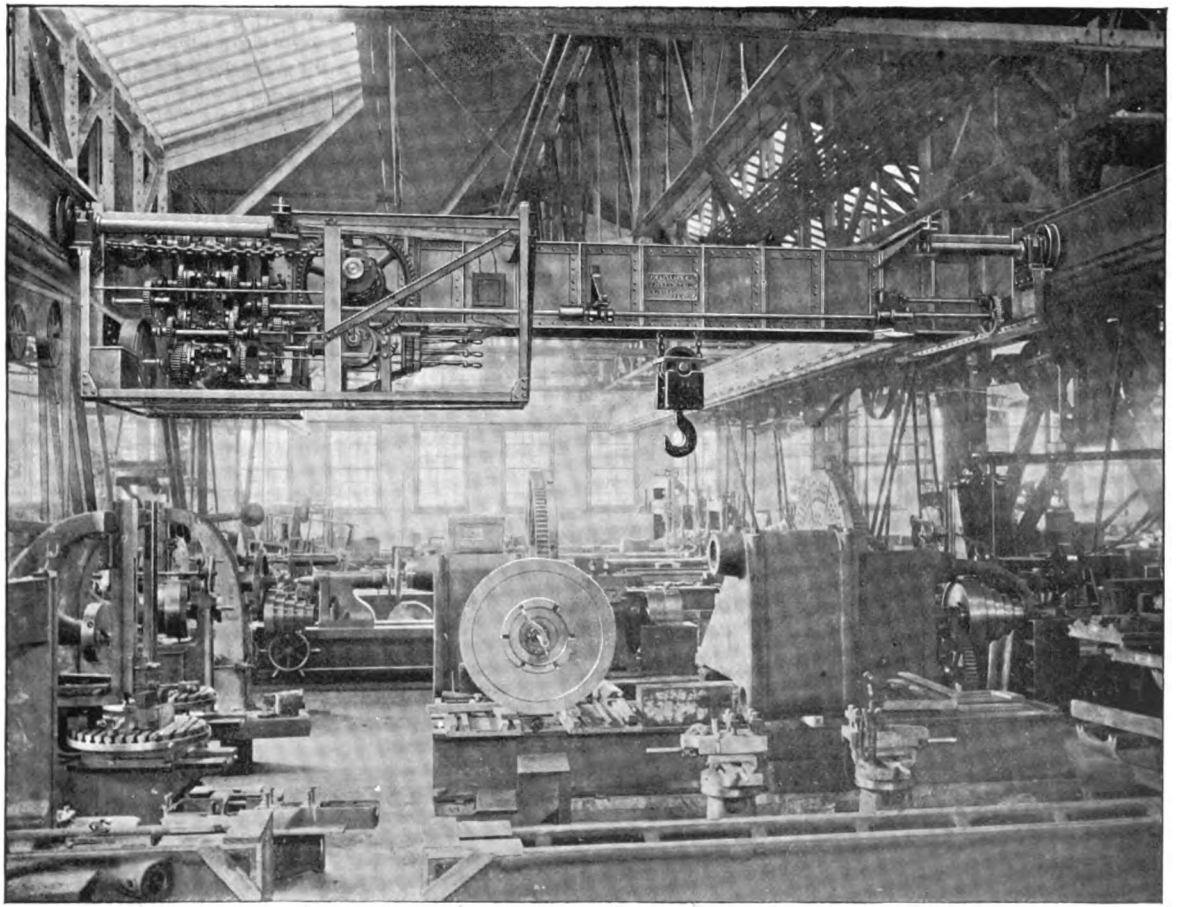
properly constructed single motor crane is quicker in starting, and can handle more work in a given time than a crane of the "all electric" type, while it is possible to make small movements of the bridge and trolley with greater accuracy and certainty.

An important feature in our travelling cranes, and one to which we invite particular attention, is the form of bridge which we generally use. It will be noticed that this consists of two plate girders of uniform depth, connected together by cross and diagonal bracing on the top flanges, and carrying on their contiguous faces near the lower flange, the rails upon which the carriage travels. These girders are carried from the supporting rails on the runways, clearing them by an inch or two where the carrying wheels are supported in bearings attached to wing-plates on the outsides of the girders. The trolley running within the bridge and close to its lower edge, the load is supported upon the tension side of the beam; the centre of gravity of the entire mass is brought as near as possible to the point of support, and the bracing which ties the two girders together insures a lateral stiffness which is amply sufficient to resist the transverse action produced by sudden stopping or starting of the heavily loaded bridge. That this action is not insignificant in a quick crane is now generally recognized, and those makers of travelling cranes who carry the trolley upon the upper flanges of the girders have been forced to meet this oversetting tendency by widening the flanges of their girders, by making box-girders instead of plain plate-girders, or by introducing external horizontal trusses, in



SECTION THROUGH BRIDGE WITH TROLLEY IN POSITION.

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15-TON ELECTRIC TRAVELLING CRANE.—IN WORKS OF WM. SELLERS & CO., INCORPORATED.

Fixed drum type. Operated by single motor. Span, 32 feet. Arranged with overhung wheels running on rails in girder supported wholly from roof. This is a crane erected in a portion of our own works, where the available head-room is very limited. The crane is used for putting work on a number of machine tools, and also for erecting purposes.

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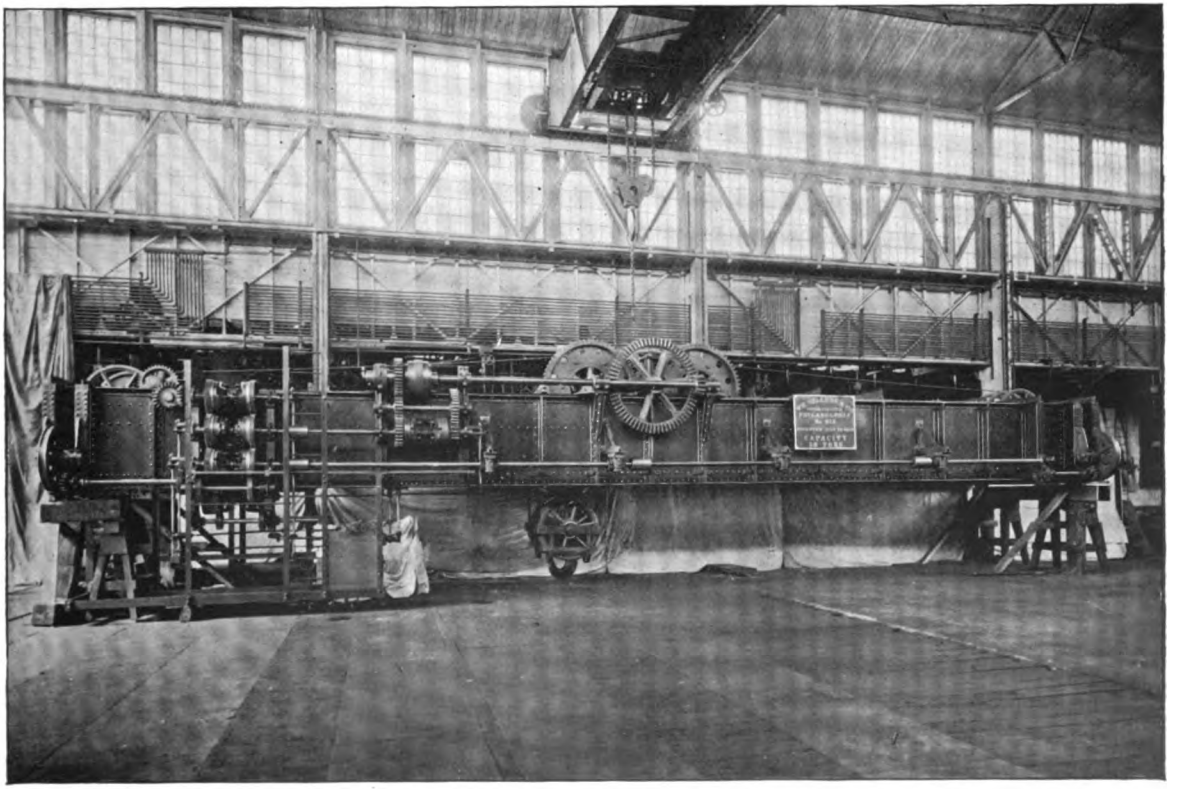
either case, increasing the weight of the bridge beyond that which is necessary to support the vertical loads. In very long spans, this increase of bridge weight is a serious matter, involving, as it does, not only increased first cost of bridge, but constant expense in moving useless material back and forth. In a well-known instance, in which the oversetting tendency of the trolley was not sufficiently provided for, it will be remembered that the bridge collapsed, and the whole structure fell to the floor with fatal results.

We think it is obvious that our construction presents clearly the advantages we have enumerated, and this becomes more evident as the span is increased. We have, for example, built travelling cranes with a span as long as 134 feet between carrying rails, and to obtain in single girders the lateral stiffness which we secured by our system of top bracing would be almost impracticable with any reasonable increase of weight. Fancy a long railroad bridge span without lateral connections between the trusses!

The objection usually urged against our form of construction is that the load is carried to one side of the web of the girder, thus tending to deflect the latter from a vertical plane. This tendency undoubtedly exists, but, owing to the small amount of the eccentricity, it is relatively insignificant, and is easily resisted. The deep cross-braces on top of the bridge are extended beyond the girders and connected by diagonal struts with the lower flanges of the girders. The tendency to spread is thus converted into a tendency to bend the cross-braces, and there is no difficulty in providing ample strength in these members to resist the bending moment; nor is there anything revolutionary or contrary to good practice in this construction. The strain is identical with that produced in the vertical drill-press, the slotter, punching- and shearing-machines, and the riveter; and in these it is easily met by properly proportioning the frame of the machine; although, in the machines cited, the whole load acts to spread the frame, while in our cranes the horizontal component is but a small fraction of the load. It is sometimes alleged that our trolley, being enclosed within the bridge, is not so easy to get at as though it were

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PLATE NO. 204.



50-TON ELECTRIC TRAVELLING CRANE.

Fixed drum type. Drums two in number, fixed in the centre of bridge. Load lifted by eight parts of $1\frac{1}{8}''$ steel rope. Span, 60 feet; hoist, 164 feet. Driven by single motor. This is a special crane designed and built for the Niagara Falls Power Co., now used in their power-house in assembling wheels and dynamos. It is peculiar on account of the great length of hoist required.

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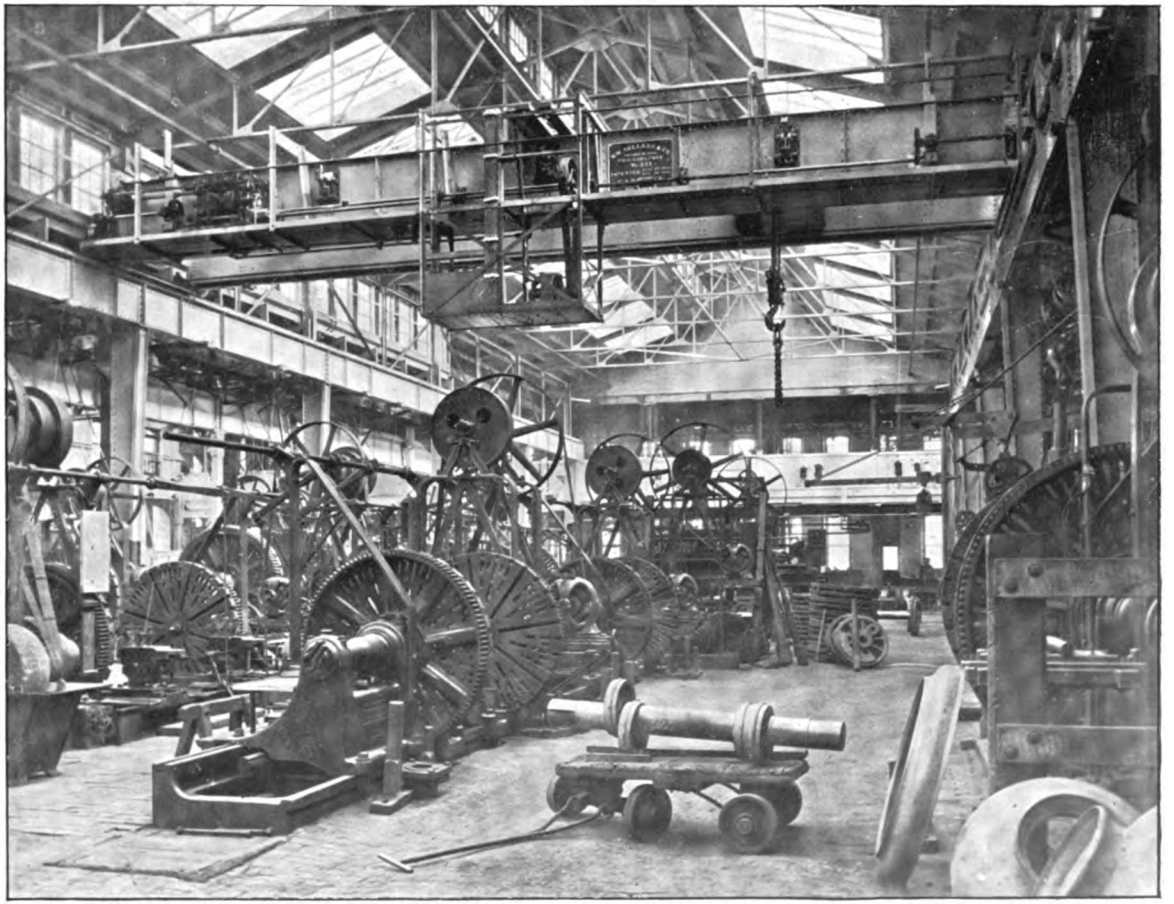
on top. This is to some extent true; but on the other hand, besides the advantages already enumerated, we may add, that in our case the cross-bracing affords an attachment for a hoisting tackle, if it be desired to remove the trolley or any portion of it; while with the external trolley, a separate structure must be erected for this purpose, unless the roof of the building can be relied upon to stand the load, which is not usually the case.

There are two general arrangements of machinery employed in our travelling cranes; these form two distinct types or styles. In the first, the trolley contains the hoisting mechanism and drums. In the other, the drum and hoisting machinery are attached to the bridge at some fixed point, and the chain or wire rope is led around suitable sheaves and through the trolley or carriage: this is exactly the arrangement of hoisting machinery which is used in jib-cranes. The first type requires usually a larger and deeper bridge, but the movement of the hook is steady, and is free from any irregularity of motion such as may be produced by the sagging of the chains in the fixed drum or jib-crane type. This irregularity is insignificant in short cranes, and for many purposes the fixed drum-cranes are perfectly satisfactory, and as they occupy very little head-room, are adapted for old shops and other locations where vertical height is limited. Both types of our cranes hoist the load in a vertical line without lateral movement and without twisting. This is an important matter, especially for foundry work.

Travelling cranes are usually moved along the runway by the traction of the supporting wheels only; but in many cases we supply spur-wheels at the ends of the bridge, engaging with cast racks attached to the rails on the runways. While not usually absolutely necessary, the racks afford a certain means of squaring the bridge and preventing any accidental derangement of its position, and they give a more positive control of the bridge movement than can be obtained by friction of the wheels on the rails. The rails for travelling cranes should be provided with efficient end-chocks or bumpers, for preventing the bridge from running beyond the proper point. Those built by us are arranged to bring the crane gradually to a stop without shock, and yet always maintain their proper alignment.

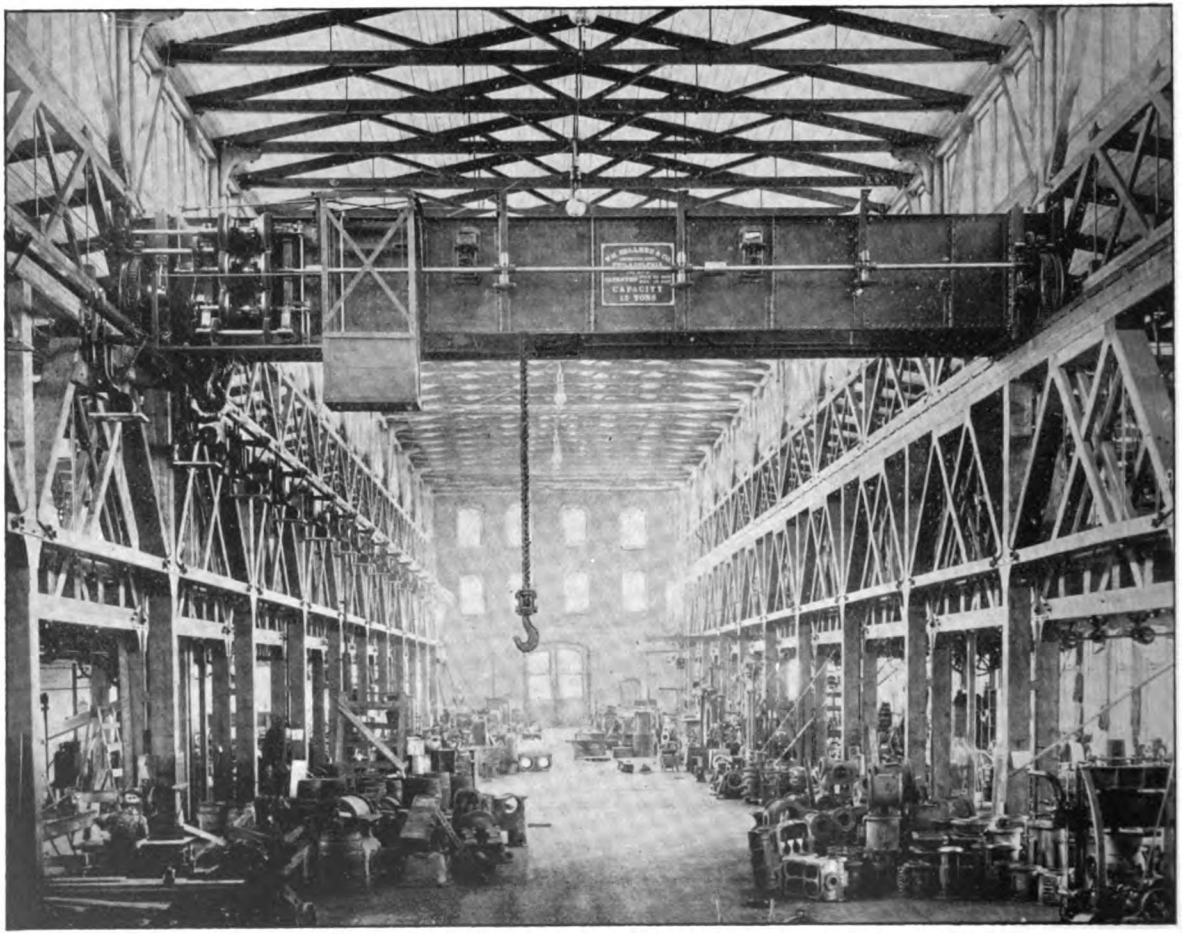
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PLATE No. 205.



10-TON TRAVELLING CRANE.—IN WHEEL-SHOP, BALDWIN LOCOMOTIVE WORKS.
Driven by single motor and operated from hanging platform in the centre. Span, 48 feet.

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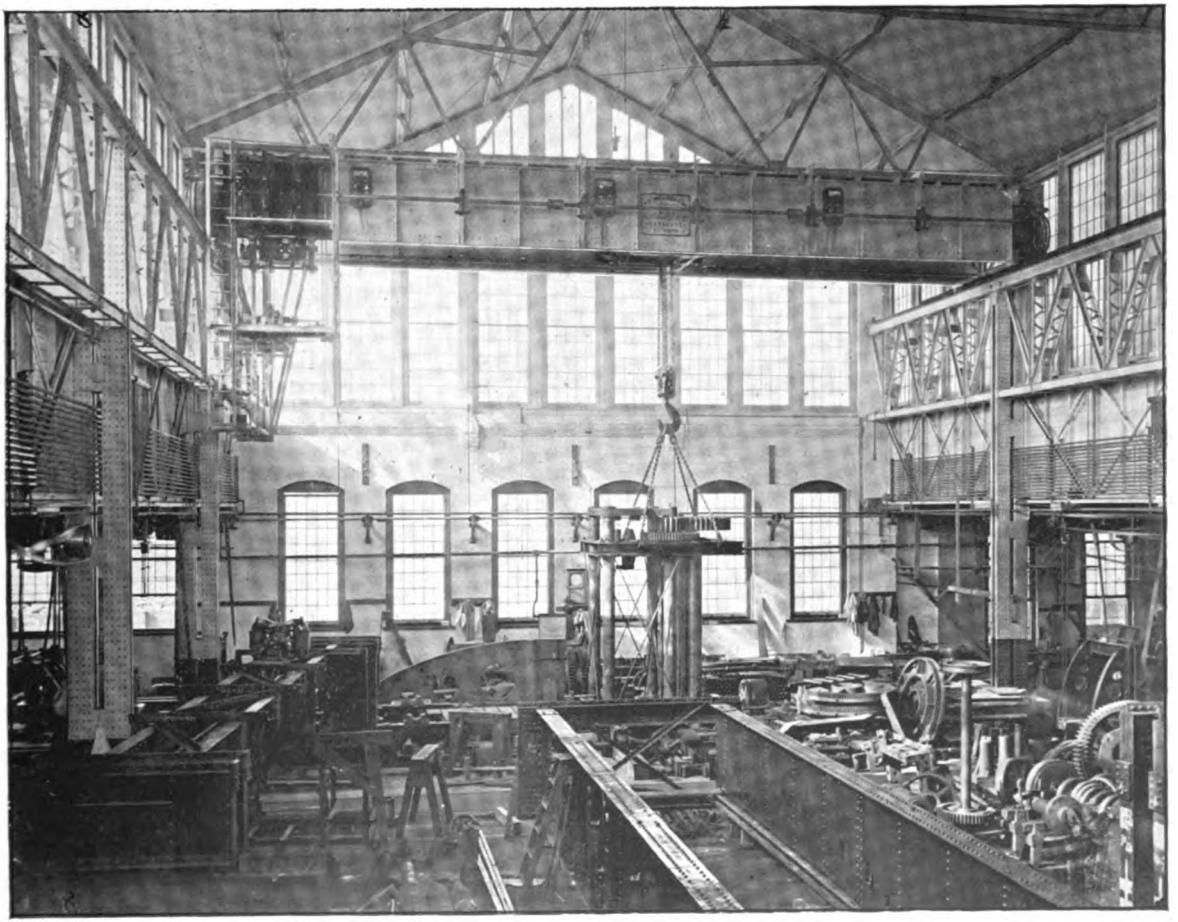


15-TON TRAVELLING CRANE.—IN ERECTING SHOP OF THE GEO. F. BLAKE MFG. CO.

Driven by a square shaft carried upon the runway girders. Runway, 330 feet long. Span, 41 feet.

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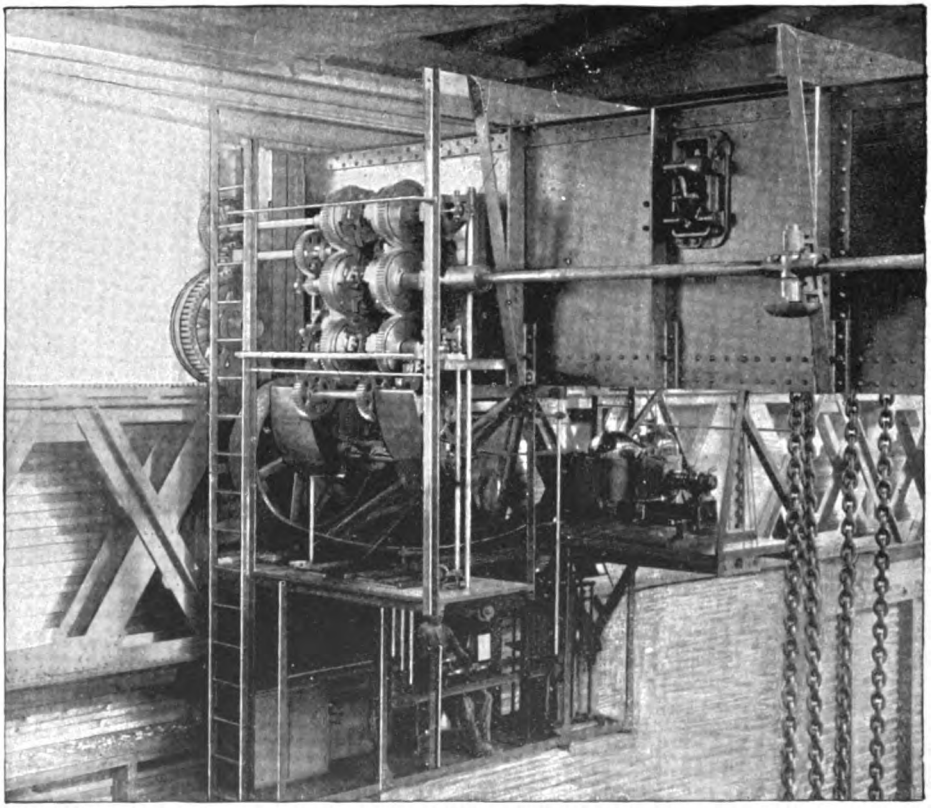
PLATE NO. 207.



30-TON TRAVELLING CRANE.—IN EAST ERECTING SHOP, WORKS OF WM. SELLERS & CO., INCORPORATED.

56 feet span. Operated by single electric motor.

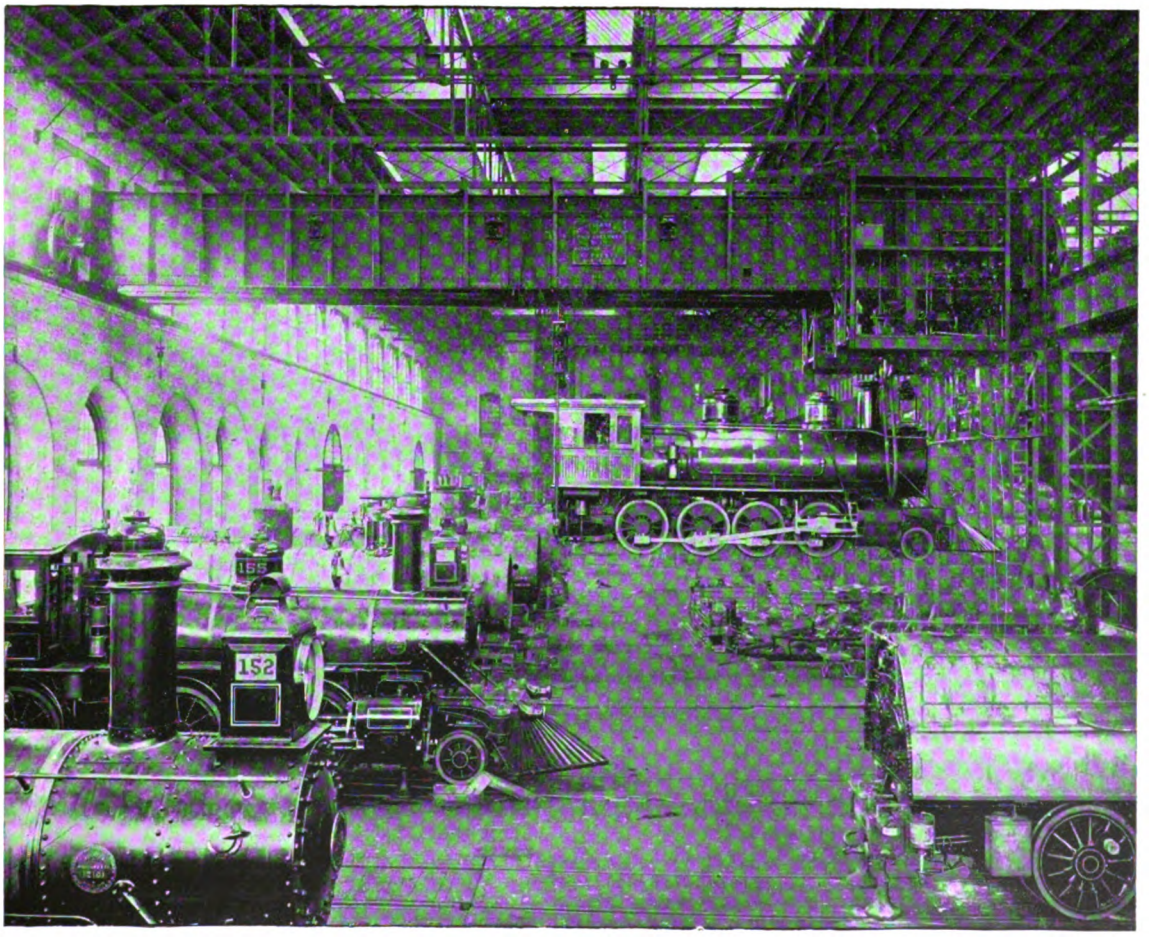
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50-TON TRAVELLING CRANE.—IN ERECTING SHOP OF THE SOUTHWARK FOUNDRY AND MACHINE CO.

Operated by single electric motor. The plate shows the arrangement of the clutches and operating machinery.

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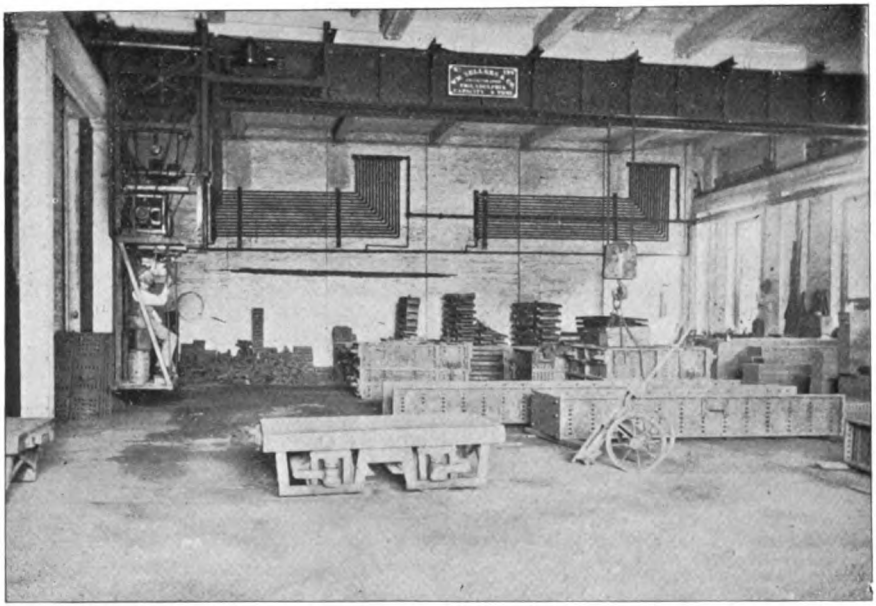


100-TON ELECTRIC TRAVELLING CRANE.—IN THE ERECTING SHOP OF THE BALDWIN LOCOMOTIVE WORKS.

The shop consists of two spans, each having one of these cranes. The span is 75′ 4″. Each crane has two independent trolleys, operated from constant speed motors.

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PLATE NO. 210.

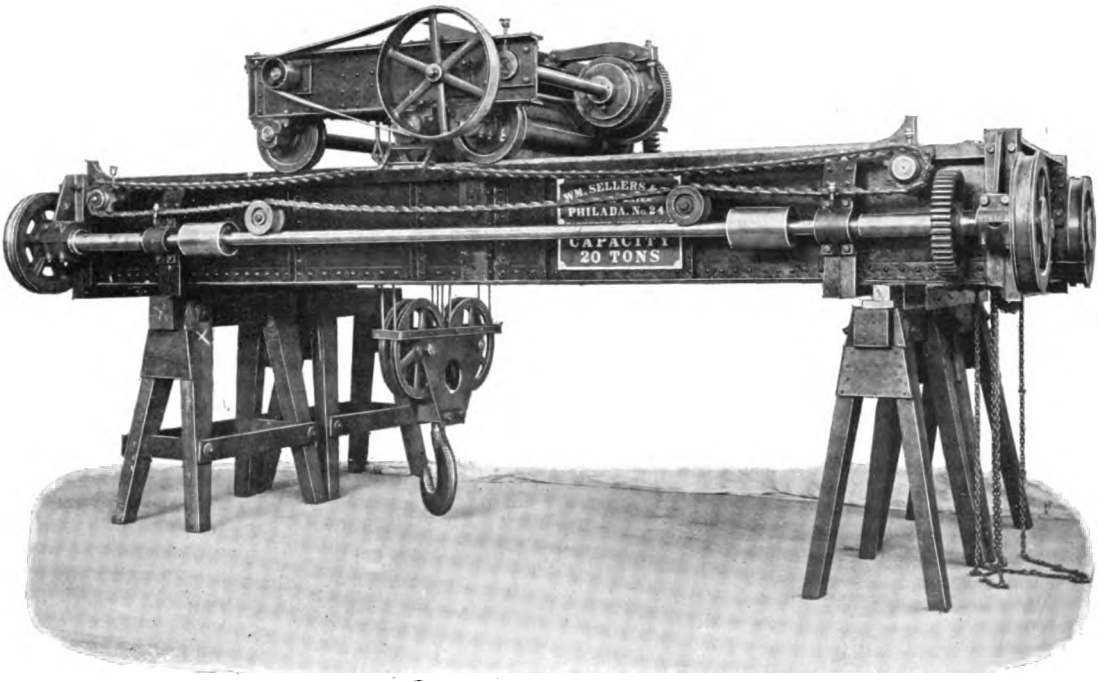


6-TON TRAVELLING CRANE.—IN FLASK SHOP, WORKS OF WM. SELLERS & CO., INCORPORATED.

43 feet span. With hoisting drum fixed at one end of the bridge. All movements by electric motors. This is a special crane designed for occasional use. No regular attendant is required; can be operated by any workman in the shop. Operator stands on a hanging platform, which is accessible from the floor.

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PLATE NO. 211.



20-TON TRAVELLING CRANE.—FOR USE OVER A RIVETING MACHINE.

The bridge and the trolley travel by means of a hand-chain worked from the floor. Hoist is operated by an electric motor operated from a fixed point near the riveter.

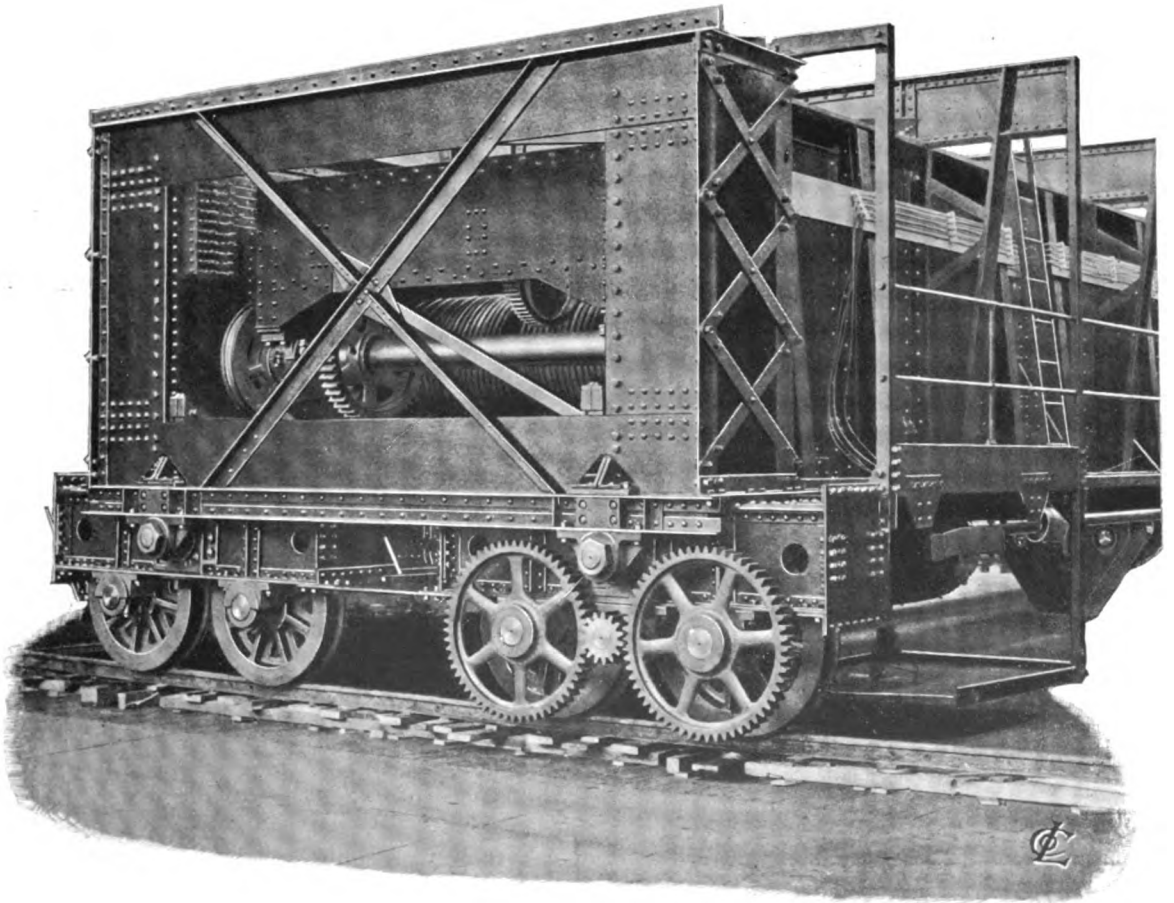
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150-Ton Electric Travelling Crane.

THE travelling crane illustrated in Plates Nos. 212, 213, and 214 was built by us for the Carnegie Steel Company, Ltd., for use in their armor department. It is of 50 feet span, and is provided with two trolleys, each capable of lifting 75 gross tons, with 30 feet clear lift. The bridge, which is of our usual construction, is carried upon eight 37″ steel-tired wheels arranged in pairs, supported in equalizing trucks to insure proper distribution of the loads; these trucks being connected to the bridge by large fulcrum pins and steel bearings. Two of the wheels at each end are driven, and two motors of the street-car type are used for the purpose of travelling the bridge. The trolleys, one of which is shown in place in Plate No. 213, are built of structural steel in the form of two frames, the lower one carrying the drum-shaft bearings and those of the pinion shaft, while the upper frame carries the motors and the fast-running gearing, as well as the bearings for the axles. The two parts are connected by stools and bolts, so that the main frame of the trolley rests upon axles and carries hanging from it the lower frame with the drum and main wheels attached. The load of 75 tons is carried upon six parts of $1\frac{3}{8}$″ chain, arranged so that the lift is vertical, and there is no tendency to lateral movement or to twisting of the load. Each trolley is provided with three motors of the street-car type, one for travelling the trolley, and the other two for operating the hoist. The hoisting motors and those for the bridge travel are controlled by the "series-multiple" system, which is now so generally used for street-car purposes, which has several advantages, notably, a full starting torque, with less current than is required for the simple rheostat control. The lower frame of the trolley is plated underneath over its entire surface, except where an opening is necessarily left for the chains, to protect it from the heat of the large masses of hot metal over which it is used. The wires for the various motors are attached to suitable insulators on the inside of the bridge girders, and current is taken off by small bronze rollers, as shown in Plate No. 214.

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PLATE No. 212.

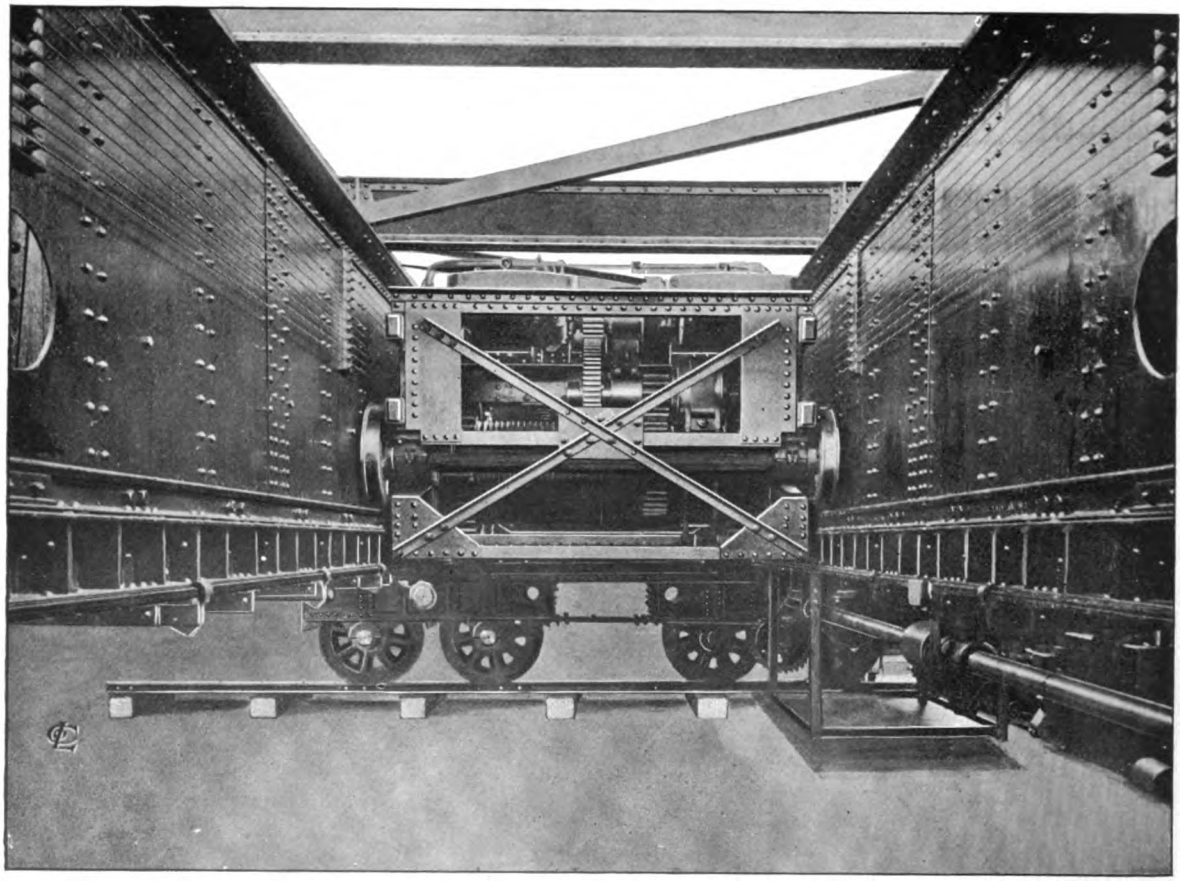


150-TON ELECTRIC TRAVELLING CRANE.—BUILT FOR THE CARNEGIE STEEL CO., LTD.

The plate shows one end of the bridge with the end carrying wheels, equalizing trucks, etc., and the trolley carrying the hoisting apparatus within the bridge.

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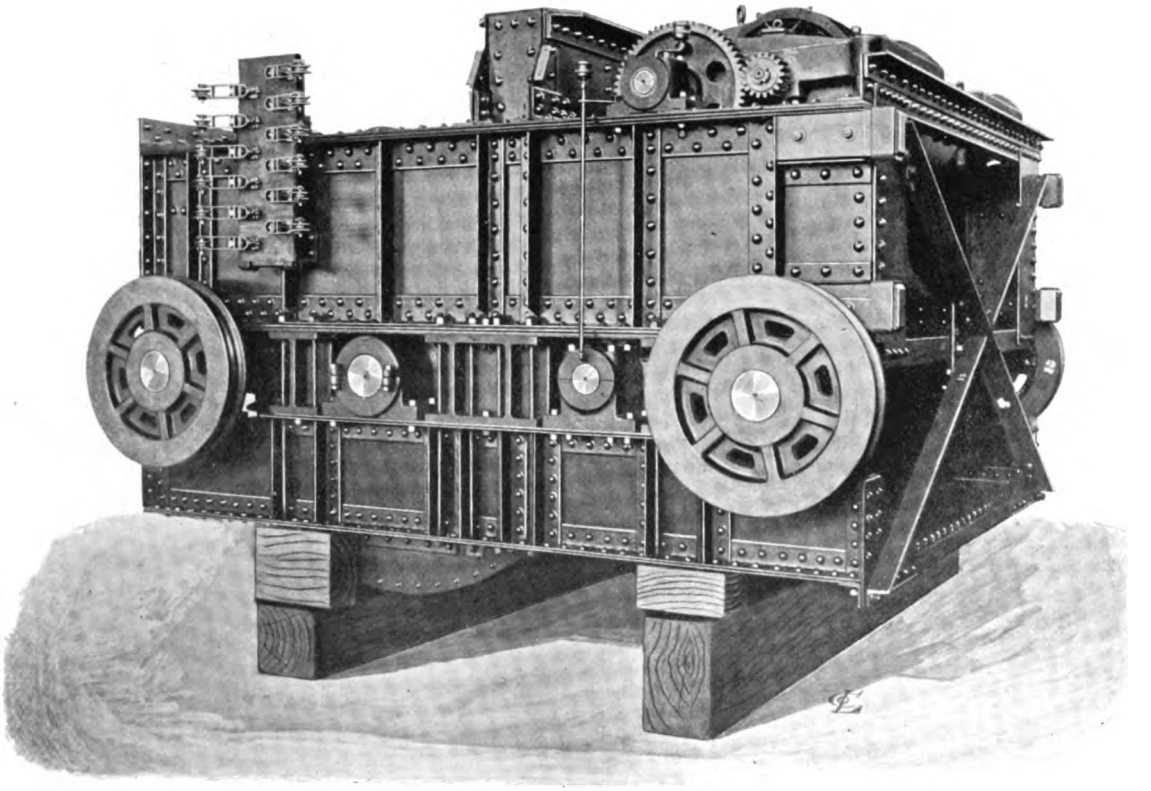
PLATE NO. 213.



150-TON ELECTRIC TRAVELLING CRANE—BUILT FOR THE HOMESTEAD WORKS OF THE CARNEGIE STEEL CO., LTD. VIEW OF INTERIOR OF THE BRIDGE, SHOWING THE TROLLEY AT THE END.

This crane is operated with independent motors for each movement. The plate represents the interior of the bridge, and shows one of the trolleys in position. Capacity of trolleys, 75 tons each.

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75-TON TROLLEY FOR 150-TON TRAVELLING CRANE.—SHOWING WROUGHT-IRON FRAME-WORK.

See Plates Nos. 211 and 212.

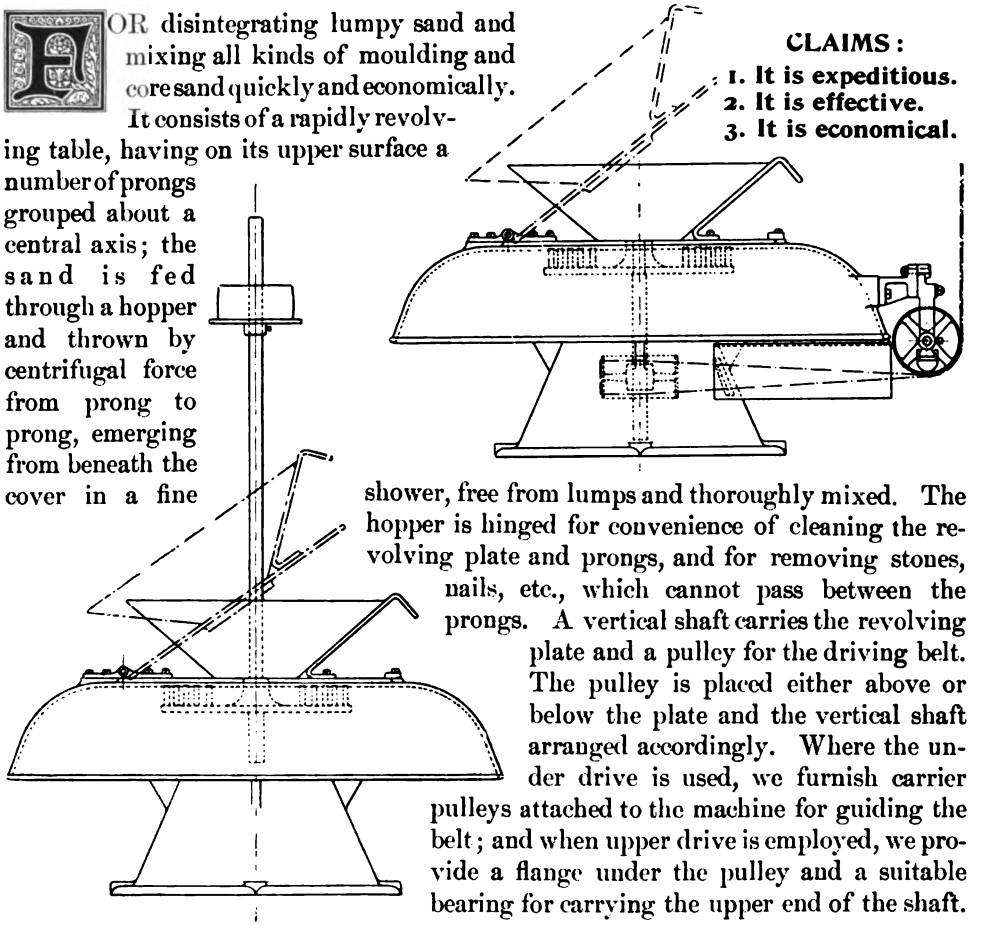
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Centrifugal Sand-Mixing Machine.

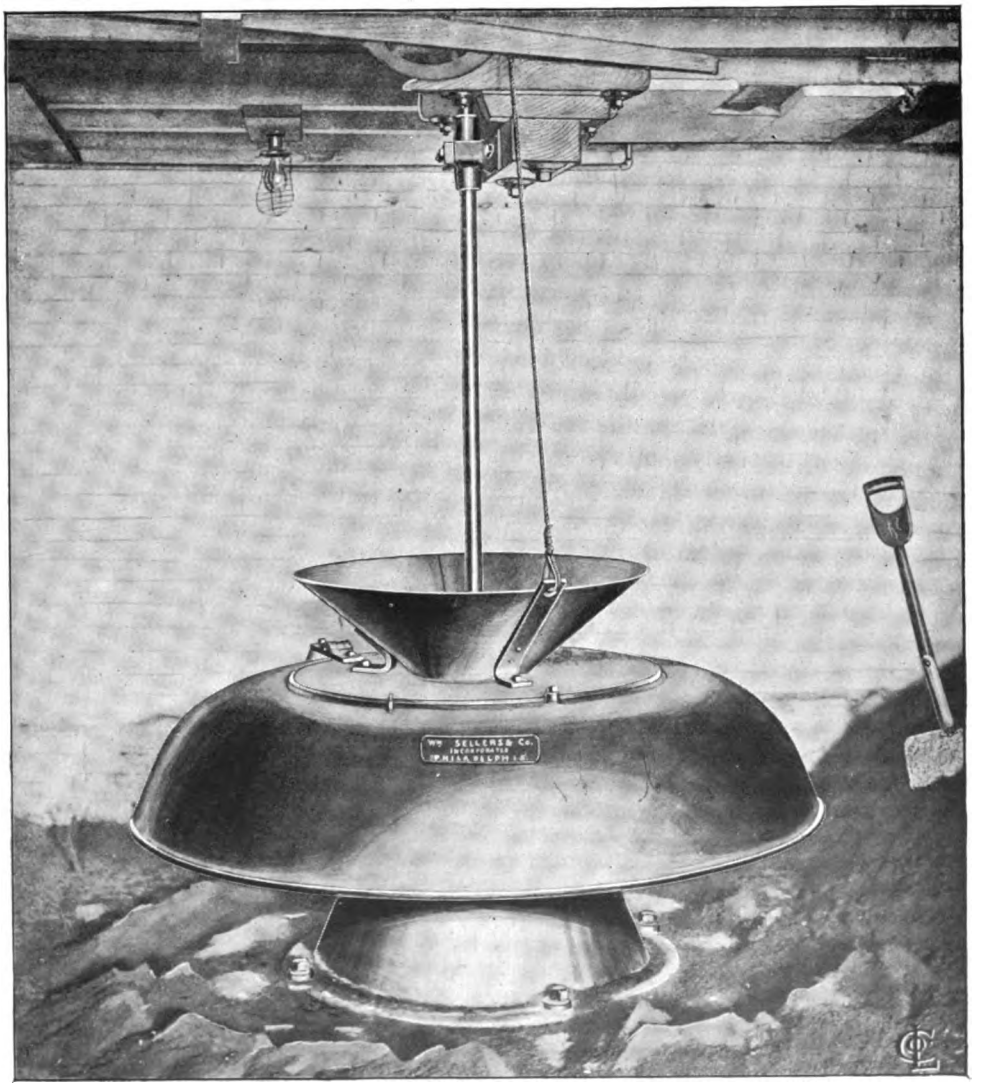
FOR disintegrating lumpy sand and mixing all kinds of moulding and core sand quickly and economically. It consists of a rapidly revolving table, having on its upper surface a number of prongs grouped about a central axis; the sand is fed through a hopper and thrown by centrifugal force from prong to prong, emerging from beneath the cover in a fine shower, free from lumps and thoroughly mixed. The hopper is hinged for convenience of cleaning the revolving plate and prongs, and for removing stones, nails, etc., which cannot pass between the prongs. A vertical shaft carries the revolving plate and a pulley for the driving belt. The pulley is placed either above or below the plate and the vertical shaft arranged accordingly. Where the under drive is used, we furnish carrier pulleys attached to the machine for guiding the belt; and when upper drive is employed, we provide a flange under the pulley and a suitable bearing for carrying the upper end of the shaft.

CLAIMS:

1. **It is expeditious.**
2. **It is effective.**
3. **It is economical.**



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CENTRIFUGAL SAND-MIXING MACHINE.

Operated by belt and pulley on vertical shaft. Driving pulley has a diameter of 9″, takes a 4″-belt, and should make 1200 revolutions per minute. Weight of machine about 1200 lbs.

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Railway Turn-tables.

GREAT changes have taken place in the size and weight of locomotives since we first began (over forty years ago) the manufacture of cast-iron railway turn-tables. To meet these changing conditions, we have from time to time remodelled our patterns and added larger sizes to our list; and, having adopted a specially strong mixture of iron, we are able to furnish cast-iron turn-tables adapted for the heaviest locomotives in use. It happens that in many locations our early tables have been retained in service, although the engines they are expected to carry have doubled and trebled in weight. As a consequence, breakages have resulted, not through any inherent defect in the cast-iron tables, but simply because those particular tables were greatly overloaded. Indeed, it is a remarkable fact, and one which speaks well for the materials used, that they have stood at all under the loads given them. Cast-iron tables can be made to carry any required weight, but they must be made deeper and heavier as the load is increased.

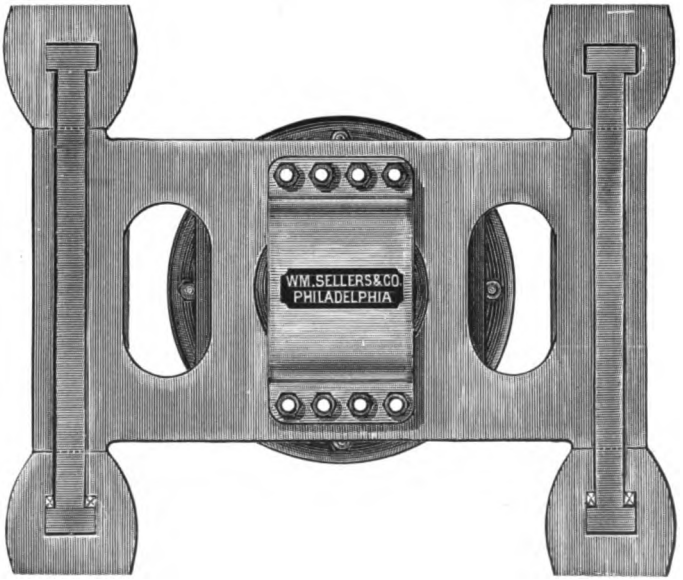
Cast-iron tables, properly designed, have many advantages in convenience of shipment, in ease of repairing, in stiffness, etc., which make them generally popular.

Our large turn-tables, though differing in the dimensions of the various parts, are essentially of the same design. They are simple in construction, easily erected, very durable when not abused, and turn with the greatest ease. The table, in general, consists of four cast-iron arms, firmly bolted and secured to a cast-iron centre-box of requisite width and strength. This centre-box surrounds and is suspended from the pivot upon which the table turns; the outer ends of the arms are connected by transverse beams or "cross-girts" which carry the wheels that bear on the circular track and take the tip of the table when the load is not balanced.

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The pivot centre itself consists first of a conical post with a broad base, for bolting securely to a large capstone upon a suitable foundation. This conical post is nearly as deep as the centre-box itself, and terminates on its upper part on a flat surface upon which rests a set of steel plates with hard steel conical rollers. Upon the top plate is balanced a casting which carries a semi-cylindrical projection upon its

FIG. 1.

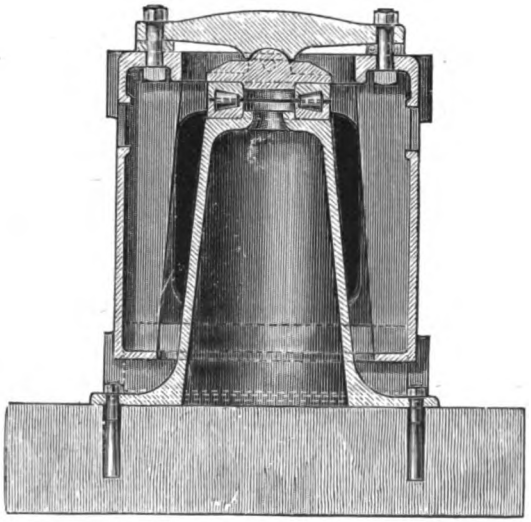


upper surface, that fits into a corresponding concavity in the rectangular steel top-cap and thus forms a hinge which will permit the table to vibrate longitudinally to balance the weight of the engine, but will effectually prevent it from tipping sidewise.

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The centre-box is suspended from the top cap by eight bolts, thus throwing the entire weight of the table and balanced load directly upon the pivot centre (Fig. 2). A layer of wood packing is interposed between the top cap, arm, and the centre-box, which may be varied in thickness to adjust the height of the table to the point required. Upon the arms and notched over them, transverse cross-ties are laid, and the rails are in turn spiked to these ties. The turn-table pit should be

FIG. 2.



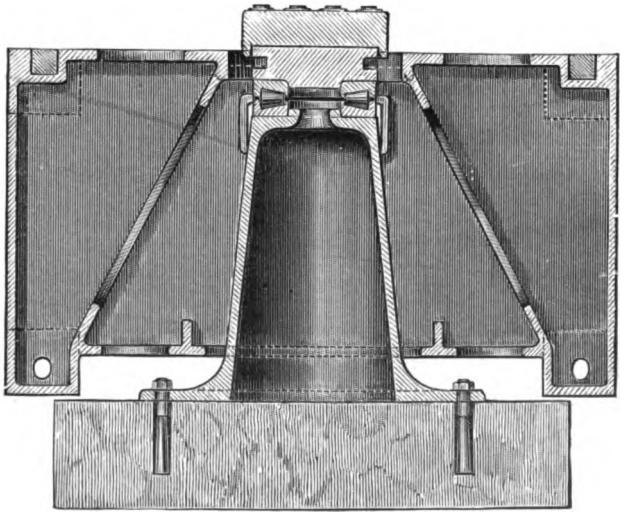
built with a proper retaining wall of brick or stone, surmounted by a suitable curb. The pit is deepest in the centre and grows shallower towards the circumference where it meets the circular track. This track should be carefully levelled and should rest on well laid sills. The distance from the top of the curb to the circular track is so slight that the pit may be crossed by stepping down into it, and, since

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the plates and rolls are situated so near the track level, no injury to the table will result from even a large amount of water in the pit; although the water will, of course, interfere with the motion of the table by its resistance. Where the nature of the soil requires it, it is best to underdrain the turn-table pit.

When our turn-tables are properly set up and the load nearly balanced, they may be turned with the greatest ease. One man can turn the heaviest engine. On

FIG. 3.



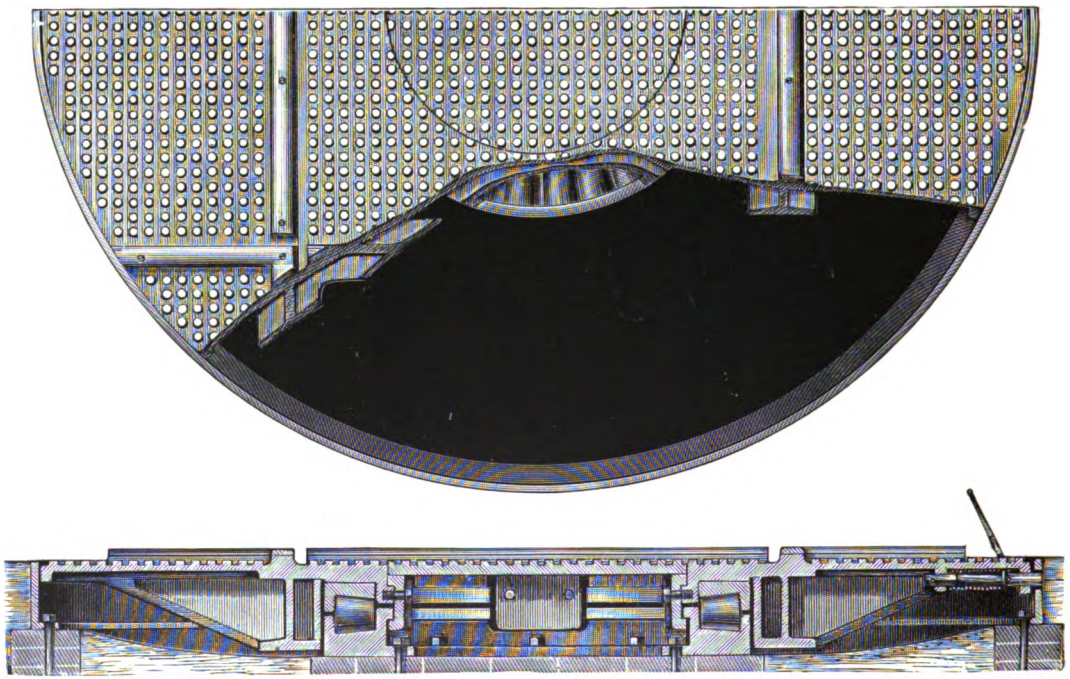
a trial at our works, it was found that one and one-half pounds applied to the end of one arm of a turn-table weighing 24,000 lbs. was sufficient to put it in motion from a state of rest. All turn-tables that we build are erected in our works, carefully fitted and properly marked for assembling, so that our customers will have no fitting to do except trimming the wooden packing so as to bring the table to the proper level. This is a simple matter.

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Small Turn-tables.

For service where the loads to be turned are all comparatively short, we make a special form of table that entirely covers its pit. It is quite shallow, turns with

FIG. 4.



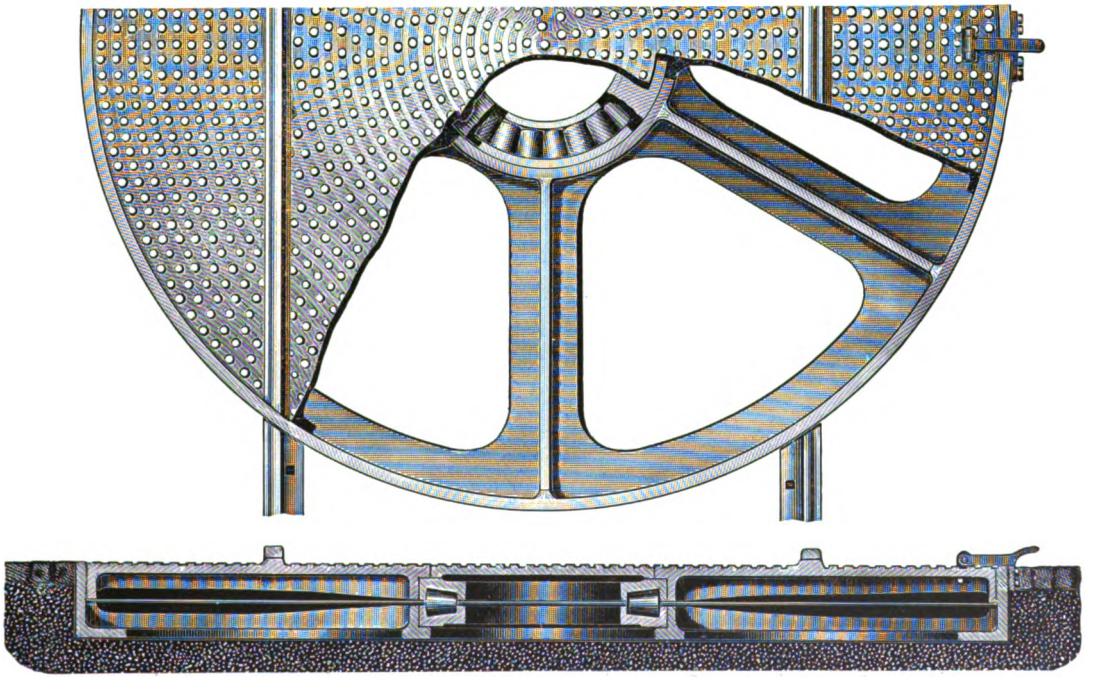
9′ 4″ EXTRA HEAVY TURN-TABLES.

great ease, and is very durable. Such tables are used for Street Railways, for Mines, Manufactories, and Warehouses, and we build various types and sizes adapted

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to various requirements. Fig. 4 shows our heavy pattern, 9′ 4″ Turn-table, which is sufficiently strong to carry the heaviest car that can be placed upon it. It will carry the passing load of locomotives, although too short to be used for turning any but very small ones. It is useful for machine shops and other manufactories

FIG. 5.

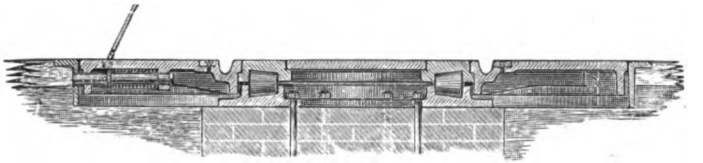


doing a heavy class of work, and also for mine cars and locomotives. Fig. 5 shows a type of lighter table, such as are used for street railways and for ordinary factory purposes where the loads passing over them are not heavier than they are

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required to turn. These, too, are made of various diameters and greater or less strength according to requirements. This form of table requires very shallow excavation, measuring only 9″ from the base to the top of the floor plate. A still shallower and lighter table for diameters up to say 6 feet is shown in Fig. 6. This

FIG. 6.

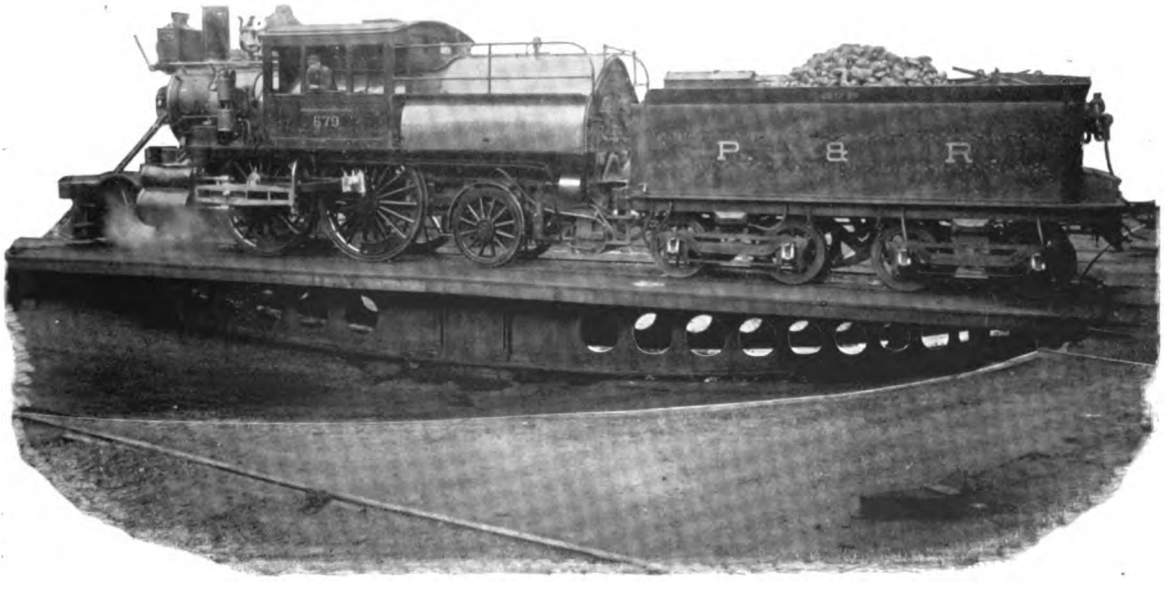


is extremely shallow, in fact, measures only 6 inches from base to top of floor-plate. All of these tables are usually made with roughened iron tops, but where required they may be covered with planking to correspond with shop floors. The rails may be elevated above the general surface, as in Figs. 4 and 5, or depressed, as in Fig. 6, when it is desired to run trucks or barrows over the track. They are arranged with latches, which may be either of the spring form operated by lever or key, as in Figs. 4 and 6, or it may be a heavy trap latch fitting into notched plates attached to the curb as in Fig. 5.

These tables are all set up before they leave our works, and are ready to put in service without any fitting on the part of the purchaser.

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PLATE No. 216.



LOCOMOTIVE AND TENDER ON TURN-TABLE.

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Centrally Suspended Pivot-Centre, for Swing Bridges.

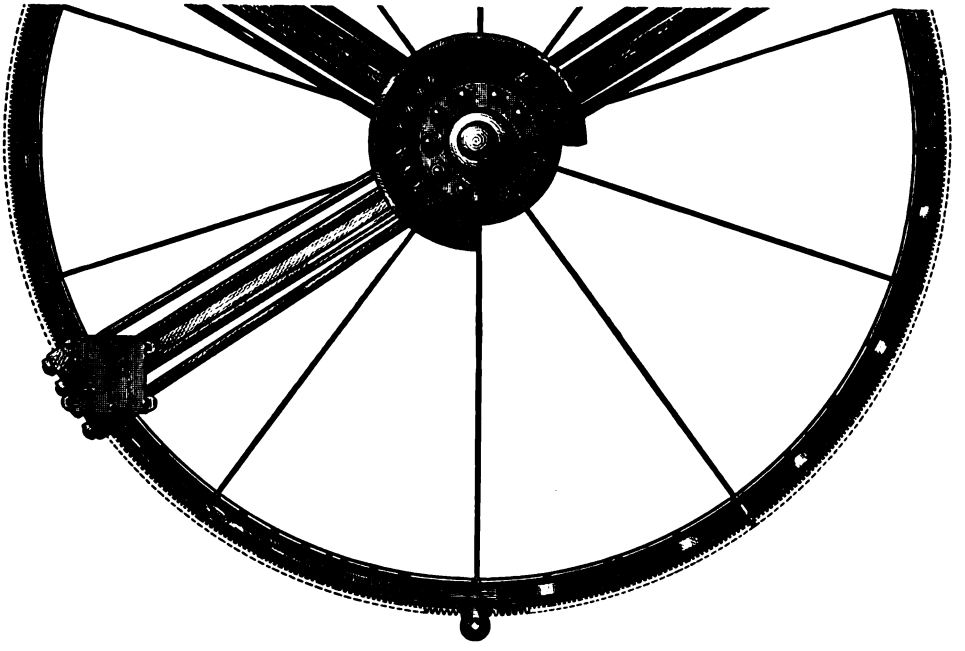
OUR pivot-centre for swing bridges was designed to support the load entirely upon a system of conical rollers, such as used in our turn-tables, and it is applicable to almost all forms of swing bridges. We arrange the structure so as to insure a concentration of weight upon the centre plates, employing track-rollers only to take the tip of the table. The pivot-span is carried upon the ends of radial arms projecting from a central box of cast-iron, these arms being formed of struts and tie-rods. The arms also carry the top circular track-drum, made of bent I-beams and shod with a cast-iron track, planed and bevelled to correspond with the taper of the conical rollers. Beneath these the rollers are carried in a wrought-iron spider-frame, held independently of both the top and bottom tracks. They rest upon cast-iron turned track, to which is bolted the rack used in turning the table.

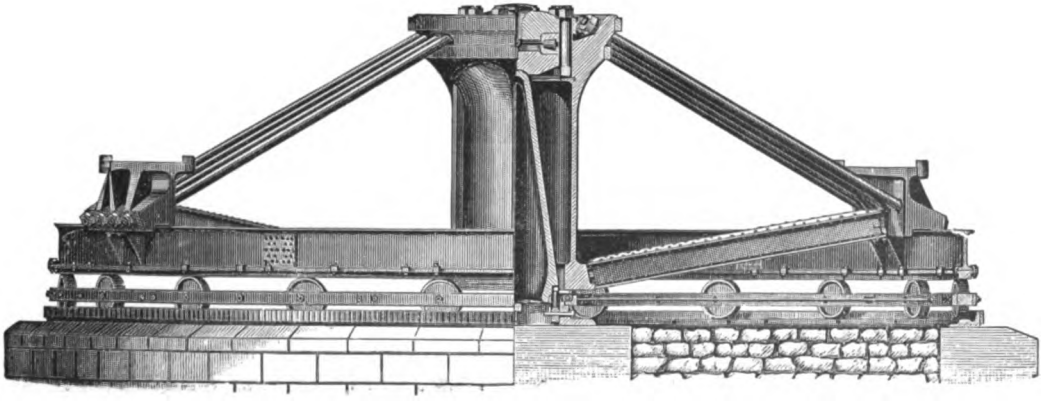
Smaller bridges are usually turned by hand. Those of three hundred tons dead weight or more are provided with power-turning gear, operated by independent steam-engine or by electric motor, according to circumstances.

To prepare an estimate for the cost of one of these tables, we should have the following information:

1. The weight of the bridge, which rests upon the pivot-centre.
2. Distance from centre to centre of chords.
3. Whether two or three chords.
4. Nature of bottom chord (width and general character).
5. Available height for table between high water and the underside of chord.
6. Distance from masonry of pier to under side of rail on road-bed, or to under side of roadway. (This distance should be about eight feet, if possible.)
7. It should be stated if the bridge is to turn by hand or power.

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TURN-TABLE FOR SWING BRIDGES.

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Hydraulic Testing-Machines.

SYSTEM OF A. H. EMERY, C.E.

THE accurate testing of iron, steel, and other metals used in constructive work presents a problem of great importance to which engineers have at all times devoted much attention, and the modern increased use of steel and iron in the largest structures renders it necessary not only that the metal work shall safely bear its load, but that it shall not unnecessarily add to it. The problem presented, therefore, to the modern engineer is to adjust with certainty a safe margin of strength with a minimum of weight (and, incidentally, of cost), and this can only be determined by experimental tests upon full-sized sections of the materials used in such construction.

Heretofore, the principal method has been by machines designed to test comparatively small sample pieces under such conditions that the breaking strength of the test-piece was measured by the machine, and from the data thus obtained the supposed strength per square inch of full-sized bridge members and other constructive material was determined on paper by calculation. A feature common to all such machines heretofore in use is, in principle, the common steel-yard balance, supported by knife-edge. While this is satisfactory for small work, it has proved inadequate for the modern requirements of testing a completed piece, such as a column, or an eye-bar forming a tension member of a bridge, by reason of the bending of the support under heavy pressure; also, the injury to the knife-edge if sharp, and, if blunted, the introduction of friction, all of which renders the calculation required to measure the strain unreliable.

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The "ideal" testing-machine would be one working without friction, capable of engaging all sizes and weights, measuring and registering with accuracy, easily and quickly operated, and practically indestructible in any use for which it was designed.

Impossible as such a combination may appear to a technical engineer, it is not too much to say that these conditions have been fulfilled; and it is the purpose of this paper to describe briefly the wholly original marvellous machine devised a number of years ago by Mr. A. H. Emery, C.E., and recently improved by us as to its mechanical details.

The original machine of this type, constructed for the United States Government, has been in actual service at the arsenal at Watertown, near Boston, for ten years, and other similar machines more recently built have served to confirm the soundness of the principles involved.

One of the "proof" experiments by the United States Government Board was the breaking in tension of a forged iron link, five inches in diameter between the eyes, at a strain of 722,800 pounds, and immediately thereafter a single horse-hair $\frac{7}{1000}$ of an inch in diameter was slowly strained, and, after stretching thirty per cent., snapped under the recorded strain of sixteen ounces. Masses of metal were subjected to pressures of one million pounds in compression alternately with eggs and nut-shells, and in all cases the machine operated with equal accuracy.

About six years ago we acquired the exclusive right to build the Emery testing-machine under the numerous patents, and have since that time devoted much study to the subject, with a view of improving and simplifying its mechanism, reducing its cost, and increasing the facility of its operation, in order that we might be enabled to supply, at a comparatively moderate expense, testing-machines adapted to the requirements of bridge constructors and other manufacturers, as well as technical schools and colleges, etc. It was found that extensive alterations in mechanical details were needed before such improved machines could be economically produced, and the machines illustrated herewith present the latest forms, combining the essential features of the original invention with the added mechanical improvements.

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Detailed Description.

The essential peculiarity of the Emery testing-machine is the method by which the stress produced upon the piece tested is conveyed to the scale and accurately weighed by mechanism that is entirely frictionless, and hence responds to the same increment of load regardless of the amount of strain upon the specimen. This result is accomplished by receiving the load upon a flat closed cylinder called the "hydraulic support." The general scheme is indicated in Fig. 1, which shows merely the relation of the parts, no attention being paid to proportion.

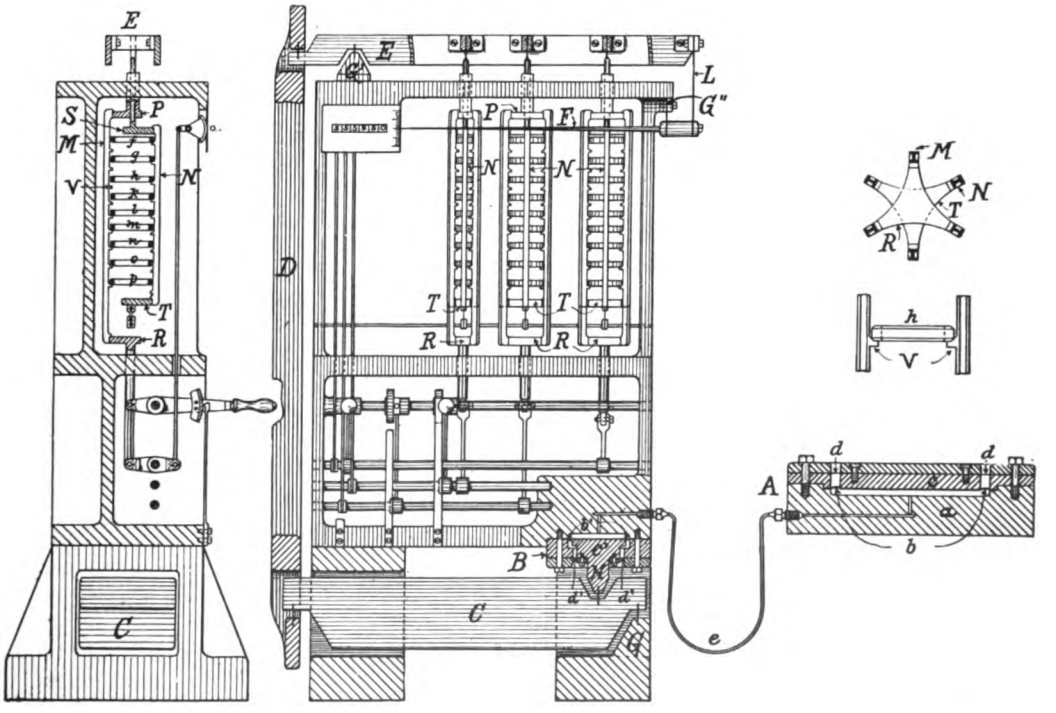
The depth of the hydraulic support cylinder *A*, is exceedingly small, the end is closed to prevent the escape of the contained fluid by a thin sheet of metal, *b*, upon which rests a piston, *c*, considerably smaller than the internal diameter of the cylinder; this piston is secured to the cylinder by thin flexible fixing plates, *d d*, which permit a very small movement in the direction of the axis of the cylinder while rigidly securing it against any lateral movement; this longitudinal movement of the piston from no load to full load is not more than .003 inch, and as there is no hydraulic packing and no sliding, there is no friction beyond that of the fluid; this hydraulic chamber is connected by a pipe, *e*, with a smaller but similar chamber, *B*, placed in the scale; the piston, *c'*, of this latter chamber acts through the block *H* against the first lever *C* of the scale, which thus receives a fraction of the load upon the piston *c* determined by the relation between the areas of the two hydraulic cylinders *A* and *B*.

The scale-body is a rigid cast-iron frame carrying the steel scale levers, all the supports and connections of which are thin flexible plates of steel firmly secured to the levers and their supports, and having a sufficient exposure between their fixed ends, that the amount of bending due to the movement of the levers shall be well within the elastic limit of the material. The long arm of the lever *C* is coupled by the bar *D* with the short arm of the poise-frame lever *E*: the long arm of this lever carries all the standard weights of the scale, and the method of putting them on or taking them off, without handling, is peculiar to the Emery system. Sus-

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pended from this lever, *E*, at suitable intervals by thin fulcrum plates, are "poise-frames," *N*, consisting of an upper cross-head, *S*, and a lower cross-head, *T*, united by three vertical bars disposed at equal intervals about the cross-heads.

FIG. 1.



These bars are provided on their inner faces with short projecting brackets, *V*, having a horizontal surface and a bevelled surface corresponding with similar surfaces formed on the weights *h*, which are short cylinders or rings with bevelled

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edges; the weights are carried by the flat surfaces and centred by the bevelled surfaces. A "weight-frame," *M*, for carrying the weights when not in use, of similar construction, has its three vertical bracketed bars alternating with the bars of the poise-frame; this weight-frame is guided, and is raised and lowered in a vertical line without touching the poise-frame, by a rock shaft and a hand-lever coupled to the rod projecting from the cross-head *R*. The brackets on the weight-frame bars are differently spaced from those on the poise-frame, and when the weight-frame is at the top of its stroke, it carries all of the weights clear of the poise-frame; a small movement downwards transfers one weight to the poise-frame, the bevelled surfaces on the brackets centring the weight if it becomes displaced sideways by a too sudden movement. A further movement transfers another, and so on; that is, the movement of the weight-frame in either direction transfers the weights singly and successively from one frame to the other; the weights *f* and *g* are shown carried by the poise-frame, *j* and *k* by the weight-frame, while *h* is being transferred from one to the other.

The operating hand-lever is provided with a notched segment, into which a click-spring plays so that the operator feels when he has moved the lever the right distance to transfer a weight to or from the poise-frame without having to watch the indicator as formerly, and the arrangement of the six bars surrounds the weights by a cage that effectually prevents any displacement and consequent interruption of the test, as sometimes occurred when the weights rested on simple shelves secured only by short-pointed pins. There is hence no necessity for opening the glass case that encloses this part of the scale, and the weights are never exposed to any risk of alteration. The weights in the first poise-frame have a value of 100 pounds, the next frame carries weights of a value of ten times as much, or 1000 pounds, the next 10,000 pounds, and so on, and the readings are summed up by a series of segments connected to the several operating shafts and provided with figures denoting the number of weights on each poise-frame. A horizontal slot in a vertical plate near the upper left-hand corner of the scale is so placed that the reading of

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the figures shown through this slot denotes the number of pounds pressure applied to the specimen.

The final lever of the scale is an indicator needle, *F*, which has a movement at its point of $1\frac{3}{4}''$ to $2''$, and this movement, calculated from the mechanical ratios of the hydraulic chambers and of the levers in the scale, is not less than 300,000 times the movement of the piston *c* in the first hydraulic chamber, and may on large machines be 6,000,000 times as much. The transfer of fluid from one chamber to the other is almost imperceptible, and while it takes force to move the metal sheets and to bend the steel fulcrums, yet this force is all returned as the various parts resume their position of equilibrium, the needle returning to the same zero point after being disturbed in either direction.

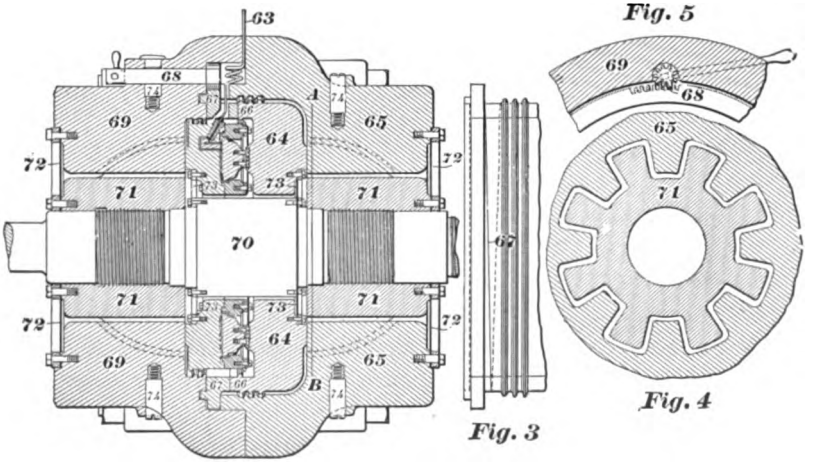


Fig. 2

Fig. 3

Fig. 4

Fig. 5

The weighing-head (Fig. 2) consists of two circular or annular beams, 65 and 69, firmly secured together by bolts placed around their periphery and by the straining screws which pass through both beams and clamp them by a shoulder and nut.

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This head and the straining-head fit easily upon the bed which maintains the axes of the two heads in the same straight line. A draw-bar, 70, is secured in the axis of these beams by two thin annular steel plates, 72; these plates hold the draw-bar securely in line with the axis of the machine, while permitting a free motion to a limited extent in the direction of the axis. The projecting end of the draw-bar is provided with a screw-thread by which the compression platform or the tension holder is secured to it. The draw-bar is enlarged in the middle, and against each of the two shoulders thus formed is secured a thin annular steel plate, 73; these plates are for the purpose of carrying and centring the hydraulic support, which is made annular, instead of circular, as shown in Fig. 1. The hydraulic support is maintained in fixed relation with the draw-bar laterally, while it is left free to move relatively to it in the direction of its axis through the small distance required. On each side of the hydraulic support, steel collars, 71, are screwed and secured to the draw-bar; these collars are provided on the periphery with a series of ribs (Fig. 4) parallel with the axis of the draw-bar, and which lie between without touching, similar ribs projecting from the interior surface of the annular beams. The ends of all these ribs on the two beams and the collars are accurately faced to true planes at right angles to the axis of the draw-bar, and the distance between the two extreme faces of the hydraulic support is made slightly less than the distance between those two planes. Movement of the draw-bar in either direction carries the hydraulic support against the ends of the ribs in one annular beam, brings the ends of the ribs on one of the collars on the bar against the opposite side of the hydraulic support, and produces pressure on the contained liquid which is transmitted through the pipe, 63, to the small hydraulic chamber in the scale.

In order to prevent the shock of recoil, resulting from the rupture of a large specimen of high steel, from doing injury to the thin brass plates in the hydraulic support, the abutting piece, 64, of the support which rests against the ribs in the annular beam, 65, when strains of tension are applied, is made larger in diameter than the hydraulic support proper, and is provided with a spiral or screw face, 66,

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which engages with a corresponding screw-face formed on a rotatable ring, 67, fitting in the other annular beam, 69. After the initial load has been applied, this ring is rotated by the pinion-shaft, 68, to bring the screw-faces in contact, see Fig. 3, and the abutting piece, 64, is thus clamped firmly to the annular beam against which it rests. When the specimen breaks, its first blow is delivered through the draw-bar and ribbed collar to this abutting piece, 64, which transmits it through the ring, 67, to the rear annular beam, 69, and as these beams, 65 and 69, are rigidly united, the blow is absorbed by the total mass of these two beams. The hydraulic support is thus thoroughly protected, and these machines can be used regularly for breaking high steel specimens up to the full capacity of the machine without any risk of injury.

The weighing-head is returned to its place on the bed after movement due to recoil by a set of spiral springs locked up in boxes secured to the bed; these springs are strong enough to move the head, and their resistance diminishes greatly the movement due to recoil, while the friction of the head upon the bed rapidly wipes out the oscillations. The annular beams bolted together, as described, constitute one built-up beam to resist the bending due to the pressure on the draw-bar midway between the straining screws. The hydraulic support is thus inclosed in a rigid mass of cast-iron and effectually protected against injury from violence or from being gummed up by oil from the straining cylinder, as has occurred with the upright machines, and the frictionless movement of this support under all conditions of service is thus insured.

Two straining screws, 77, are provided (Figs. 6, 7, and 8), fixed firmly to the weighing-head and passing freely through bearings, 88, formed on each end of the straining-head, 87; a revolving nut, 89, provided with gear-teeth on its periphery, is placed on each straining screw between the two bearings, 88, formed on the sides of the straining-head; these nuts are revolved by the wide face pinions, 90, driven through the bevel-wheels, 92 and 93, by a balancing train of gearing consisting of a gear-wheel, 96, carrying two balancing bevel pinions (see Fig. 8), meshing with

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two bevel-wheels, one on each side of the first gear-wheel, 96, so that power applied to the gear, 96, is by means of the balancing pinions divided equally between the two bevel-wheels, and thus imparts equal pressure to the revolving nuts, 89, on the straining screws. This arrangement does away with the necessity heretofore existing of having the straining screws of exactly similar pitch throughout their length. With this construction the screws could be of different pitches, the alignment of the heads being secured by the fit of the screws in their bearings and of the heads on the wrought-iron bed or shear; by driving this train of gearing either by hand or by power, the straining-head is moved back and forth upon the bed to accommodate the varying lengths of specimens; when the head is adjusted to place, the nuts form the abutments upon the screws to resist the movement of the cylinder for strains of compression or extension. The nuts, 89, do not fit snugly endwise as heretofore, but a space of several inches is left between the ends of the nuts, 89, and the faces of the bearings, 88 (see Fig. 6). This provides for the shock of recoil when breaking a long and large specimen, the sudden release of the straining screws from their load when the specimen breaks, together with the force resulting from the sudden contraction of that end of the specimen attached to the straining-head, merely give the head a push along the bed, and it slides freely until its momentum is absorbed by its own friction, the space between the revolving nuts and the bearings allowing ample room for this travel even when the heads are thoroughly lubricated. This head is thus entirely cut off from the rapid vibrations of the straining screws, and the necessity of making the nuts an exceedingly good fit to both screw and head is entirely avoided.

The straining-head is provided with a piston packed to receive fluid pressure in either direction, and the piston-rod passing through a packed bearing in one end is provided with a screw-thread, similar to that on the draw-bar, to receive the various holders. The fluid is supplied to this straining cylinder through two systems of jointed pipes, which are connected through the valves at the scale-case with the pressure pump and the tank respectively, so that each pipe acts either as a

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pressure pipe or an exhaust pipe, depending upon the direction in which the strain is to be exerted upon the specimen.

The Emery testing-machines are now made horizontal instead of vertical; in the first place to make all sizes of machines of one type, and in the second place to get certain advantages in overcoming the shocks of recoil. In all but the very

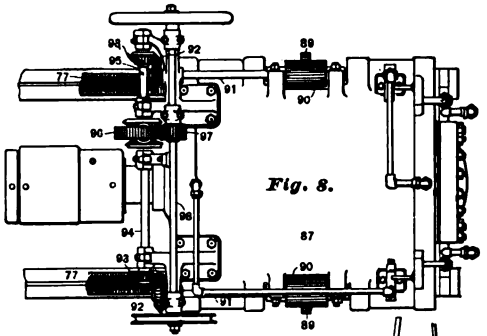


Fig. 8.

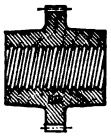


Fig. 9.

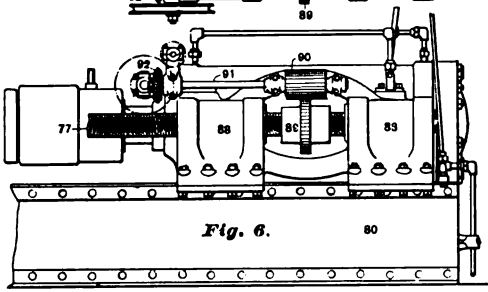


Fig. 6.

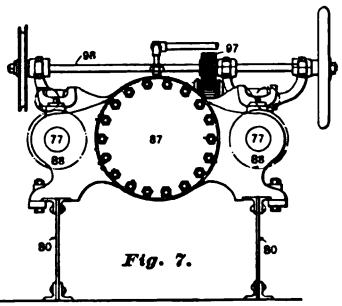


Fig. 7.

smallest size of machines, the weighing-head and the hydraulic cylinder or straining-head are carried and aligned by the top surface of a wrought-iron bed, as shown in the view of a 200,000-pound testing-machine, Plate No. 223, the straining-head on the right hand and the weighing-head on the left, back of which stands the scale, and to its right is the pump; in the foreground are the parts of the tension holders.

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Hydraulic-Support Testing-Machine.

THIS is a costly special apparatus, illustrated in Plate No. 215, for calibrating all new testing-machines. By means of this instrument, known pressures are applied to the annular hydraulic support or metallic bag of each new machine up to its maximum capacity, the actual weight required on each poise-rod in the scale-case is thus determined, and the poise-weights are carefully adjusted thereto.

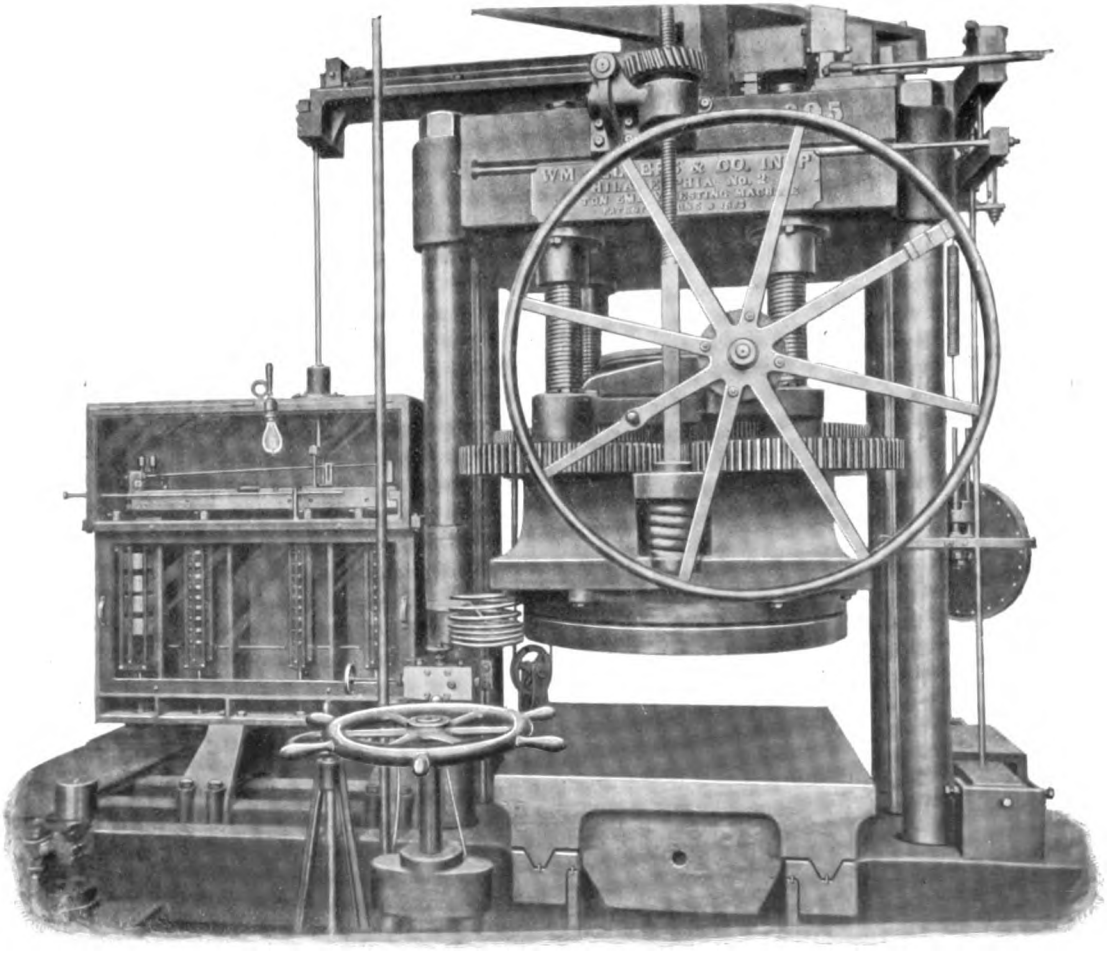
In ordinary operations, the machine will accurately indicate, when loaded to its full capacity of 500,000 pounds, an additional weight of four ounces, and can be readily set to a much more sensitive point when desired.

There are two auxiliary weighing platforms used exclusively for calibrating standard weights, one of these has a ratio to the main weighing platform of 100 : 1 ; the other of 1000 : 1, with correspondingly increased sensitiveness ; it is thus practicable to standardize large weights with a degree of precision heretofore unattainable.

This large scale shows conclusively that the use of fulcrum plates instead of knife edges eliminates friction ; a weight of 200 grains laid on the main platform puts in motion material weighing more than 20,000 pounds, and moves the needle .02 inch, and in all of our experimental work on this machine we were unable to perceive any reduction in this sensitiveness when fully loaded. The same weights are used for the three platforms, being decreased in value for the small platforms by the ratio that they bear to the main platform, thus a 1000-pound weight in the scale balances one pound on the 500-pound platform, which turns with half a grain.

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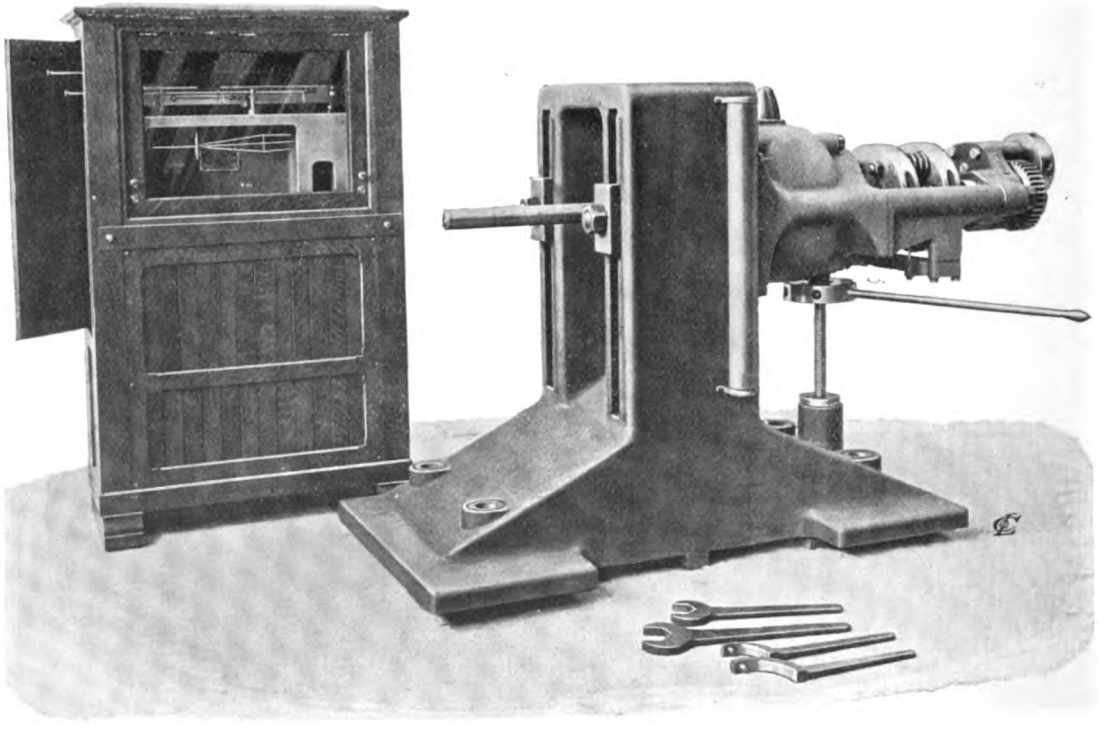
PLATE NO. 218.



HYDRAULIC-SUPPORT TESTING-MACHINE.—MAXIMUM CAPACITY, 500,000 LBS.

Ratio from main weighing-platen to point of indicator needle in scale-case, 300,000 : 1. Weight of moving levers and platforms, over 20,000 pounds.

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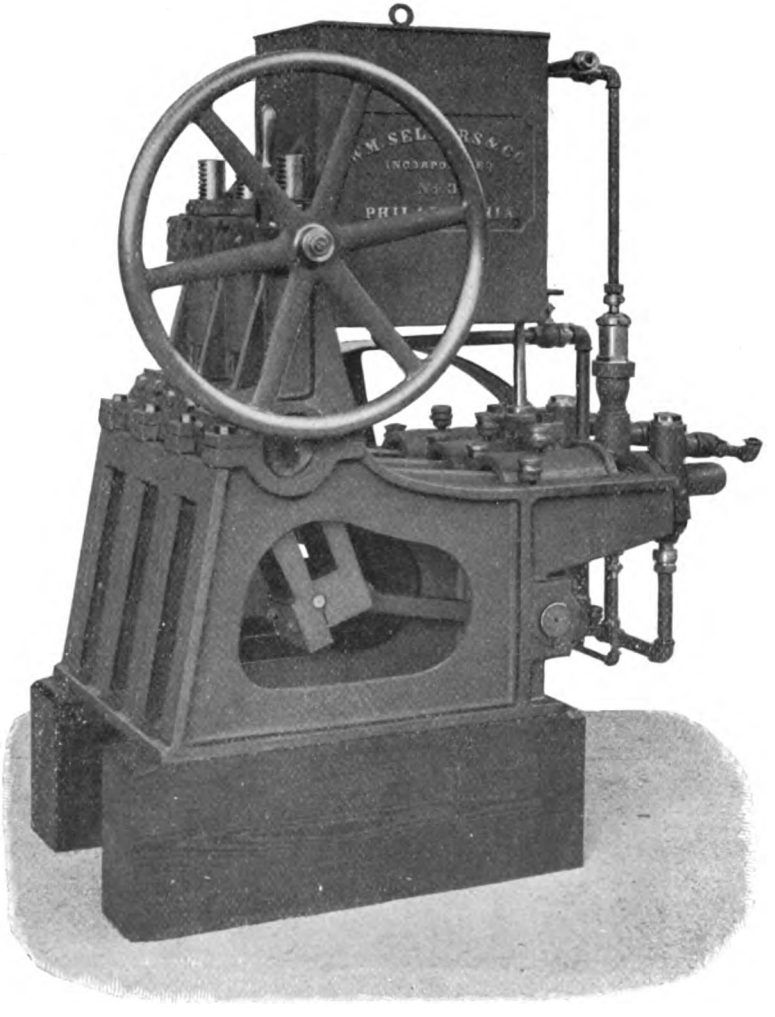


30,000-LB. DYNAMOMETER AND SCALE-CASE.—FOR WEIGHING TRACTIVE FORCE OF LOCOMOTIVES.

Centre of pull adjustable from 28″ above foundation to 46″.

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PLATE NO. 220.

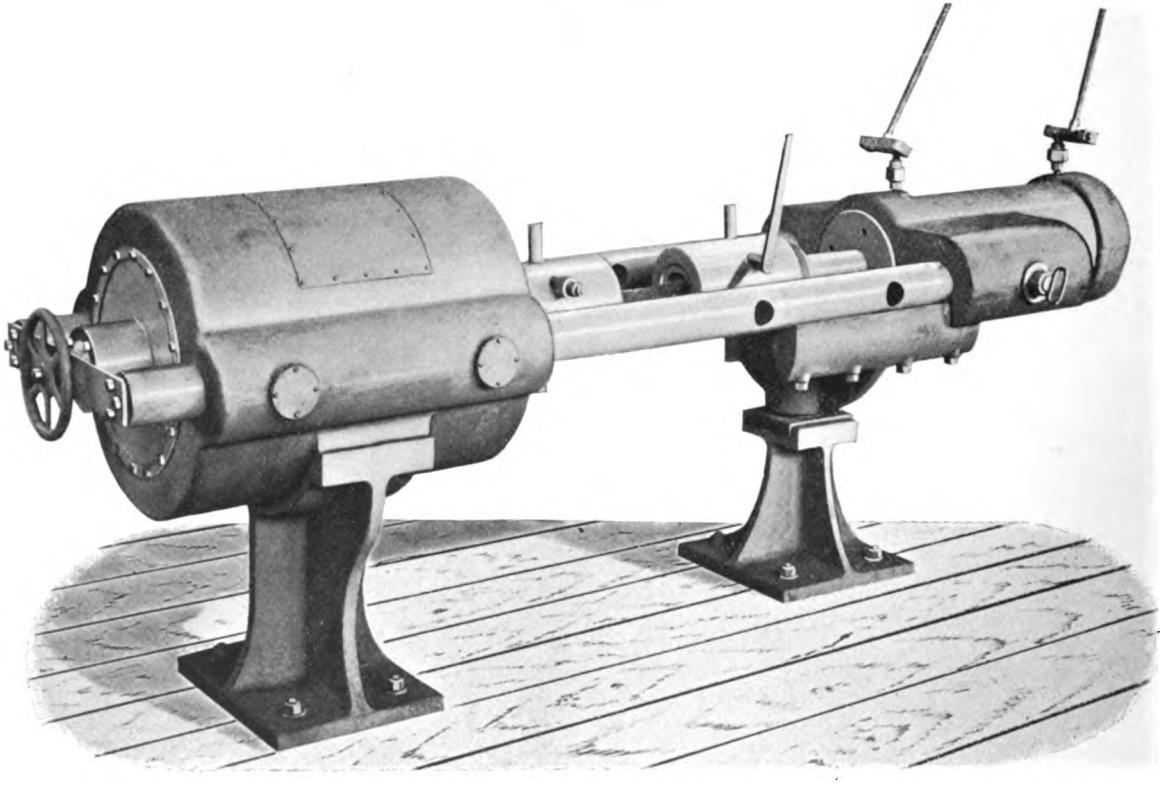


PUMP FOR HYDRAULIC TESTING-MACHINES.—WITH ADJUSTABLE STROKE.

Maximum stroke of plungers, 5″. Maximum discharge, 1178 cubic inches per minute. Crank-shaft, 100 revolutions per minute.

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PLATE No. 221.

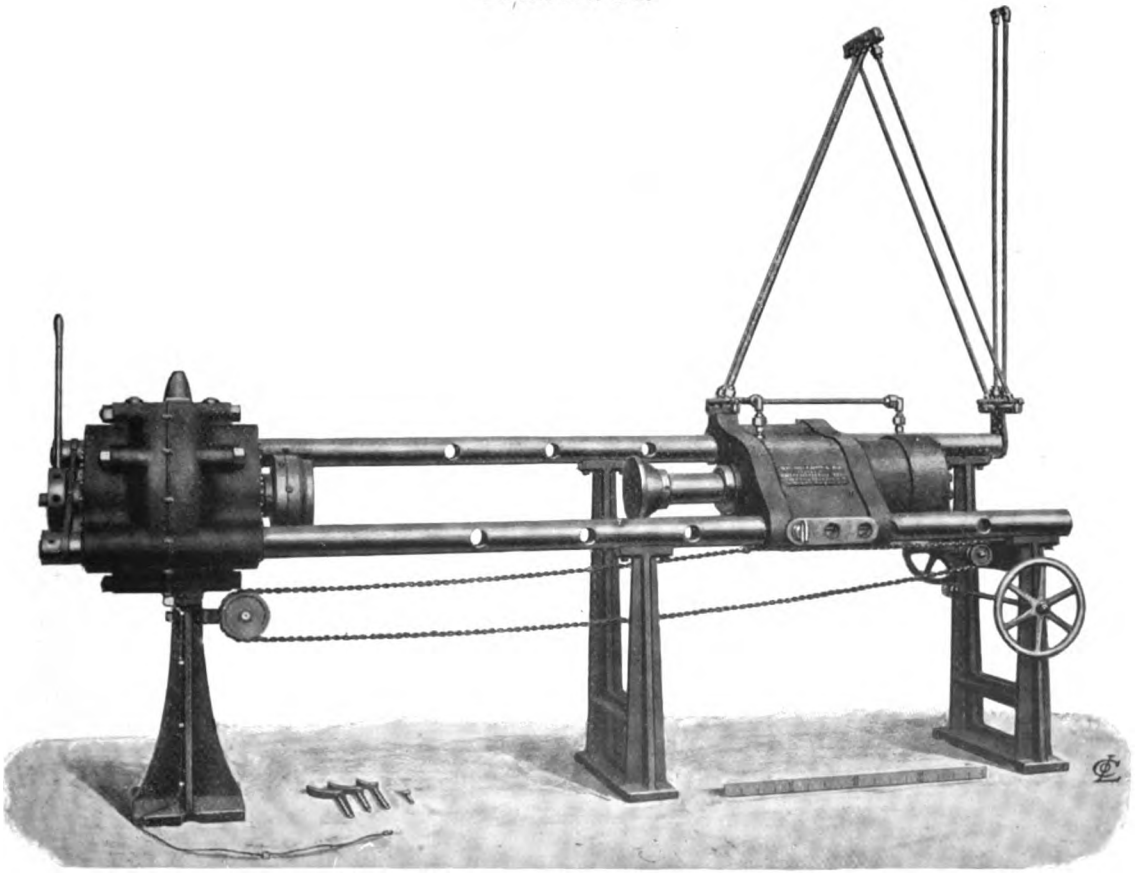


100,000-LB. TESTING-MACHINE.—FOR SHORT SPECIMENS.

Maximum stroke of piston, 24″. Maximum travel of piston with pumps at maximum delivery, 15″ per minute. Capable of testing specimens 3′ 5″ long in compression, 19″ long in tension.

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PLATE NO. 222.

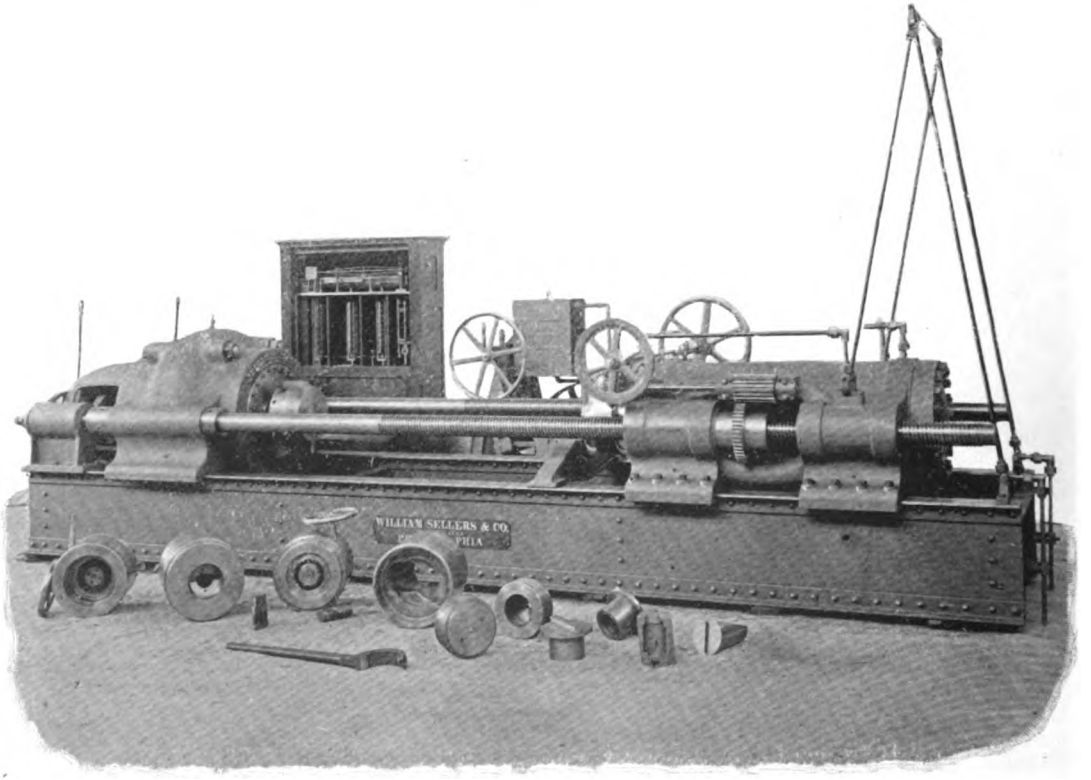


100,000-LB. TESTING-MACHINE.

Capable of testing specimens 8′ 4″ long in compression and 5′ in tension. Maximum stroke of piston, 24″.

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PLATE NO. 223.

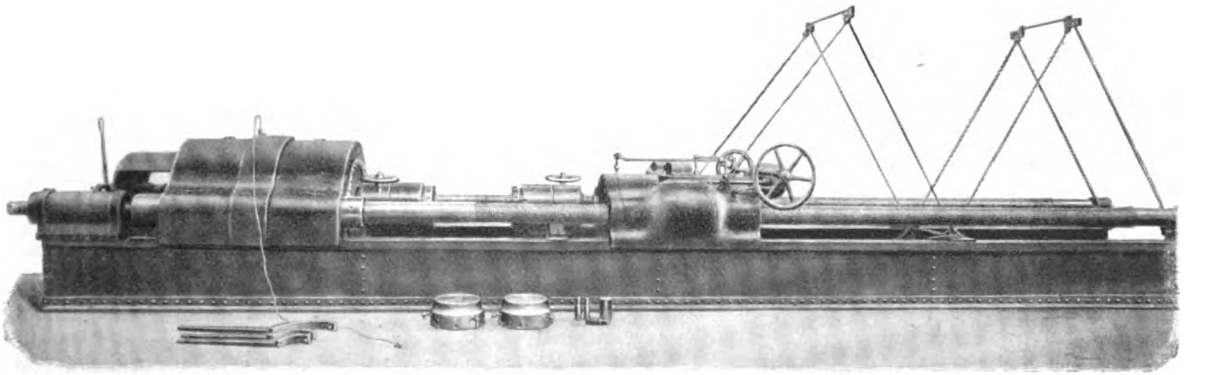


200,000-LB. TESTING-MACHINE.

Capable of testing specimens 7′ 9″ long in compression and 5′ 5″ long in tension. Maximum stroke of piston, 3′ 6″. Maximum travel of piston with pumps at maximum delivery, 4½″ per minute.

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PLATE NO. 224.



300,000-LB. TESTING-MACHINE.

Capable of testing specimens 18′ long in compression and 13′ long in tension. Maximum stroke of piston, 3′ 6″. Maximum travel of piston with pumps at maximum delivery, 4½″ per minute.

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Shafting.

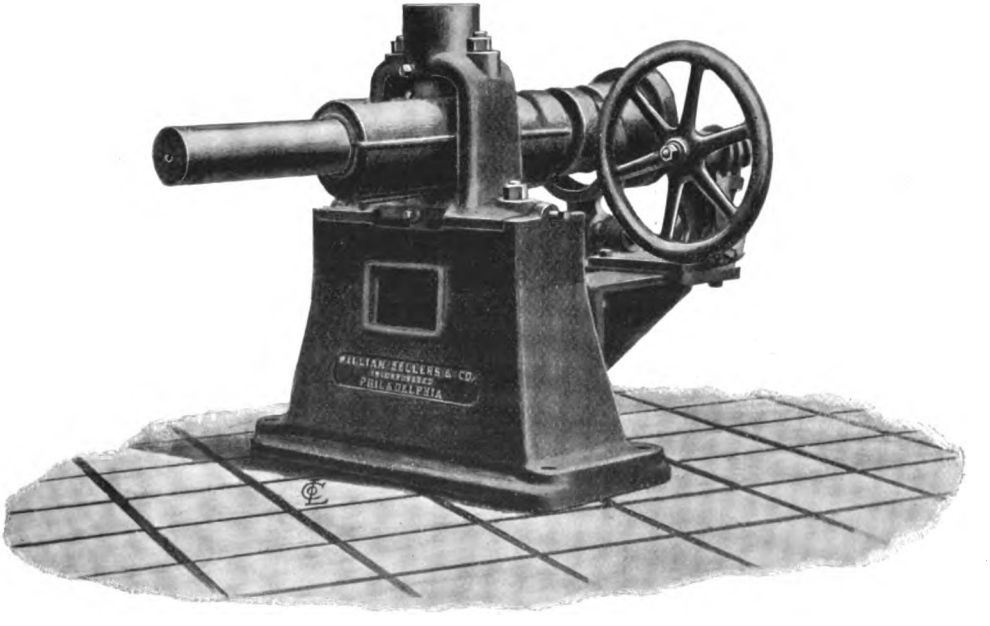
SHAFTING—so called—is a comprehensive term, firmly established by usage, and includes all the various appliances for the mechanical transmission of power. It is the intermediate agent through and by which the power of any establishment is conveyed from the source where generated to the various machines which are to receive motion.

The machinery of all manufacturing establishments can be properly divided into three main or fundamental parts,—viz., *first*, the source of power, whether it be steam, with its boilers and engines; water, with its wheels; or electricity, with its generators and motors; *second*, the shafting, which carries the power and distributes it in quantity and kind wherever required; and, *third*, the manufacturing machinery, which is the producing element, is kept in motion by means of the prime mover and the shafting.

It is clearly to be seen that the best results in manufacturing cannot be secured without equal intelligence and judgment in the selection of all of the above, so proportioned and arranged that each may satisfactorily perform its part in perfect harmony with the others. The design and arrangement of shafting for power transmission is a subject worthy of more consideration than is generally awarded it. In fact, it cannot be wisely treated as in any way secondary to any other unit in the sum total of any manufacturing plant. In a large factory, the shafting, with its couplings, pulleys, belt carriers, and other similar adjuncts, considered as a machine to transmit motion, is frequently the largest in the establishment; hence, every consideration of economy requires that it should do its allotted work with the least possible loss of power in the transmission. It calls for economy in first cost and economy in use. The generation of power to be expended in operating machinery

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PLATE NO. 225.



PEDESTAL BEARING.—WITH SELF-OILING BOX AND FLOOR STAND.

This form of bearing and stand is especially designed for use in electric plants, or where the shafting and the machinery to be driven are on the same floor. As shown in the plate, the floor stand has attached our hand-wheel and worm shifting device, which is alike applicable to tooth and friction clutches.

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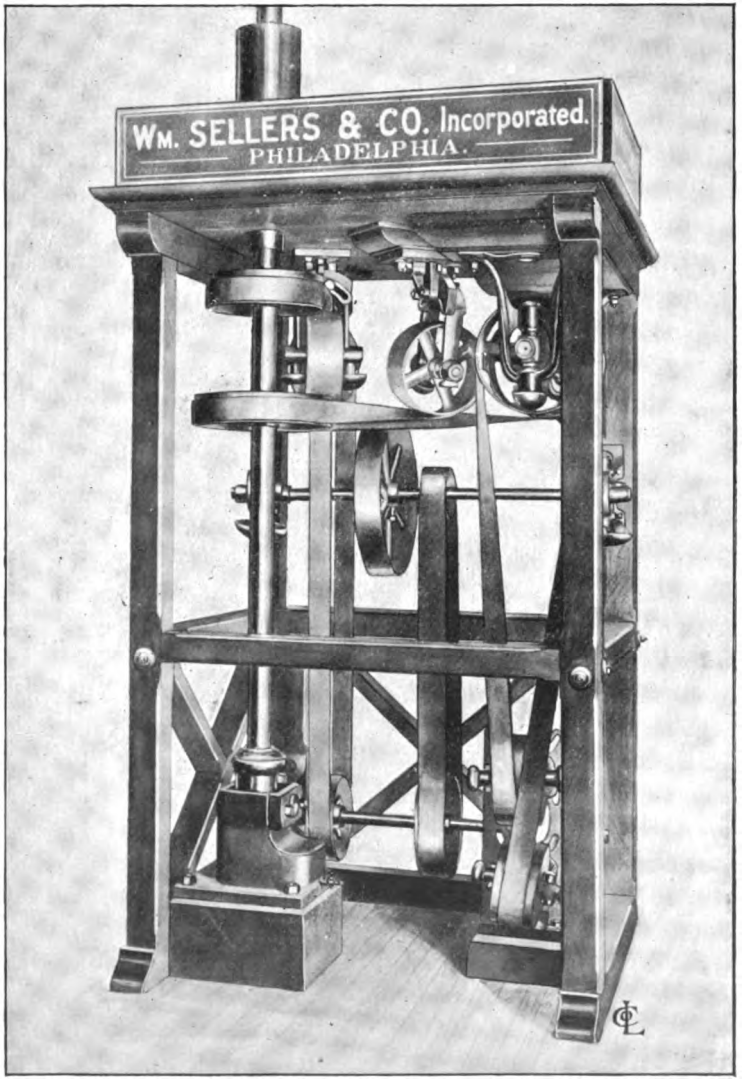
to do work costs something; it may cost much money in fuel consumed, or it may cost something in energy expended, the expense in most cases being in proportion to the amount of power generated and absorbed either in the direct operation of the machinery, or in the friction due to the transmission. In any case, the more perfectly the whole power is distributed to the operating machinery the more profitable will be its use.

In reviewing the history of the art of manufacturing shafting, it is evident that its growth has been one of continuous development. In our present practice, quiet and rapid running belts have superseded the noisy and slow running gears which were previously in such general use. Heavy, slow-moving shafts, sometimes of cast-iron, have been replaced by lighter and stronger ones of wrought-iron or steel, which are run at much higher speeds. The perishable wooden pulleys in their imperfect way served their day, and have yielded place—in the best practice—to nicely balanced, light and imperishable iron pulleys; whilst the old style of rigid bearings have been almost entirely supplanted by "swivel" and self-adjusting journal boxes. The time-honored "plate" or "flange" coupling for connecting shafts has become a thing of the past, and its important place has been largely taken by the cone-vise coupling. Many ingenious and reliable appliances for driving by means of belts or ropes, around corners and at various angles, have been adopted with very satisfactory results. These and many similar improvements are the result of experience and the continued study of this important subject.

To obtain the high speed found advantageous in mill practice, and at the same time reduce the friction load to such a minimum as will give the highest degree of economy in running, it is necessary that great care be used in the selection and disposition of the various materials used. The shafts must be straight, truly cylindrical, properly proportioned for the work to be done, and made of carefully selected materials, having such chemical and physical properties as will best resist the torsional and deflecting strains to which they are to be subjected.

They must be united by couplings that hold them firmly, and be provided with

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VERTICAL SHAFT AND COUNTERS.—WITH CARRIERS FOR "QUARTER TWIST" AND ANGLE BELT DRIVES.

This plate illustrates an exhibition arrangement of a vertical shaft and counter-shafts, and shows various ways of connecting shafts that are at right angles with each other by means of belts so supported and guided that the strain is distributed through their entire width, and they will run in either direction.

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self-adjusting bearings that will maintain them in true line. All of the work should be so designed that it may be readily attached or detached, and a standard as to sizes should be adopted, so that the various parts may always be interchangeable.

These results, together with good judgment in the arrangement of the work so that the best effects may be produced, with the least expense as to outlay and the cost of running, can only result from long and extensive experience.

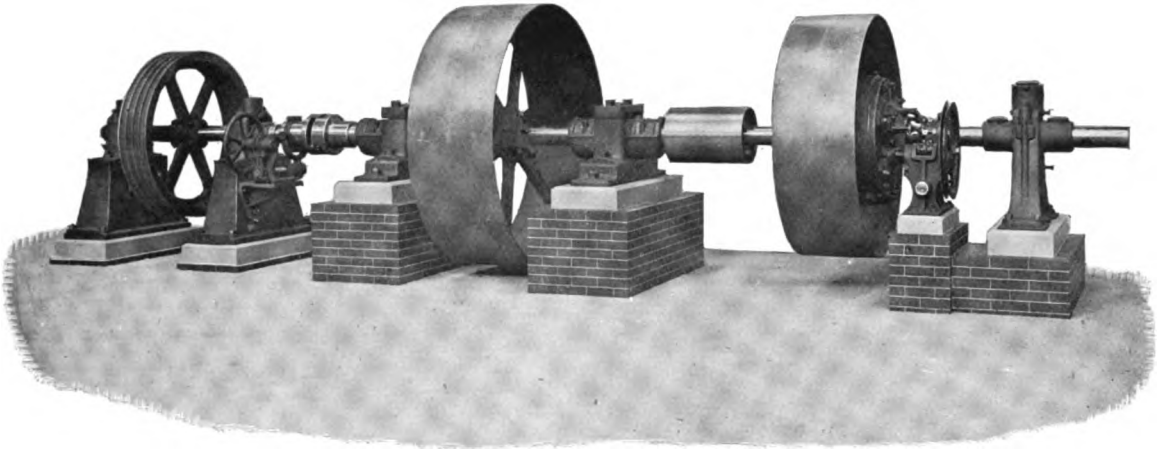
It is important to state, however, that no matter how thorough a system of shafting is adopted, its arrangement, proportions, disposition of parts, and general adaptation to its special purposes, should all be carefully studied and determined upon by one who is an expert in such matters before the mill or factory building is designed. Too frequently this important matter is left without consideration until after the building is erected, and then the shafting must be arranged to suit controlling conditions, with results, both as to cost and efficiency, that are far from satisfactory.

No one not familiar with this business—as conducted upon an extensive scale —can have any idea as to the extent and variety of its details. In addition to the every-day demands in the line of general practice, there continually arise cases of a peculiar kind, requiring hitherto unused expedients which can only be designed and applied by those having had long and successful experience in this line, and the demands of the day are so great, so varied, and so constantly increasing, that no establishment can properly meet them unless it has appliances and resources that are practically without limit.

Our extensive plant is the outgrowth of an experience in the front rank of over forty-six years, during which time our products have found a market among the most exacting customers in almost every civilized country upon the face of the earth. At the beginning of this period the art of making shafting was in a very crude state, and the products of to-day are to be compared with those of that time much as daylight is to darkness. We do not hesitate to state, with justifiable pride, that most of the prominent improvements in this line originated with us, and have

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PLATE No. 227.



LINE OF SHAFTING

This cut illustrates various types of bearings, pulleys, clutches, etc.

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since been extensively copied by other manufacturers. This is notably the case with the "swivel" or "ball-and-socket" bearings, which are now almost universal in their use, and with the "cone-vise" compression couplings, which since the expiration of our patents have been extensively made by a number of others, both in this country and in Europe.

We were the first to introduce a scale of fixed prices for each separate article, by which the purchaser is enabled to know in advance the exact cost of his work,—a foreknowledge which cannot be possessed by those who purchase "by the pound." We claim that our customers not only make a direct saving in first cost over those who purchase in any other way, but that the advantages are continuous, in that they secure a well-designed and easy-running system, which is constructed with as little expenditure of material as is consistent with absolute strength.

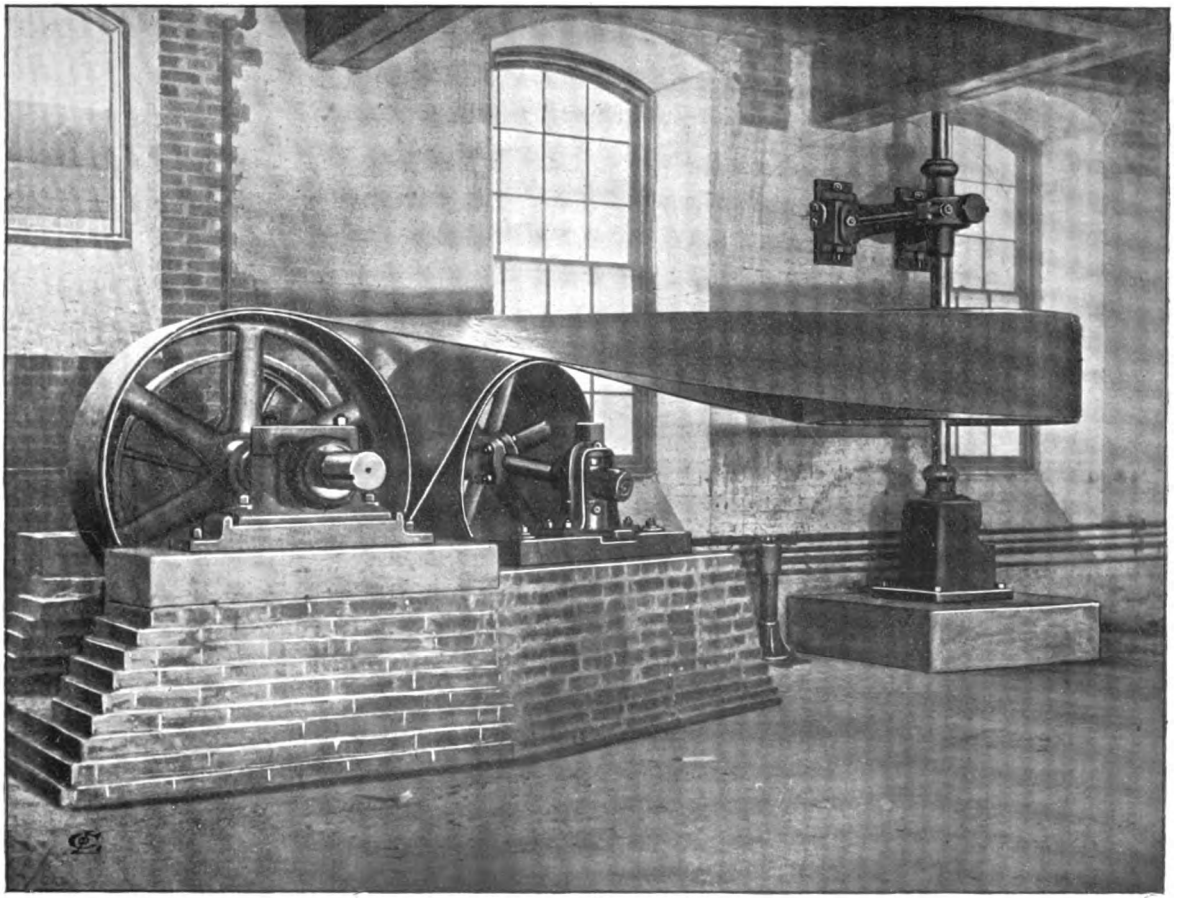
We publish for distribution a Shafting Price-List, illustrating our standard articles of manufacture, and giving price for each item. This book also contains tables for use in the laying out and proportioning of shafts, together with general dimensions of bearings, etc. All the prices given in this book are subject to discount, the rate of which will be furnished upon application.

We keep in stock a large assortment of the standard articles in this line, such as Shafts, Couplings, Hangers, various forms of Carriers, etc., which can be delivered promptly upon receipt of order, and our plant is so extensive that we can promptly make to order such articles as are not in stock.

Our shafts are made of rolled bars of either steel or iron,—as the customer may prefer,—and of stock carefully selected, and known to possess properties best suited for the purpose.

They are finished with care to standard ring gauge sizes upon lathe centres, thus making them truly cylindrical. No shaft of any kind is furnished by us that has not been treated in this way. All key-seats, unless otherwise ordered, are cut to standard sizes, and the shafts are subsequently restraightened as a final process before boxing or delivery. Our standard sizes are one-sixteenth of an inch less in

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VERTICAL SHAFT.—WITH STEP AND DRIVING PULLEYS.

This plate shows the method of conveying power from a horizontal to a vertical shaft by means of a belt, and one carrier so adjusted as to distribute the pulling strain through the entire width of the belt. In this way power may be distributed through each story of a building without belts running through the floors. The shaft, coming from an adjoining building, is 5″ in diameter, with driving-pulley 48″ in diameter, and conveys 150 horse-power through a 20-inch double belt to the vertical shaft, which makes 200 revolutions per minute.

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diameter than the nominal sizes; thus, what we call a 3-inch standard shaft is in reality $2\frac{15}{16}$ inches in diameter. This difference is due to the allowance for turning, although we can furnish shafts of full nominal sizes when so ordered. For large sizes and for heavy duties we make special shafts of forged iron or steel.

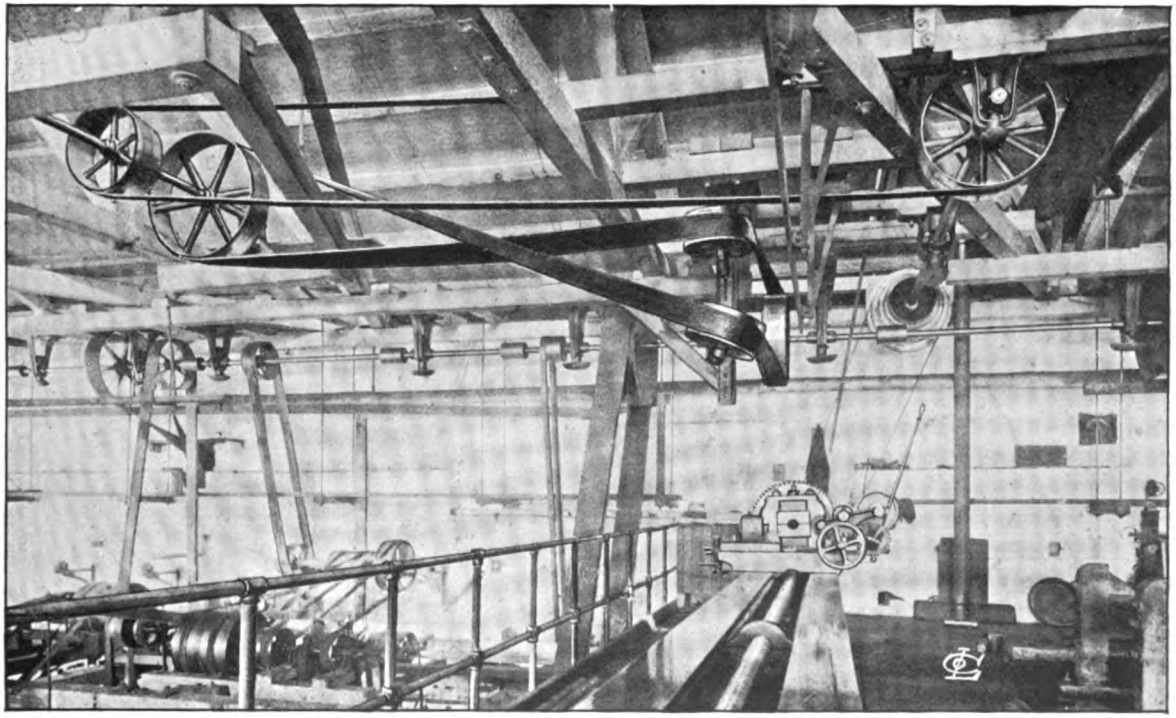
Our hangers are of the "double-braced," "ball-and-socket" variety, so designed as to resist with equal efficiency strains exerted in any direction, and having vertical adjustment by means of the "plungers," which are the "sockets" carrying the "ball" on the journal box or bearing. This "ball" is a sphere, having its centre coincident with the centre of the box. A bearing when made in this way can adjust itself to any deflection or settlement of the shaft with equal facility in any direction, and thus distribute its load equally over its entire surface. This is, in fact, the only correct form of swivel box, and is usually made by us, with a length equal to four times the diameter of the shaft. We manufacture numerous modifications of this form of hanger, many of which will be better understood by reference to the shafting price-list before mentioned, where they are illustrated and described.



The question of properly lubricating the bearings is one of great importance, and the various methods and materials used for this purpose are almost without limit. To meet a very diversified range of requirements, we make—with certain modifications—two standard forms of boxes or bearings for our hangers. First, the ordinary box, so arranged that it can be oiled by hand, or can have attached any of the well-known forms of drop feeders. Each of these boxes is made with two small grease reservoirs or cups on its upper surface, and these can be filled with grease, or can have attached tubes for "candle" lubricators, which are now quite extensively used. In this way we meet the ordinary requirements for oil or grease lubrication.

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PLATE NO. 229.



ANGULAR BELT DRIVE.

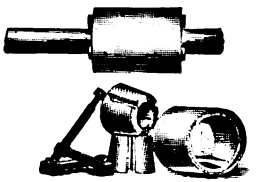
A method of connecting by belt two shafts that are at right angles and not upon the same plane. In this instance the belt is "crossed," and is carried upon one of our adjustable *Mule Pulley Stands.*

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Our second form of box is of the "ring" or "chain" self-oiling type. This is a neat and efficient adaptation of a method of oiling already in use for other purposes, and at the same time preserving the integrity of the ball-and-socket box. Each box has attached to it an oil reservoir or chamber extending its entire length, and having free communication between the two ends. Supported upon the shaft journal there are two rings or chains which hang into the bath of oil below, and which revolve with the shaft whenever it is in motion. With said rings or chains a copious supply of oil is carried to the journal at all times, and a complete lubrication is constantly maintained. A single charging of oil should keep the box in good running condition for several months without renewing. Our ordinary box or bearing for hangers is made of iron, bored accurately to size, so as to distribute the journal load over its entire length. Our long experience has demonstrated that for ordinary use cast-iron used in this way is superior to other metals as a material for boxes. We make to order, however, boxes babbitt lined, or of brass or bronze.

Couplings.

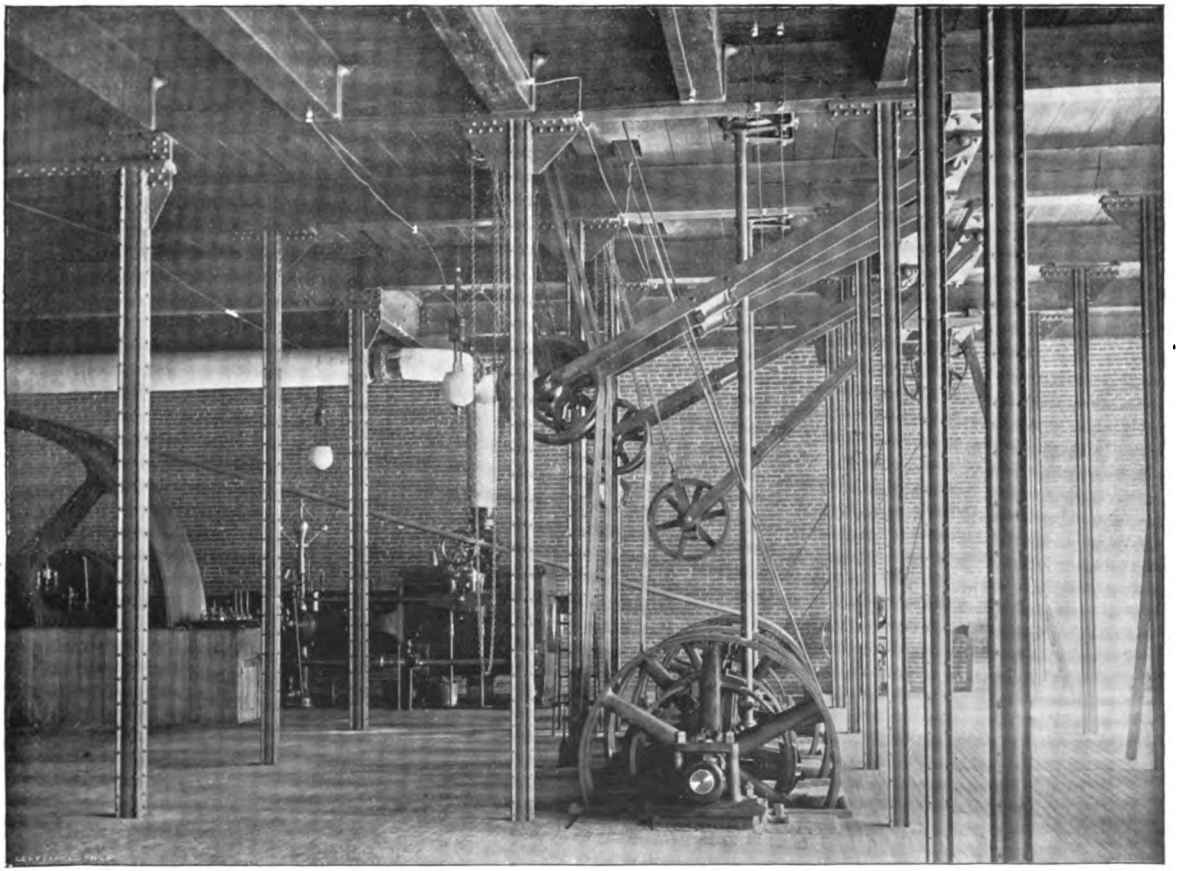
Our standard coupling is the double "cone-vise" coupling, universally known and commonly spoken of as the "Sellers Coupling." Its very extensive use has made it such a familiar object that anything more than a general description is unnecessary.



This coupling, as is plainly to be seen, consists of three (3) principal parts, viz., one outer "shell" and two "cones," the latter of which are drawn together within the former by means of three bolts. The construction is such that the cones compress with equal force upon both of the shafts to be coupled, holding them in absolute "line" with each other, whether the two are turned to the same finished diameter or not. They can readily be attached or removed without the use of any but the most simple appliances. Shafts of different sizes can be connected by this

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PLATE NO. 230.



A LINE SHAFT IN THE STATION OF THE NORTHERN ELECTRIC LIGHT AND POWER CO. OF PHILADELPHIA.

The dynamos on the floor above are driven from this shaft by nearly vertical belts, to which tension is given by means of belt-tighteners that are raised and lowered by chain-blocks.

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coupling, either by reducing the end of the larger shaft to the diameter of the smaller one, and using a coupling of this size, or by the better practice of using a coupling of the proper size for the large shaft, and having one of its cones bored and finished to suit the small one. Each standard coupling has a strength greater than that of the shaft to be driven, and, under ordinary conditions, has a durability co-equal with that of the shaft itself. One particular feature of the cone-vise coupling is its combination of simple parts, any one of which can be replaced by a new one in case of breakage or excessive wear, and the coupling thus restored at a small cost to its original condition of usefulness and reliability.

Pulleys.

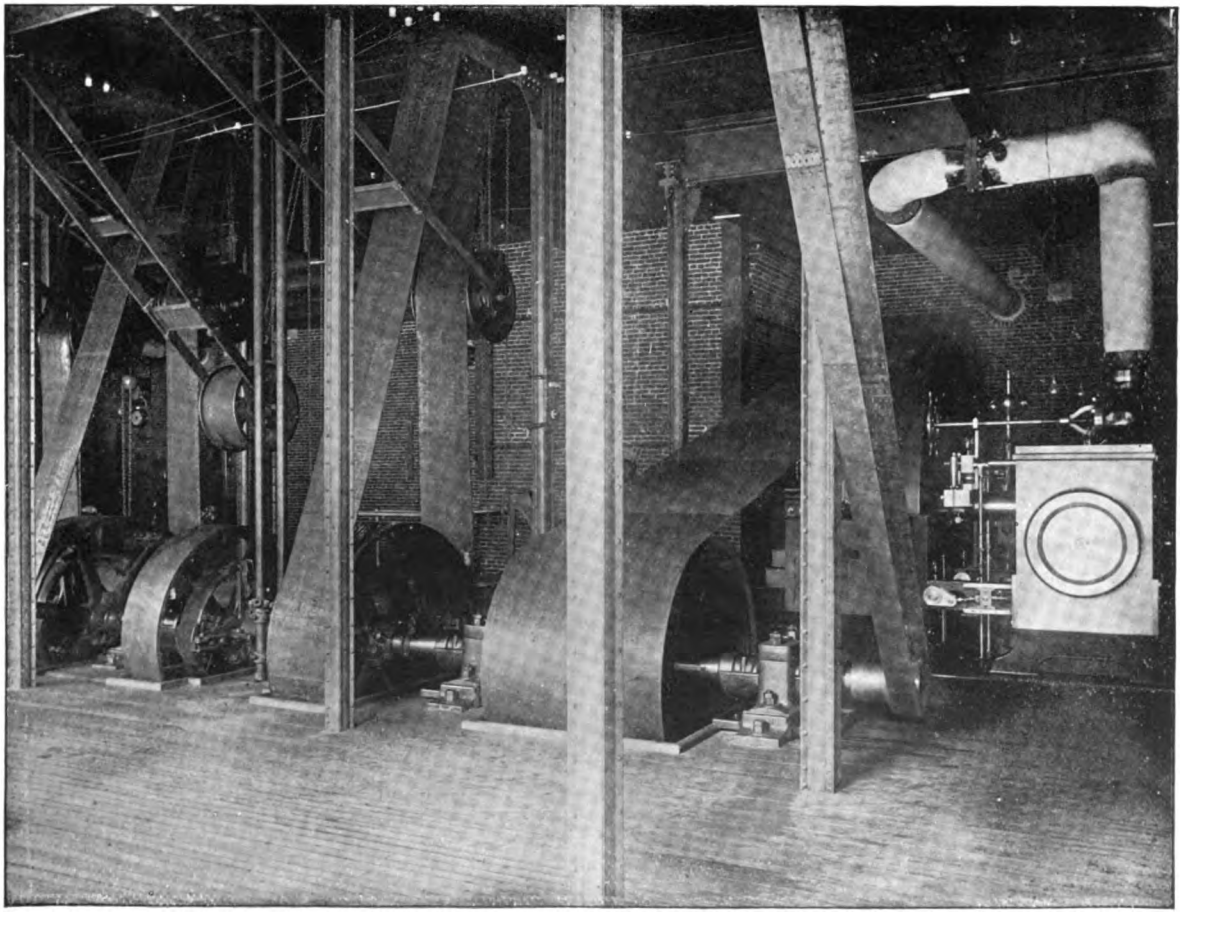
A review of the history of pulley making recalls the time when the substitution of iron for wood as a material for pulleys, and the capacity to do so skilfully and inexpensively, was justly considered as one of the great strides in the art. A properly proportioned and correctly finished iron pulley has, accidents excepted, a life of reliable usefulness that is practically without limit. No other material has the same capacity for resisting wear, and is so little affected by changes in atmospheric conditions, and no other pulley is so graceful in appearance and action, and presents in revolving so small a surface to the resistance of the atmosphere.



Most of our pulleys are machine moulded, all are made with straight tapering arms, are properly proportioned, and in every way have an abundant and well distributed strength, without having any superfluous material to add to the necessary weight that is kept in motion at the expense of power. They are all bored to fit accurately to their carrying shafts, are made for other "single" or "double" belts, turned either "straight" or "high" on the face, as their service may require, and are balanced carefully, with a special reference to

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PLATE No. 231.



END VIEW OF THE LINE SHAFT SHOWN IN PLATE No. 230.

Illustrating distinctly the clutches and shifting devices by means of which the operator on the second floor is enabled to control the action of the clutches on the floor below.

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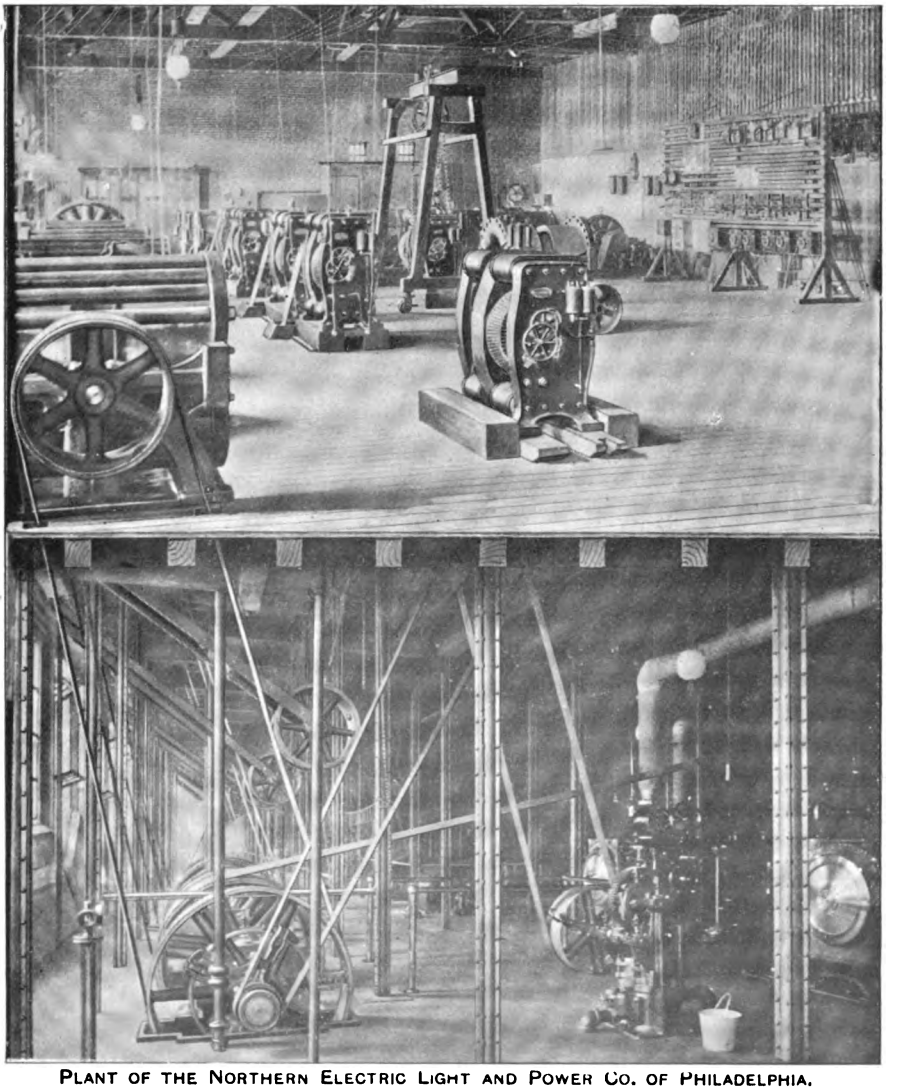
the speed at which they are to be run. Wherever the conditions are peculiar, as is frequently the case, we make the pulleys with special reference to these conditions. Our patterns and general facilities for pulley making cover an extensive range as to sizes, and include everything that is in the line of the best practice.

Friction pulleys are now quite extensively used for many purposes, and have a position in the line of power transmission which is exceedingly important, and will undoubtedly be lasting. The same may be said of friction clutches when used as cut-off couplings. By the use of both of these the operator possesses many advantages in the facility with which his machinery or shafting may be instantly started or stopped, and he is further enabled to engage or disengage certain parts of his machinery without in any way interfering with the continuous running of the other parts. The increasing recognition of the advantages in the use of frictions among users of machinery of all kinds has led to a demand which, though already large, is constantly growing. The market is abundantly supplied with "good, bad, and indifferent" in this particular line. Whilst probably no mechanical product is so annoying and unreliable as an improperly constructed friction, none is more useful and serviceable than frictions made upon sound mechanical principles and adapted for their special duty. We are prepared to furnish either friction pulleys or friction cut-off couplings (of the latter class only) of all sizes, suitable for all speeds, and adapted for any conditions of service, and we will be pleased to correspond at any time with any one contemplating purchasing.

The subject of pulleys would be incomplete without special reference to those used in the transmission of power by means of ropes as a substitute for belts. This practice, but recently introduced in this country, has become firmly established, and, under certain conditions, possesses advantages which are worthy of recognition. There are two principal methods of rope transmission; first, by means of several ropes running side by side in properly shaped grooves upon the faces of the pulleys, and having a combined capacity equal to the amount of power to be transmitted; and second, by means of one rope, having several turns (or wraps) in the grooves of

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PLATE NO. 232.



PLANT OF THE NORTHERN ELECTRIC LIGHT AND POWER CO. OF PHILADELPHIA.

Showing method of arranging engines and shafting on lower floor. All dynamos are on floor above. Absence of shafts and belting on the upper floor is a notable feature.

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the two wheels of sufficient number to convey the power required, and having its tension regulated and the travel of the rope returned to its starting groove in one of the wheels, by means of a "sheave" wheel with single groove, on a traveller or tightener, commonly called a "tension carriage."

Both of these systems have their special advocates, both have merit, and each has superior advantages under certain conditions. In the application of either method, it is important that the mechanical devices employed should be the best of their kind. The transmission wheels should be of IRON only, and have turned grooves of sizes and shapes that have been proved by long experience to be best for the purpose. They should be properly balanced, the various grooves should be so accurately turned to the same pitch diameter, that all of the ropes, or the various wraps of the same rope, may travel at the same velocity, and they should be so fitted and attached to the shaft that the grooves will "run true" and without vibration.

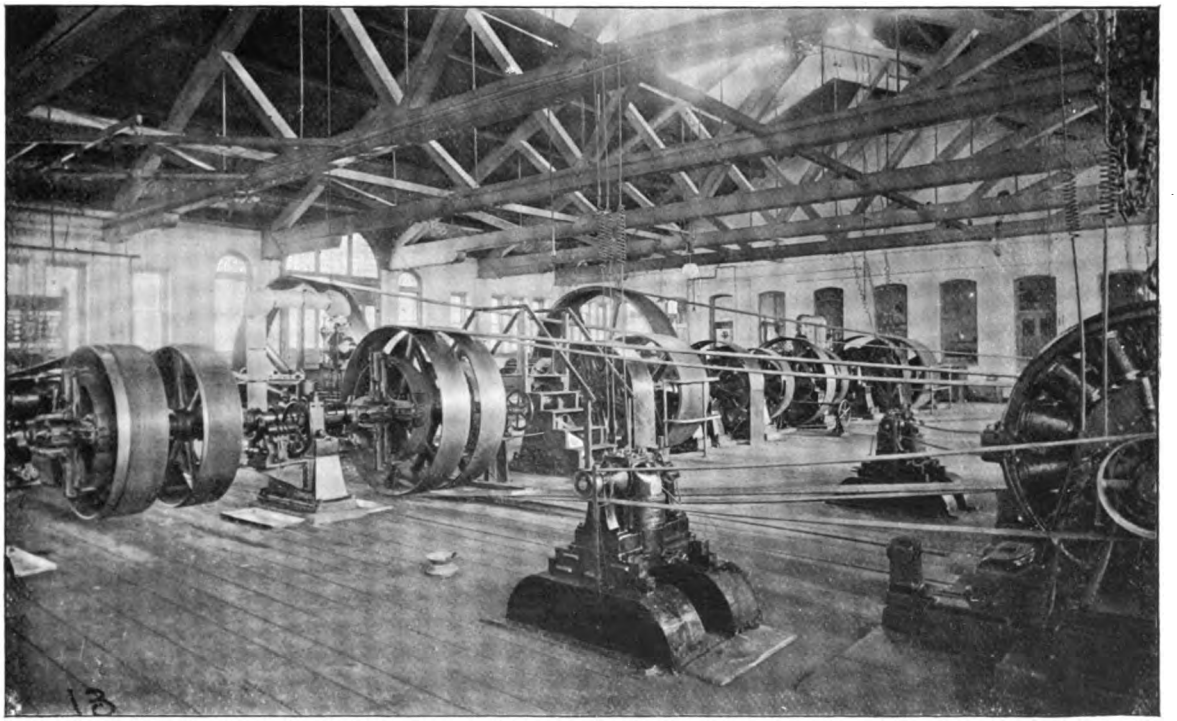
We can furnish to order transmission wheels with varieties as to pitch diameter, size, number, and shape of grooves, that will meet the broadest requirements for the best methods of rope driving. We have also designs and patterns for various forms of "tension carriages," rope carriers, etc., and are prepared to adapt to either usual or special conditions any standard or exceptional requirements in this line.

We will gladly render to any of our customers such engineering assistance as will enable them to secure a well-designed system of *Rope Transmission* which will insure a maximum of efficiency at a minimum of cost.

In the preceding pages, the limits of space have restricted us to but a general and somewhat superficial mention of the standard and commercial articles manufactured by us under the comprehensive head of *Shafting*. It is scarcely necessary to say, therefore, that we have been compelled to omit any mention of various other and equally important items which we manufacture for the same general purposes of power transmission. In fact, our regular output includes an extensive variety as to gearing, tighteners of various forms, carriers, mules, etc., many of which are standard and meet every-day requirements, whilst others have been

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PLATE NO. 233.



LINE SHAFT IN THE STATION OF THE WEST-END ELECTRIC CO. OF PHILADELPHIA.

This is, in fact, three separate lines, each having an independent engine, but all so arranged that by means of friction cut-off couplings the three lines can be connected into one, and driven by either of the engines. It will be noticed that these lines are supported and their clutches operated by the pedestal-bearing, floor-stand, and shifting device more fully shown in Plate No. 225, on page 373.

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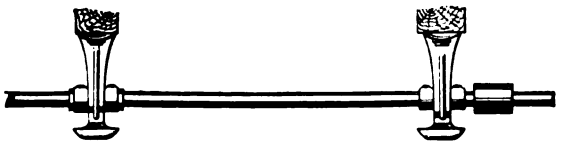
designed to do service under special and peculiar conditions. We state, therefore, without hesitation, that we are fully equipped with all modern facilities for furnishing promptly and in any quantity all of the latest and most approved appliances for the mechanical transmission of power.

Our *Engineering Corps* is an important feature in this department, and is well equipped for arranging general Shafting details,—or special features, if needed—in accordance with the best practice of the times.

Many of our customers find it greatly to their advantage to consult us as to the arrangement and proportions of their work, as they thus secure the best mechanical efficiency, and frequently at an important reduction both in first cost, and in expense of maintenance.

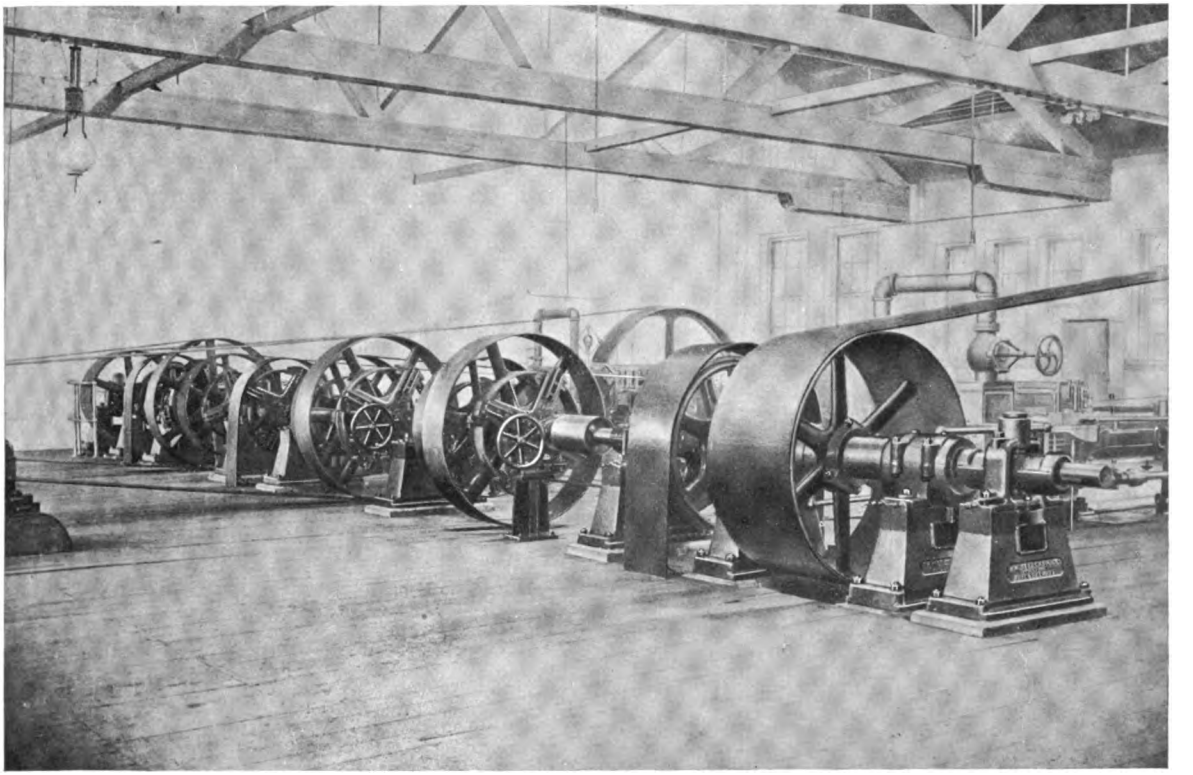
In our *Millwrighting Department* we keep employed a number of skilled millwrights, whose extensive and varied experiences make them masters of the general details of their trade. We are prepared to do constructive millwright work of all kinds, though the special feature of this department is the careful, accurate, and judicious erecting in place of the shafting made by us.

The proper and skilful erection of work goes "hand-in-hand" with its accuracy of design and construction; and no matter how perfect may be said design, and how well adapted to the purposes may be the various parts, they cannot yield their best efficiency unless they are judiciously erected and adjusted.



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PLATE NO. 234.



END VIEW OF LINE SHAFT SHOWN ON PAGE 389.

The special feature in this view is the mounting of the receiving pulley on a "sleeve" or "quill," which is entirely independent of and apart from the line shaft which runs through it. The two are connected or disconnected by a friction cut-off coupling, so that either can be in motion while the other is at rest, and neither will be exerting any wearing strain upon the other.

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Injectors.

THE Injector is now such a familiar object to all steam users that it is difficult to realize the scepticism with which the claims of the inventor were first received, and yet the present efficient locomotive-boiler feeder embodies the same principle, and is but a modified form of the ingenious device for which a patent was granted in 1858 to Henry J. Giffard.

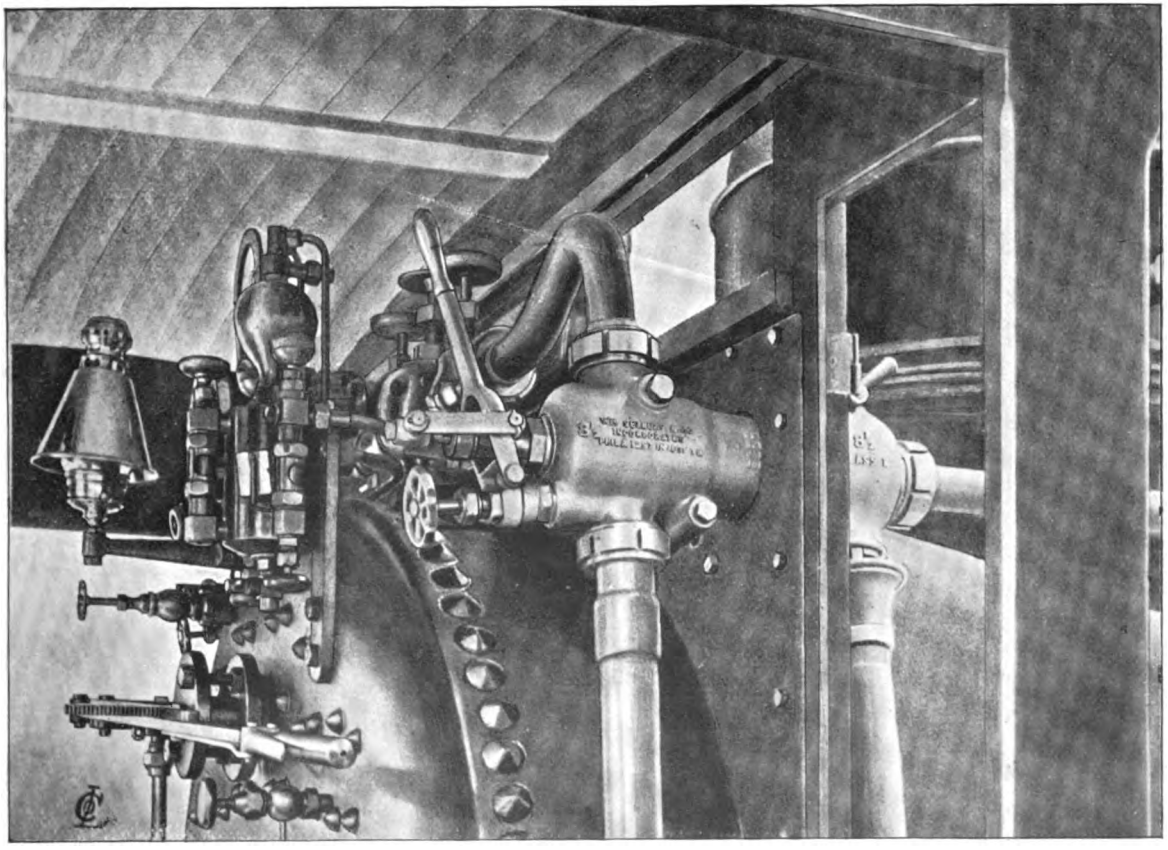
In 1860, the exclusive rights of manufacture for this country were obtained by our house, and constructive changes were introduced to increase the durability and the efficiency of the injector and to adapt it to American railroad practice. The most radical of these changes was due to the invention of the self-adjusting combining tube, and by its use was avoided the frequent adjustment of the position of the steam-nozzle in order to vary the water supply to suit changing steam pressures. This improvement was the chief feature of our injector of 1865, which passed through a number of subsequent modifications, and found its final development in our injector of 1876. The description of this injector in the following pages is fully justified by its extensive use in this and in foreign countries.

In the year 1887 an entirely different form was introduced. Differing essentially in its construction, this injector was designed so as to automatically adjust its water supply to suit any variation of the steam pressure, and, in addition, to re-start automatically after a temporary interruption of the steam or water supply. This result was obtained after a long series of experiments, whose object was to produce an automatic, self-adjusting injector without recourse to moving parts or special complication of valves. This instrument is applicable to a wide range of service, and has been adopted by, or is in use upon, most of the leading railroads of this country and upon many of those abroad.

These two patterns of injectors are specially suited to locomotive service, or to

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PLATE NO. 235.



VIEW OF LOCOMOTIVE CAB.

Showing the method of attaching the Self-Acting Injector of 1887. The door of the cab has been removed to show the waste-pipe; the frame fits neatly around the injector body, the steam- and feed-pipes are inside and protected, and the starting lever and the regulating valve are within easy reach of the engineer.

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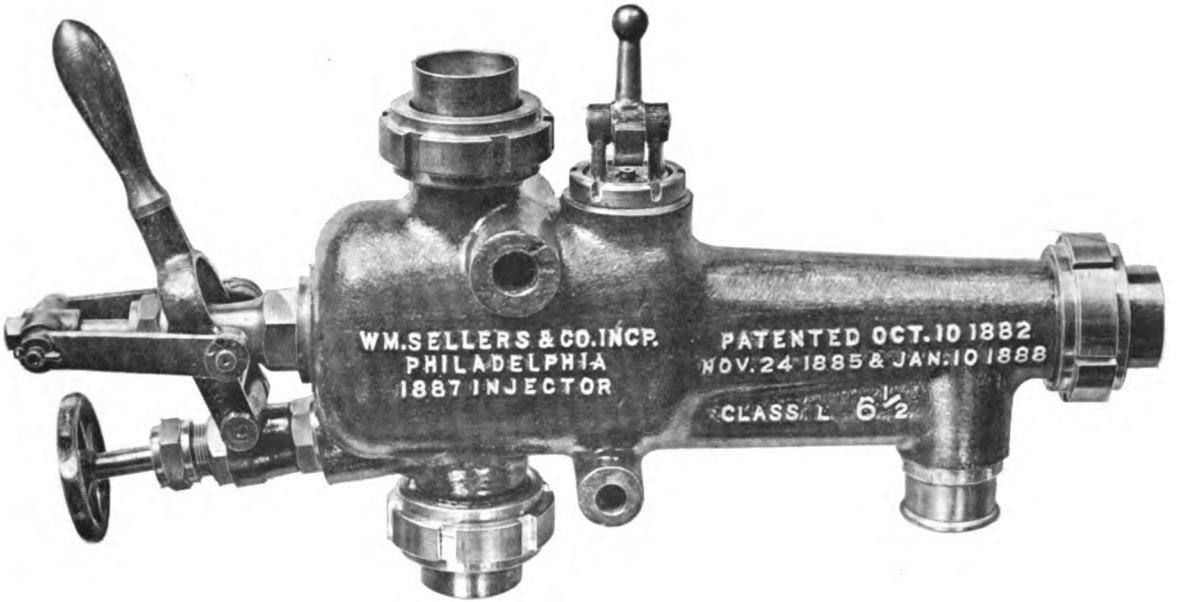
be used in connection with boilers carrying very high steam, or where the pressure is variable. By their use the watchful care on the part of the engineer in charge is reduced to the minimum, and his time and attention can be given to other duties. For stationary boilers, steam tugs, traction or logging engines, simpler and cheaper forms answer equally well, and for such boilers we have designed and recommend our injectors of 1885 and 1892.

All our different styles of injectors and valves are manufactured in large quantities, and each part is fitted to and tested by special gauges, insuring accuracy of dimensions and perfect interchangeability of parts, permitting repairs to be made without the necessity of the return of the injector to our works. The size number is cast in raised figures upon a conspicuous part of the body, and this figure always corresponds to the exact diameter of the smallest orifice of the delivery tube, expressed in millimetres; for instance, the diameter of the delivery tube of a No. 6 Injector of 1876 is 6 millimetres; and of a No. 10½ Injector of 1887, 10½ millimetres; a millimetre is equal to 0.03937″. Each injector is composed of the simplest form of tube and casing that will produce the desired results, combining the fewest possible movements to start and operate with high efficiency and small consumption of steam; facility of repair is also well considered, and although beauty of design and finish of parts are not essential to the actual working of the injector, yet they instinctively suggest greater care upon the part of the operator, and therefore tend indirectly to prolong the life of the instrument.

The following pages contain all necessary information regarding the principal kinds of injectors which we manufacture. As each instrument is thoroughly tested upon our own boilers before leaving our works, the accuracy of the tables of capacities can be depended upon. An injector is not a delicate instrument, yet, like all other important accessories of the boiler, requires occasional attention; a little time spent upon regrinding leaky valves, or upon the removal of dirt or scale from the tubes, will be more than repaid by the continuous satisfactory performance of the boiler-feeder and by its longer time of service.

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PLATE NO. 236.



THE SELF-ACTING INJECTOR OF 1887, CLASS L.

Automatically adjusts the water supply to suit all changes in the steam pressure without wasting at the overflow. Re-starts automatically. Lifts promptly and feeds steadily with hot suction-pipe. Pennsylvania Railroad standard connections. Capacities given in Table I., page 400.

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The Self-Acting Injector of 1887.

A noticeable feature of this injector is the simplicity of its construction, while the ease with which it can be started and regulated and the certainty of its action, render its use upon locomotives specially advantageous. Retaining the same arrangement of tubes so as to promote interchangeability of parts, the injector of 1887 is made with several styles of bodies in order to adapt it to the requirements of all railroads. The form in which it was first manufactured is designated as Class L, and is shown in Plate No. 236. Its threaded branches for pipe connections and the stay-bolt holes are placed in the same relative positions as those of the 1876 injector, so that two injectors of the same size are interchangeable.

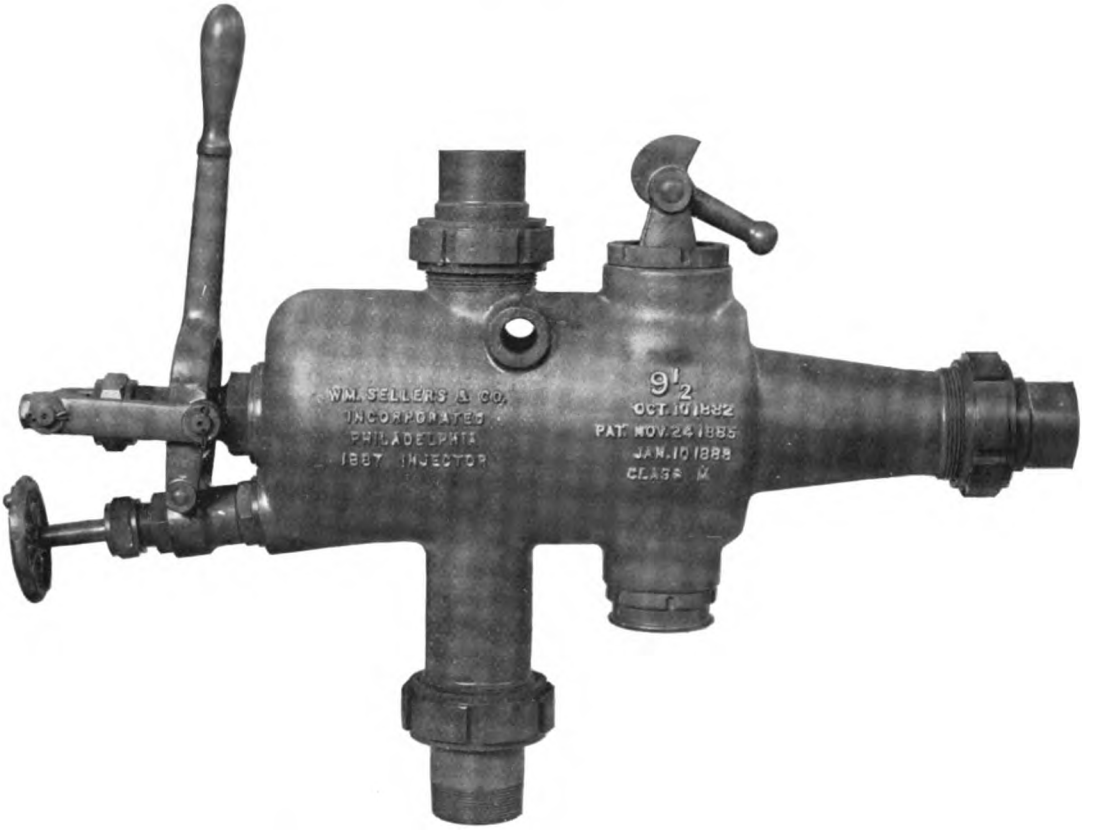
Class M, Plate No. 237, is differently proportioned, both in the size and position of the branches; although the capacity and method of handling are the same as that of Class L, and the same parts, with the exception of the body, are used in its construction.

Class N, Plate No. 238, on the other hand, is interchangeable with Class L, and therefore with the injector of 1876; the chief difference lies in the construction of the waste-pipe, which is a hollow casting or sleeve, which slides over the lower end of the body and is held in place by a jam-nut. It is made removable, so that the body may be placed through a circular hole in the cab-frame of the same diameter as the outside of the body, and is shown in the position it usually occupies in the cab in Plate No. 235.

For places in which the water supply does not have to be lifted, we provide Class N.L., shown in Plate No. 239. Its position upon the locomotive is under the foot-board, and it is so constructed that the overflow valve can be placed on either side of the injector, which is thus either right or left hand. Although there is considerable difference in the form of these different bodies, the same tubes are used in all, and all have the same special features, which may be enumerated as follows:

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PLATE NO. 237.



THE SELF-ACTING INJECTOR OF 1887, CLASS M.

Automatically adjusts the water supply to suit all changes in the steam pressure without wasting at the overflow. Re-starts automatically. Lifts promptly and feeds steadily with hot suction-pipe. For capacity, see Table I., page 400.

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a. Automatic adjustment of feed to suit all variations of steam pressure.

b. Automatic re-starting.

c. Wide range of capacities.

d. High admissible temperature of the feed-water.

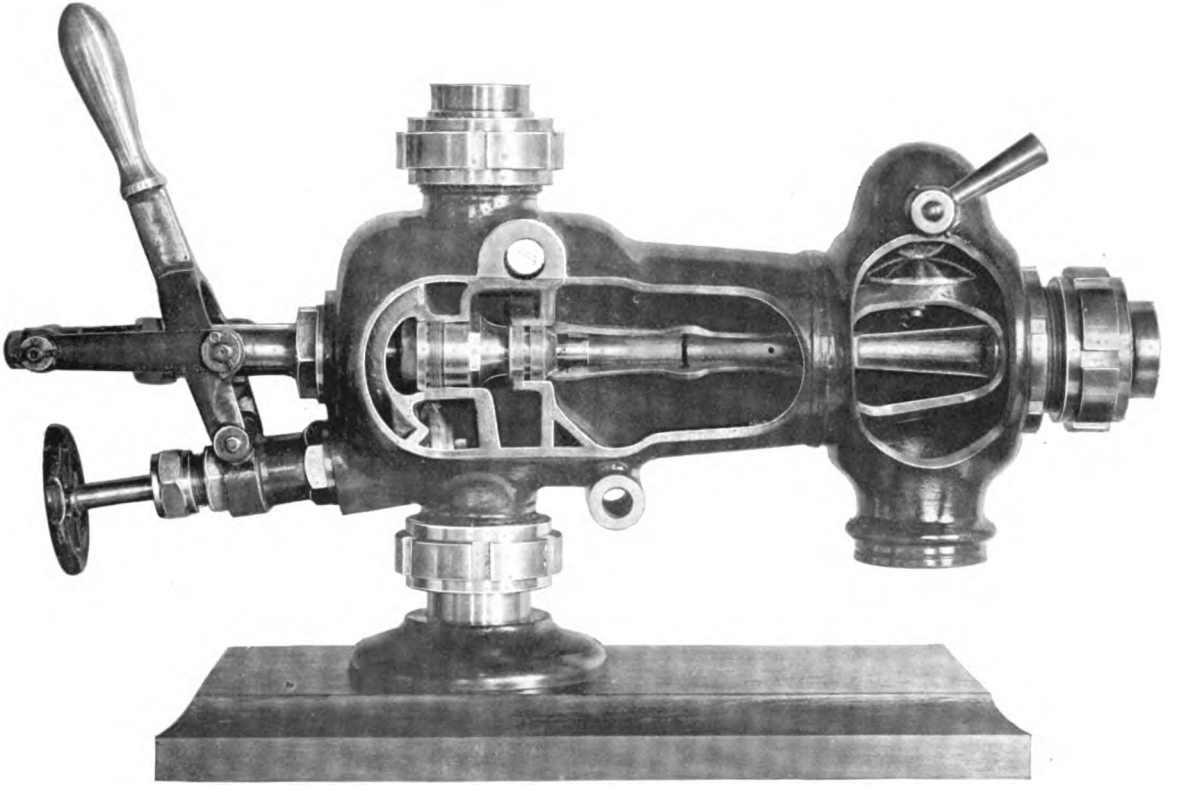
e. Small expenditure of steam.

These are obtained entirely by the proportions of the tubes and the arrangement and disposition of the overflows. A sectional view of a Class N injector on page 399 shows the constructive features which are common to all. Steam from the boiler is admitted to the lifting steam-nozzle by drawing the starting-lever back a short distance, and when water appears at the overflow it is pulled all the way open; this withdraws the central plug and allows the steam to discharge through the forcing steam-nozzle against the mass of water within the combining tube, forcing it with increasing velocity and reducing cross section into and through the delivery tube to the boiler pipe. The tubes are proportioned so that there is always a strong suction in the supply pipe, even when the steam-valve is wide open, so that the usual operation of starting is drawing the lever backward with a continuous, steady motion. The wide range of capacities depends upon the use of a very small forcing steam-nozzle; this ensures a small steam consumption, and, in this injector, a very low minimum, which is obtained by throttling the water-valve only. At a steam pressure of 120 pounds, the amount of water delivered can be reduced to 36 per cent. of the maximum, while the range is still greater at lower boiler pressures; although it is always more advantageous to use cold feed-water, as it enhances the certainty of action of all forms of injectors and increases the capacity, it is possible to feed a boiler at 120 pounds of steam with this injector when the temperature of the supply is 120 degrees Fahrenheit, without interfering with the automatic action; if the waste-valve is closed by means of the small lever over the waste-valve, the temperature may be still further raised to 136 degrees before the injector refuses to work.

The capacity of the injector of 1887 is approximately the same as that of the

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PLATE NO. 238.



SELF-ACTING INJECTOR 1887, CLASS N.

A sectional view, showing steam-nozzle, combining and delivery tube; also, removable overflow sleeve, which is held in place by the jam-nut at the rear of the coupling nut. Injector is automatic or re-starting, and self-adjusting. It starts promptly and will lift and feed hot water. Pennsylvania Railroad standard connections. For capacity, see Table I., page 400.

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injector of 1876, although the sizes of the former pattern are made fractional. A table of these capacities is given, which is based upon recent improvements which have largely increased the delivery at 180 and 200 pounds steam pressure.

TABLE I.

SIZE NO.	CAPACITY PER HOUR. LIFTING 5 FEET.						DIMENSIONS OF PIPES. CLASSES L, N; N, L.				
	STEAM PRESSURE, 60 LBS.		STEAM PRESSURE, 120 LBS.		STEAM PRESSURE, 180 LBS.		STEAM AND DELIVERY.		WATER SUPPLY.		OVERFLOW.
	Cubic Feet.	Gallons.	Cubic Feet.	Gallons.	Cubic Feet.	Gallons.	Iron. Inside.	Copper. Outside	Iron. Inside.	Copper. Outside	Iron. Inside.
$4\frac{3}{10}$	55	412	71	532	69	517	1″	$1\frac{1}{4}$″	1″	$1\frac{1}{4}$″	1″
$5\frac{4}{10}$	89	667	121	907	131	982	$1\frac{1}{4}$″	$1\frac{1}{2}$″	$1\frac{1}{2}$″	$1\frac{3}{4}$″	$1\frac{1}{2}$″
$6\frac{1}{2}$	129	967	175	1312	190	1425	$1\frac{1}{4}$″	$1\frac{1}{2}$″	$1\frac{1}{2}$″	$1\frac{3}{4}$″	$1\frac{1}{2}$″
$7\frac{1}{2}$	172	1290	233	1747	253	1897	$1\frac{1}{4}$″	$1\frac{1}{2}$″	$1\frac{1}{2}$″	$1\frac{3}{4}$″	$1\frac{1}{2}$″
$8\frac{1}{2}$	221	1657	300	2250	326	2445	2″	2″	2″	$2\frac{1}{4}$″	2″
$9\frac{1}{2}$	277	2077	374	2805	407	3052	2″	2″	2″	$2\frac{1}{4}$″	2″
$10\frac{1}{2}$	338	2535	457	3427	497	3727	2″	$2\frac{1}{4}$″	2″	$2\frac{1}{4}$″	$2\frac{1}{2}$″
$11\frac{1}{2}$	405	3037	549	4117	596	4470	$2\frac{1}{2}$″	$2\frac{3}{4}$″	$2\frac{1}{2}$″	$2\frac{3}{4}$″	3″

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PLATE NO. 239.



INJECTOR OF 1887, CLASS N-L.

Designed to be used under slight head of water; other characteristics are the same as those of Classes L, M, and N. Automatic and self-adjusting; capacity given in Table I.

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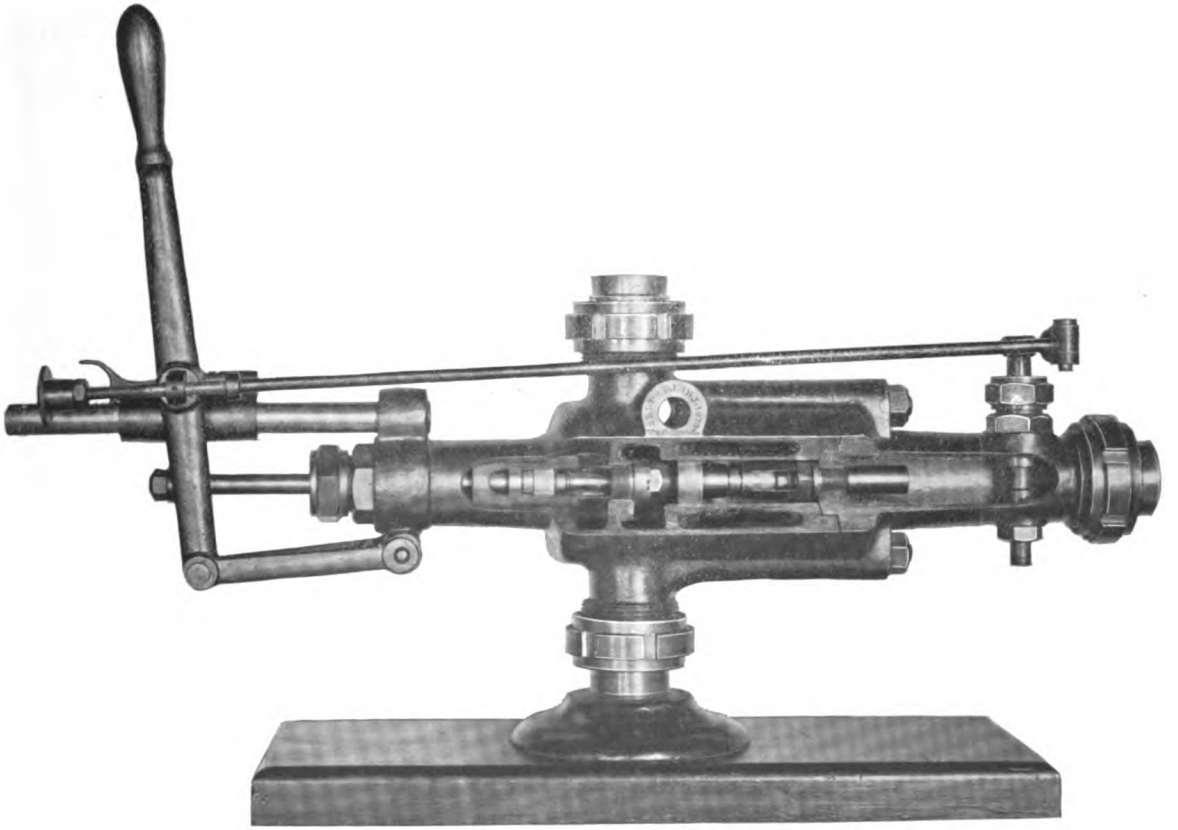
The Injector of 1876.

The principle of the movable combining tube of the injector of 1876 depends upon the change in the internal condition of the jet at mouth of the delivery tube, whenever there is a deviation from the correct proportions of water to steam. By means of an overflow space between the lower end of the combining tube, communication is established between the jet and the piston of the combining tube; an excess of water supply will cause an overflow from the jet at this point, forcing the combining tube toward the steam-nozzle, and reducing the area for the inflow of water until the normal condition of the jet is re-established. A deficiency of water causes a reversal of this action and a downward movement of the tube until the correct proportions again obtain. By this means the maximum efficiency of the steam jet can be obtained under varying conditions, as is shown from the fact that the capacity of the injector increases as the steam pressure rises, and the temperature of the water delivered to the boiler upon the minimum is almost precisely the same as that of the maximum; the former capacity is obtained by reducing the steam discharge by inserting a taper-spindle in the steam-nozzle.

Referring to the sectional view on page 405, H is the starting-lever, which is drawn back a short distance until the resistance of the main steam-valve X is felt; this movement admits steam to the hollow spindle C, which discharges through the delivery tube D, and produces a partial vacuum in the suction-pipe. When water appears at the overflow, the starting-lever is drawn all the way back, striking against the nut T, and closing the waste-valve K by means of the connecting-rod, forcing the water to enter the boiler. The regulation of the capacity is effected by adjusting the position of the lever by means of the steel latch V on the guide-rod J; this alters the area of steam discharge by changing the distance of insertion of the taper steam-spindle, and any variation of the weight of steam discharged induces an automatic movement of the combining tube, which preserves the correct ratio between the weights of the water and the steam. An air-chamber, M, cored

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PLATE NO. 240.



SELF-ADJUSTING INJECTOR OF 1876.

Part sectional view. Injector is operated entirely by one lever. Self-adjusting throughout widest ranges of steam pressures. Pennsylvania standard. Capacities given in Table II., page 404.

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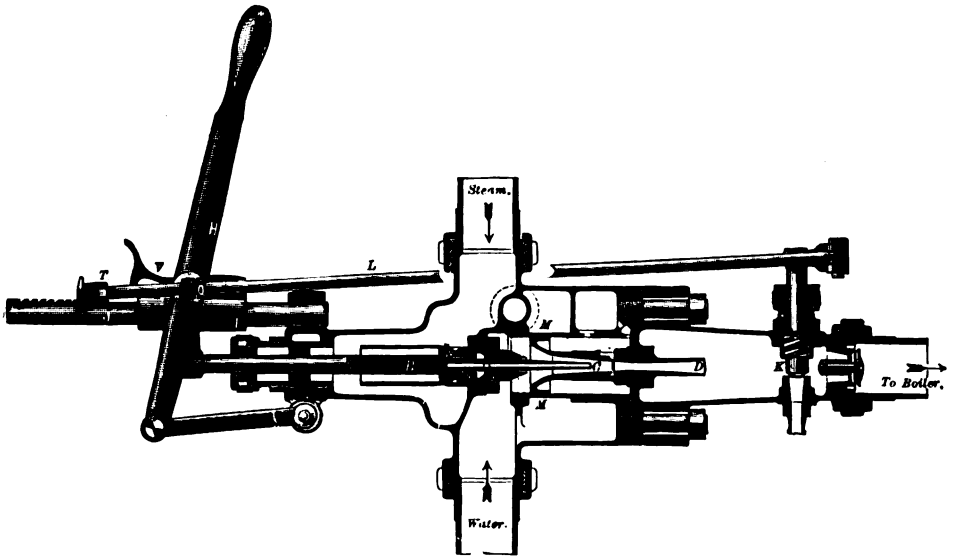
in the body, is connected with the column of water in the suction-pipe, so that all shocks or jars will be reduced by the elasticity of the enclosed air and lessen the danger of breaking the jet.

The position and sizes of the threaded branches of the injector of 1876 have been adopted by the Pennsylvania Railroad as the standard; all sizes are interchangeable with corresponding sizes of our Class L and Class N of the 1887 pattern. This injector is very conveniently arranged for operating, as it is started, regulated, and stopped by means of a single lever, requiring no hand adjustment for any variation of the pressure of steam, height of lift, or temperature of the feed-water. The ratio of the minimum capacity to the maximum is 50 per cent., and the feed temperature may be raised to 130 degrees before the jet breaks. A list of capacities at 120 pounds steam pressure is given below.

TABLE II.

SIZE NO.	CAPACITY PER HOUR.		DIAMETERS OF PIPES.			
	STEAM PRESSURE, 120 LBS.		STEAM AND DELIVERY.		WATER SUPPLY.	
	Cubic Feet.	Gallons.	Iron. Inside.	Copper. Outside.	Iron. Inside.	Copper. Outside.
3	38	285	$\frac{3}{4}''$	$1''$	$\frac{3}{4}''$	$1''$
4	72	540	$1''$	$1\frac{1}{4}''$	$1''$	$1\frac{1}{4}''$
5	112	840	$1\frac{1}{4}''$	$1\frac{1}{2}''$	$1\frac{1}{2}''$	$1\frac{3}{4}''$
6	162	1215	$1\frac{1}{4}''$	$1\frac{1}{2}''$	$1\frac{1}{2}''$	$1\frac{3}{4}''$
7	220	1650	$1\frac{1}{4}''$	$1\frac{1}{2}''$	$1\frac{1}{2}''$	$1\frac{3}{4}''$
8	290	2175	$2''$	$2''$	$2''$	$2\frac{1}{4}''$
9	365	2737	$2''$	$2''$	$2''$	$2\frac{1}{4}''$
10	453	3397	$2''$	$2\frac{1}{4}''$	$2''$	$2\frac{1}{4}''$

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SELF-ADJUSTING INJECTOR OF 1876.

Sectional view, showing interior construction, the movable combining tube, the delivery tube, and the steam-nozzle, with the taper-spindle for reducing the capacity.

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The Fixed-Nozzle Injector of 1885.

The body or casing of this injector contains all the necessary operating valves; the stem of the steam-valve is attached to the screw-handle, the water-supply valve is directly underneath, and the check-valve is placed in the delivery branch to prevent backflow of water from the boiler. Only two tubes are required,—a steam-nozzle and a delivery tube,—because the combining and delivery tubes are formed in the same casting to reduce the number of parts used in the construction; the latter tube is attached to the end-cap by a bayonet joint, so that the motion of unscrewing this piece draws the delivery tube out of the body; the steam-nozzle is removed from the opposite end after unscrewing the stuffing-box of the steam-spindle. The overflow valve can be placed on either side of the body, and may be rotated to maintain its vertical position, independent of that of the body. The injector can be started and operated with equal facility when the water supply is lifted and when it is received under pressure, for the steam-spindle is provided with a taper-plug which enters the steam-nozzle and reduces the discharge, so as to give a strong suction in the feed-pipe when the starting-valve is one-quarter turn open. The minimum capacity is obtained by regulating both the water- and the steam-valves, although the latter adjustment is not necessary unless a very great reduction is desired; in the first case, a minimum of 25 per cent., and in the latter a minimum of 36 per cent. can be obtained. The high admissible temperature of the feed-water is also a special feature of this injector; at 60 pounds steam, and feed-water flowing under a slight head, the feed temperature may rise to 135 degrees without preventing the injector from re-starting automatically, and if the overflow valve be screwed tightly on its seat, this temperature may be increased to 150 degrees before the jet breaks. It is seldom desirable, however, to use a warm-water supply, as the capacity of the injector is reduced and its action rendered less certain, besides increasing the size necessary for the boiler.

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A sectional view is shown on page 409. Attention is called to the special arrangement of the tubes and the method of removal from the body; no screw-threads are used, as the pressure of the steam and the delivered water is sufficient to hold them firmly against the walls of the casing.

This injector is very simply constructed, and can be operated even by the most inexperienced hands; in order to start it, it is only necessary to open the water-valve and the steam-valve.

TABLE III.

NOMINAL SIZE OF INJECTOR.	STEAM PRESSURES.				SIZE OF IRON PIPES FOR CONNECTIONS.
	30 Lbs.	60 Lbs.	90 Lbs.	120 Lbs.	
	CUBIC FEET OF WATER DISCHARGED PER HOUR.				
No. 2	9.33	12.67	13.77	15.	$\frac{1}{2}''$
" $2\frac{1}{2}$	14.6	19.5	20.9	22.8	$\frac{1}{2}''$
" 3	21.	28.5	31.	33.75	$\frac{3}{4}''$
" 4	37.33	50.66	55.11	60.	$1''$
" 5	58.33	79.16	86.11	93.75	$1\frac{1}{4}''$
" 6	84.	114.	124.	135.	$1\frac{1}{4}''$
" 7	114.33	155.16	168.77	183.75	$1\frac{1}{2}''$
" 8	149.33	202.66	220.44	240.	$2''$
" 9	189.	256.5	279.	303.75	$2''$
" 10	244.44	316.66	344.4	391.16	$2''$
" 12	336.	456.	496.	540.	$2\frac{1}{2}''$

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The Re-starting Injector of 1892.

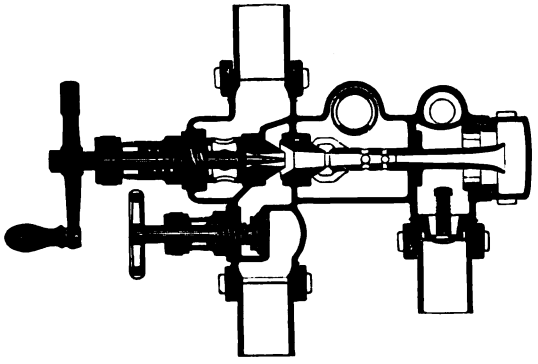
This instrument is shown on page 409, and is specially designed for small stationary, portable, or locomotive boilers, and contains only the parts actually essential to its working. The usual steam-starting valve is omitted, as the automatic action of the jet is so strong that the opening of an ordinary globe-valve in the steam-pipe is sufficient to lift the feed-water more than sixteen feet; for the purposes of regulating the amount of water supplied, a valve must be placed in the suction-pipe. The steam enters at the top, the feed and the delivery branches are at the sides and opposite; the waste-pipe forms also a cap for the inside delivery chamber; unscrewing it from the body, draws the tubes out for cleaning or repairs without disconnecting the pipes.

The injector may be operated by the most inexperienced hands, as it is only necessary to open the steam- and water-valves in order to start it; after water appears at the overflow, regulate the supply until the overflow ceases.

TABLE IV.

SIZE NO.	STEAM PRESSURE.		SIZE OF PIPE CONNECTIONS.
	60 Lbs.	100 Lbs.	
	Cubic Feet per Hour.	Cubic Feet per Hour.	
2	13	15	$\frac{1}{2}''$
$2\frac{1}{2}$	21	24	$\frac{1}{2}''$
3	29.5	32.5	$\frac{3}{4}''$
4	49	61.5	$1''$

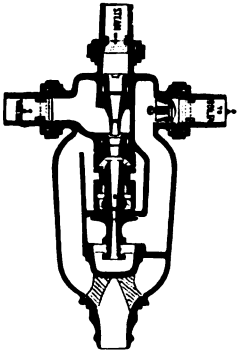
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FIXED-NOZZLE INJECTOR OF 1885.

Designed for stationary service. Gives unusually wide range of capacities and good results with warm feed-water.

A quick-starting, simple injector, easy to clean and repair. Tubes can be removed without disconnecting. Suitable for Traction engines, as it is not affected by jars. Re-starts instantly.



RE-STARTING INJECTOR OF 1892.

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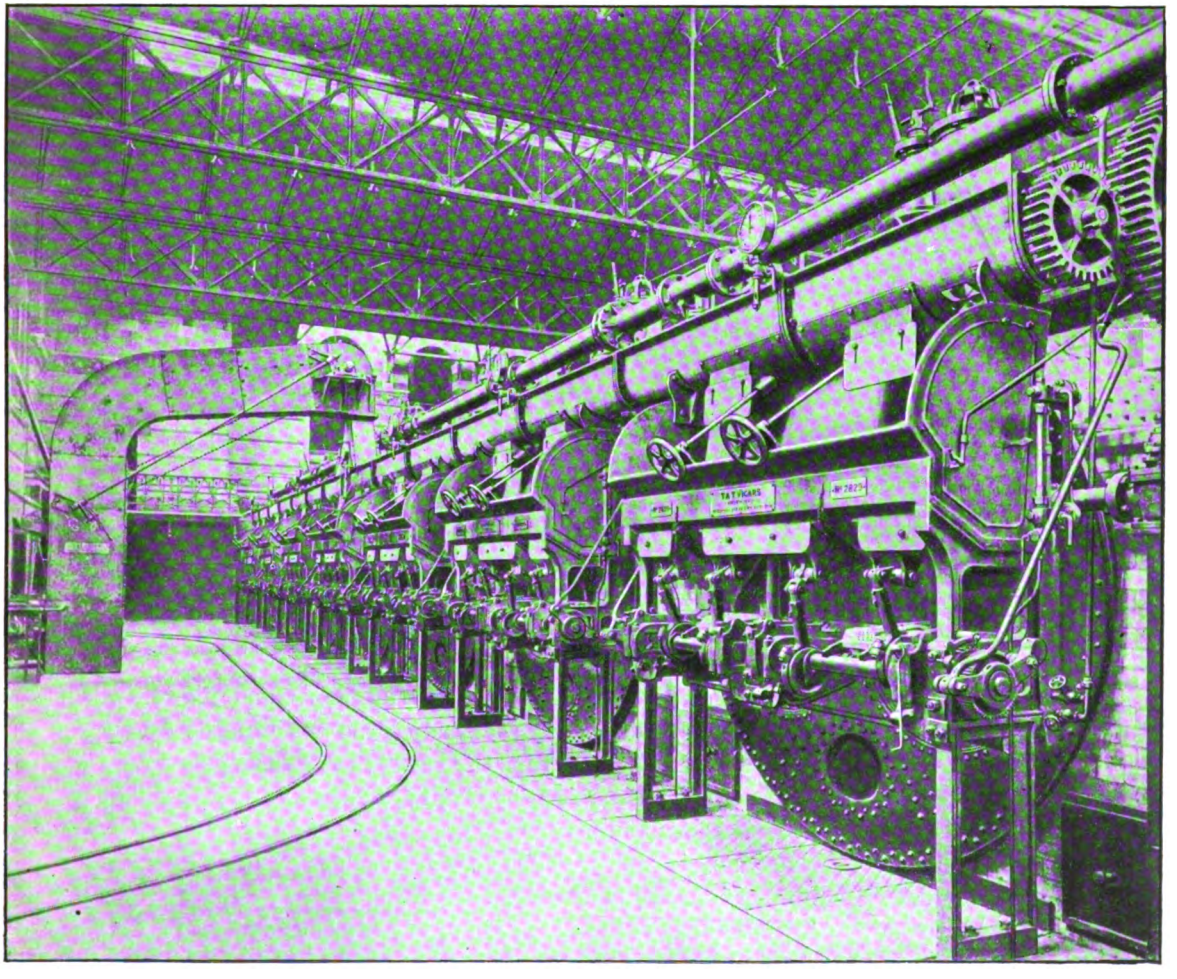
Vicars' Mechanical Stoker.

IT is now generally recognized that feeding coal to steam-boiler furnaces by hand is, as a rule, costly, wasteful of fuel, and destructive to boilers. To overcome these difficulties, various forms of mechanical firing machines or stokers have been devised and introduced with more or less success. The stoker invented by Messrs. T. & T. Vicars of Lancashire is especially adapted for internally fired boilers, and its success in England has been so marked that we were led to experiment with it in our own works. The results we obtained were so satisfactory, that we secured from the Messrs. Vicars the exclusive right for the manufacture and sale of their patented stokers in the United States. We have perfected the apparatus, and, having made some alterations better adapting it to American practice, we are now prepared to furnish a full line of stokers adapted to all sizes of internally fired boilers and to boilers of various other forms, water-tube boilers, etc.

The Vicars' stoker is shown attached to boilers in plates Nos. 241 and 242, and its operation is described by Mr. Daniel Kinnear Clark in his treatise on steam-engines and boilers, as follows:

"In the system of Messrs. T. & T. Vicars, in which small coal and slack are fed automatically into the furnace, the fuel is fed from a hopper into two cases or boxes, from which it is gradually pushed by reciprocating plungers alternately into the fireplace, when it falls on the firebars, which, by a slow reciprocating movement, carries the burning mass gradually backwards. Such unconsumed coal as reaches

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VICARS' MECHANICAL STOKER.
Showing a battery of boilers operated by the stoker.

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the end of the grate-bars, together with the clinker and ash refuse carried back, are discharged over the ends of the fire-bars into the flues, wherein they form up and maintain a bank which acts as a bridge, closing the far end of the ash-pit, and on which the combustion of the precipitated fuel is in due course completed."

There are thus two movements in the operation of the stoker,—the coal-feed and the grate-motion,—and they are independently adjusted. The coal-feed is varied by varying the motion of the plungers, which may be checked entirely or increased to full stroke, each furnace of the boiler being independent of the other. The back and forward movement of the bars in like manner may be varied from a state of rest to the full travel of four inches per stroke.

The bars in each furnace are arranged into sets, which operate together in moving toward the rear end of the boiler, but return alternately. Thus the fuel carried forward by the simultaneous movement of the bars remains in position without being disturbed by either return, each successive movement of the bars serving to carry the fuel further toward the end of the grate where the mass drops over.

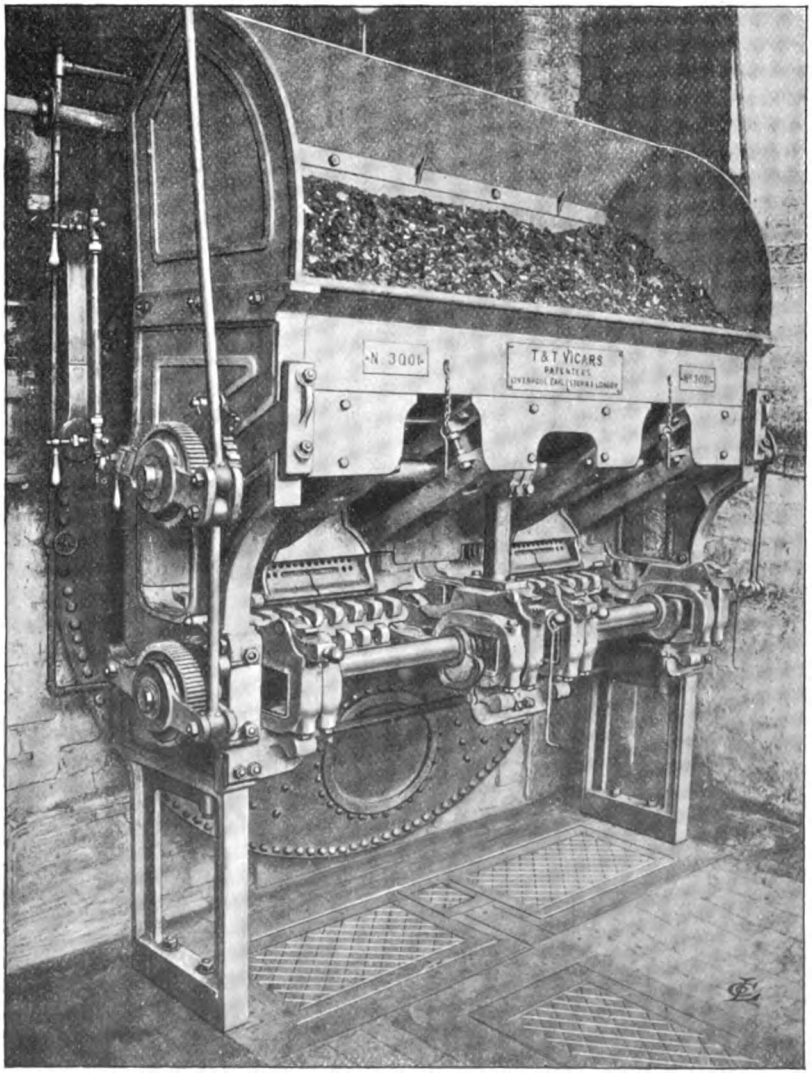
Motion is derived from an overhead shaft, which, by a crank-motion working ratchet-wheels and pawls, causes a transverse shaft to revolve, and by means of cams on this shaft, the horizontal movements of the grate-bars are effected. Means are provided for firing by hand if desired.

The action of the stoker is positive, uniform, and continuous, and the rate of feed can be adjusted as closely as required. The ordinary fire-doors are opened only to bank the fires, and the usual cooling off from this cause is avoided. The grate-bars are protected at the most exposed places by small steam jets, so that they last longer than if used with ordinary hand-firing.

The Vicars' stoker can be cheaply applied to most boilers with little or no alteration, and among its many advantages are the following:

It is absolutely smokeless.—In our own experience, we have burnt the worst coal offered without any appearance of smoke at the chimney top.

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VICARS' MECHANICAL STOKER.
Showing the latest patented form.

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It will use the cheapest fuels.—Small anthracite, bituminous slack, etc., with the same grate-bars.

It is simple and positive in its action.—The apparatus is strong and not likely to get out of order. The power required to drive it is not considerable.

It spreads the fuel uniformly, and its rate of feed can be adjusted to the utmost nicety.

It saves labor in stoking, and permits the use of mechanical conveying machines for the coal and the ashes, enabling one man to attend to a large battery of boilers.

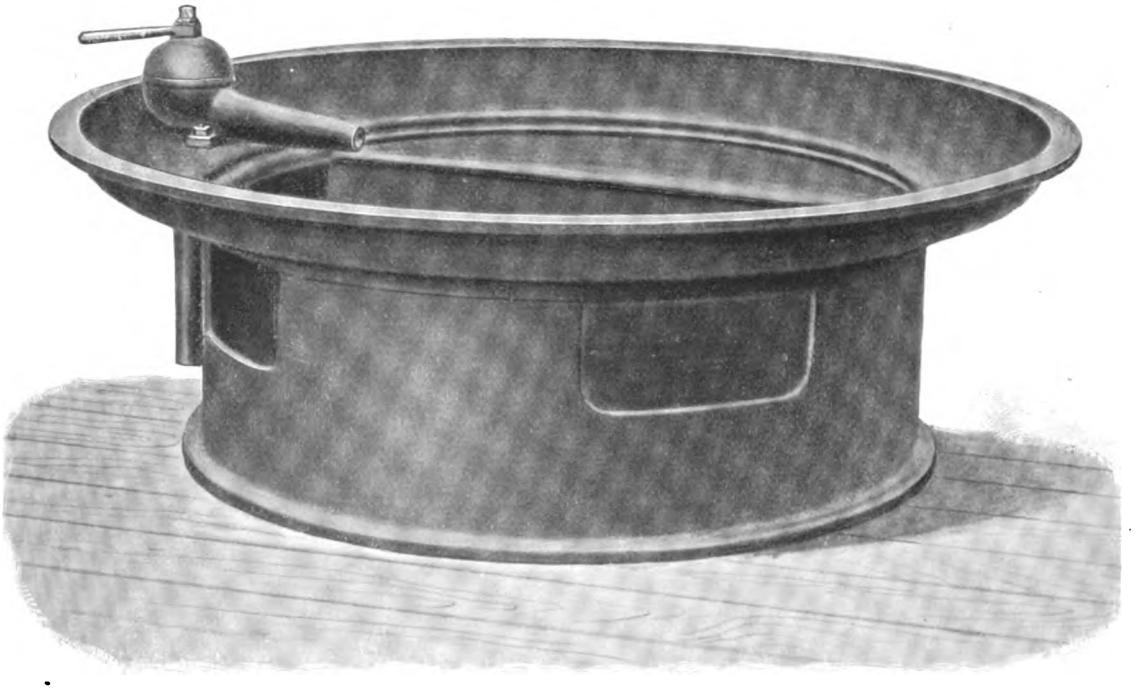
It is economical in fuel.—The fuel is supplied only as fast as it is required and can be burned. It produces better results than can be maintained by hand-firing.

ERRATA.

On page 174 read "Whitworth" instead of Whitwork.
" " 200 " "Plates Nos. 120 and 121" instead of Nos. 117 and 118.
" " 234 " "blade" instead of plate.
" " 341 " "Plates Nos. 212 and 213" instead of Nos. 211 and 212.
" " 364 " "Plate No. 218" instead of No. 215.

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PLATE NO. 243.



CAST-IRON FORGE.—SIX FEET IN DIAMETER.

This is a convenient form of forge, complete with iron tuyere and wind-valve. It has tool-box and water-tank in the base, and requires no separate foundation or brick-work. Outside diameter, six feet. We also make a similar forge four feet in diameter.

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