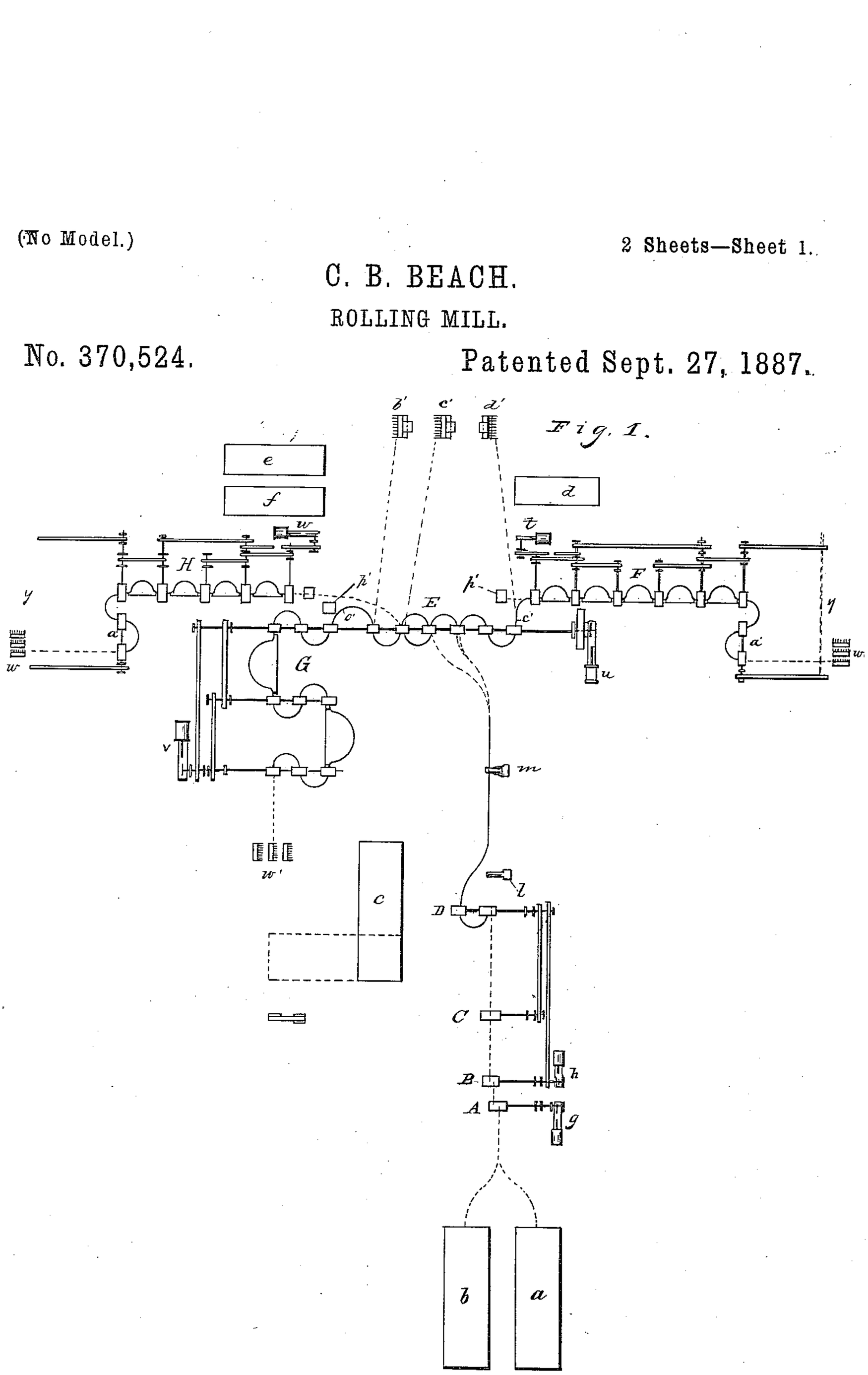
(No Model.) 2 Sheets—Sheet 1.

C. B. BEACH.

ROLLING MILL.

No. 370,524. Patented Sept. 27, 1887.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

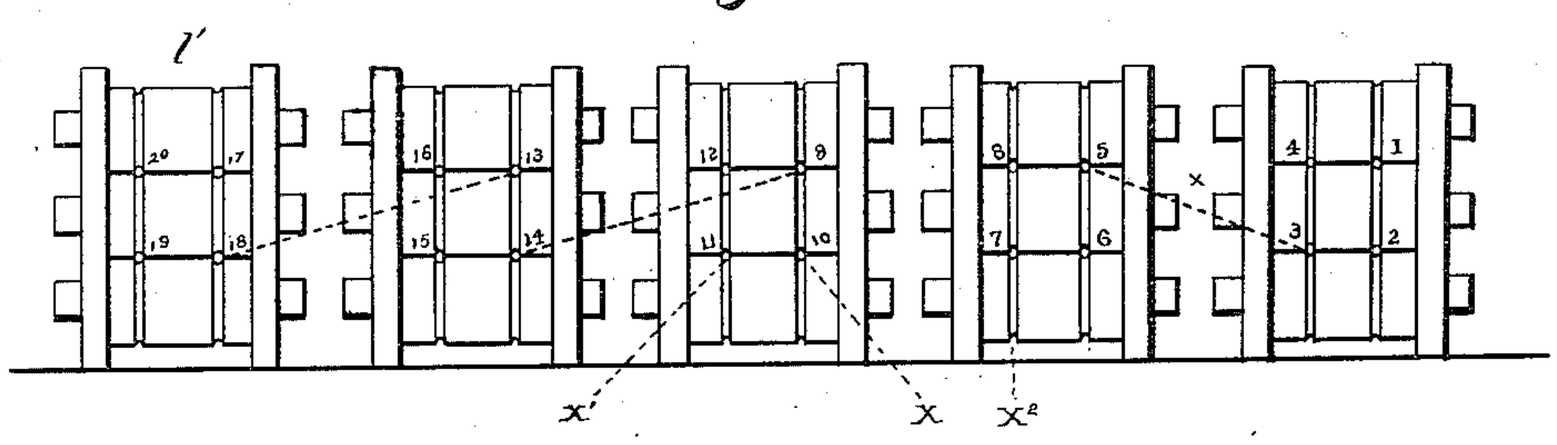


Fig. 3.

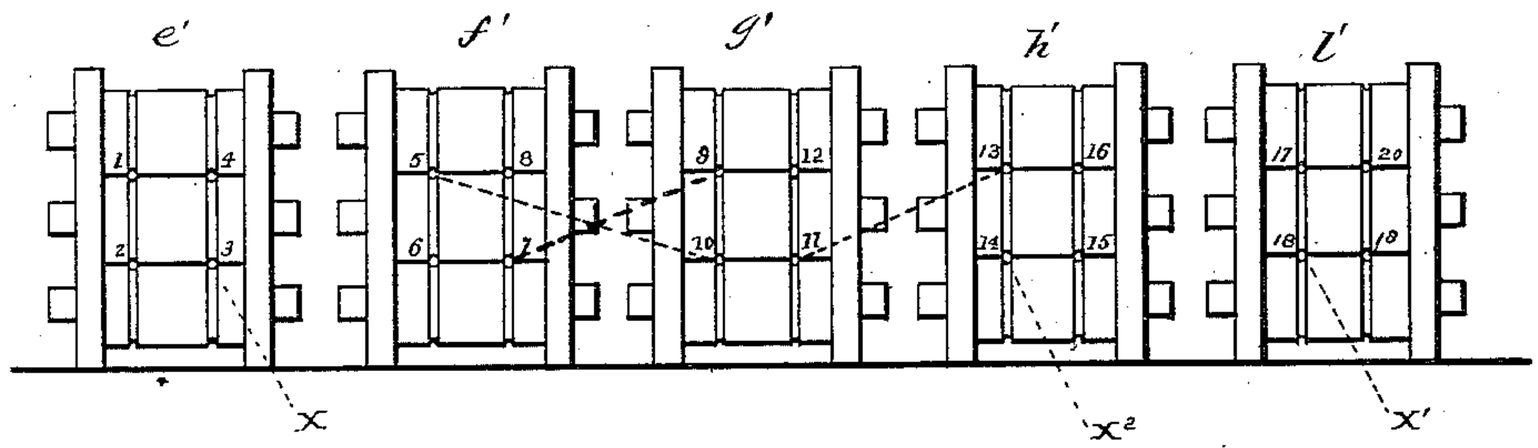


Fig. 4.

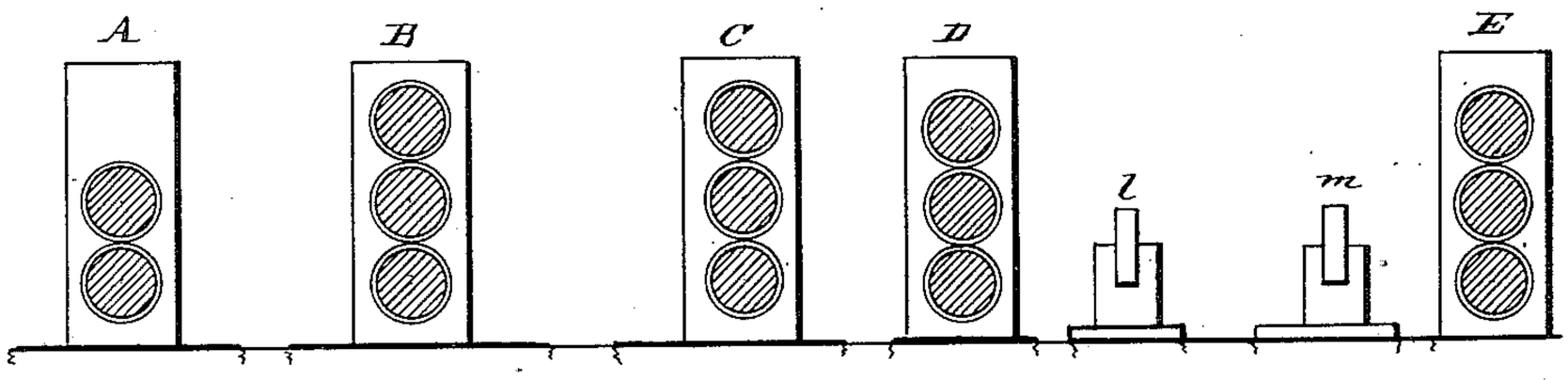
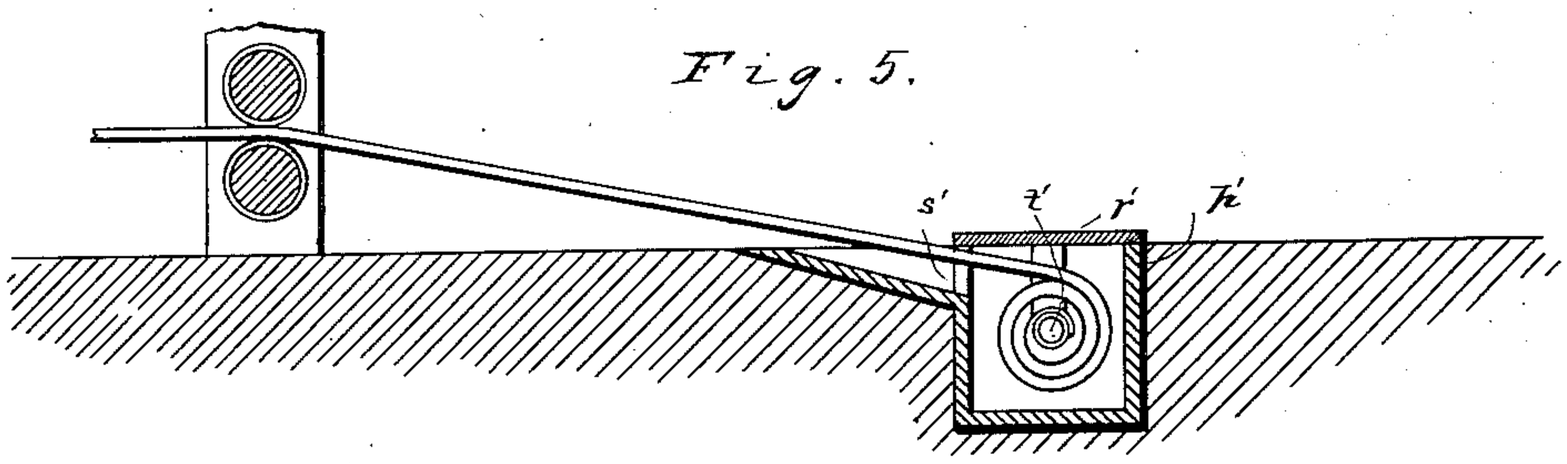


Fig. 5.



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UNITED STATES PATENT OFFICE.

CLIFTON B. BEACH, OF CLEVELAND, OHIO.

ROLLING-MILL.

SPECIFICATION forming part of Letters Patent No. 370,524, dated September 27, 1887.

Application filed August 19, 1885. Renewed April 7, 1887. Serial No. 234,020. (No model.)

To all whom it may concern:

Be it known that I, CLIFTON B. BEACH, a citizen of the United States, residing at Cleveland, county of Cuyahoga, and State of Ohio, have invented certain new and useful Improvements in Rolling-Mills; and I do hereby declare the following to be a description of the same and of the manner of constructing and using the invention in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it appertains to construct and use the same, reference being had to the accompanying drawings, forming a part of this specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle so as to distinguish it from other inventions.

The economical operation of a manufacturing plant with respect to a continuous operation involving successive steps depends very largely upon the arrangements and location of its different parts or departments. This is especially true where the material being handled is heavy or bulky. In a rolling-mill plant, where hundreds of tons of finished material may be daily produced, it not unfrequently occurs that the cost of handling, from first to last, quite equals the cost of the labor involved in actual manipulation and production.

While it is well known to all manufacturers that in the production of a wire rod or other small section from a large ingot a large percentage of the cost of production would be saved if the ingot could with one heat be reduced to a No. 6 rod, still there is not in this country to-day, if, indeed, there is in the world, a plant that is arranged and operated to accomplish this desired result, or, in fact, to approximate to it. The different departments—as, for instance, the steel-mill, the large hammers or blooming-trains, down to the last pass of the finishing—are, as a rule, located, arranged, and speeded as though there were no interdependence or relation between them. In the ordinary blooming-trains as now operated from twenty to twenty-four passes are given to a fourteen-inch square ingot to reduce it to a four-inch square, and all at the same speed. It is very apparent that in this operation alone there is such a waste of time and heat as would, if properly employed, reduce the same-sized ingot to a No. 6 or smaller rod.

The purpose of my present invention is to demonstrate the practicability of so arranging and locating the different parts of a mill that with the aid of automatic conductors and repeaters, and the employment of gradually accelerated speeds, the operation of reducing a large-sized ingot to a small section shall be accomplished by a continuously successive and substantially uninterrupted operation. Furthermore, the plan and arrangements are intended to make it convenient to meet and provide for almost any possible emergency which may arise, whereby the normal operations of the system are interrupted, so that if an obstacle or any difficulty presents itself in the way of the production of the article or thing especially designed to be produced the operations of the parts of the system not thereby affected may, without material disadvantage, be continued until the difficulties are removed and the normal condition and operation of the whole plant are established. To this end I shall herein particularly describe the arrangement and operation of a plant designed for the production of wire rods and other small sections.

In the drawings, Figure 1 is a plan view of the plant. Fig. 2 is a detail view in front elevation, illustrating the method of operating mill E, where five stands are employed, instead of six stands, as shown in the plan view. Fig. 3 is a rear elevation of the mill shown in the preceding view. Fig. 4 represents in detail in transverse section mills A B C D E, and also represents, in elevation, the shears *l* and *m*. Fig. 5 is a transverse vertical sectional view of the heat-retaining box as in use.

I will now call attention to the prominent details of the plan view.

Six furnaces, *a b c d e f*, are employed in the complete system; but if the mill A should not be used the two furnaces *a* and *b* should be moved into close proximity to mill B. Furnaces *a* and *b* are for the initial heating of a large ingot—say fourteen inches square by four feet long, (more or less.) Furnace *c* is to be used for reheating the sections of blooms made by mill D, (and sheared, as hereinafter shown,) when a stoppage occurs at mill E.

Furnaces *d e f* are used for the purpose of reheating such of the billet-coils as mills F and G and H cannot take, owing either to stoppage in these mills or to the fact that too much metal is presented from below for the capacity of these mills.

Mill A is an ordinary reversing blooming-train. The number of passes which the ingot is to receive in this mill is odd—that is to say, I give the bloom eleven, thirteen, or fifteen passes, as the case may be, the last pass delivering the bloom in the direction of the next succeeding mill and presenting the forward end thereof in close proximity to the receiving-pass of the next train. This principle of construction is illustrated in application Serial No. 144,508, filed by me October 22, 1884.

Mill A is coupled directly to the reversing-engine *g*, which, running at a certain speed and actuating rolls of a certain diameter, will deliver a certain number of feet of bloom in a given time. The operation of this mill having been accomplished, the bloom by the last odd pass is delivered in the direction of the mill B, and its forward end is presented to the receiving-pass of said mill.

Mill B is coupled directly to engine *h*, while mills C and D are respectively driven by belting from said engine shaft, according to a system of belting illustrated in application Serial No. 148,572, filed by me November 22, 1884. It is evident that by this system of the transmission of power an accelerated speed can be given to each of the mills C and D. Mill B may, if desired, be also a reversing-mill; but if in mill A the large ingot has been reduced to about the size in cross-section of an ordinary rail-ingot I consider the best practice to be to here employ a three-high train, and from this on to and including mill E, as illustrated in Fig. 4. The bloom from mill A, having been delivered and presented to the receiving-pass of mill B, is handled in the usual manner of a rail-ingot or a bloom.

Mill B, I design to run at a higher speed than mill A. The bloom by this time will have been materially reduced in cross-section and elongated, and as mill B is a three-high it may be run at a materially-increased speed. In this mill the bloom should be given three, five, or seven passes, as the case may be, the last pass delivering the bloom in the direction of and in close proximity to the receiving-pass of mill C.

In mill C the number of passes to be given to the bloom will depend both upon the size of the bloom presented and the article to be produced. By the time the bloom reaches mill C it will have been sufficiently reduced to admit of the practice which is now universally employed in working smaller-sized blooms and billets, and which, in my opinion, should be employed in large-sized blooms—to wit, passing from square to oval, or from oval to square, instead of from square to square. Mill C by its last odd pass will deliver the bloom in the direction of mill D, and present the forward end thereof in close proximity to its receiving-pass. This mill D by my system of power-transmission may be run at any desired speed. For the present purposes, however, suffice it to say, that it is speeded higher than mill C, and that the size of the roll is somewhat reduced. In mill D, if desired, the process of automatic repeating or doubling may be employed on the last pass. This will depend, however, very largely upon the size of the billet desired to be produced by the finishing pass or passes of mill E. When the bloom is being delivered from the finishing-pass of mill D, it is conducted by properly-arranged conductors through shears, whereby it is severed or divided into desired lengths. I have shown two shears, *l* and *m*, respectively adapted to cut long and shorter lengths, as may be desired. These shears may be automatic in their operation—that is say, when a certain length of bloom has been fed through them, the forward end of the bloom may engage a mechanism which will operate the shears and sever the continuous line of bloom being delivered by the delivering-pass of mill D.

If the plant is working upon an ordinary-sized three-rail ingot, it will be found impracticable to reduce at the initial heat to a commerciall rod all of the sections coming up as they are successively delivered by mills D and E; but if the ordinary one-rail ingot—to wit, an ingot seven inches square and weighing about seven hundred pounds—is being reduced, it will be found to be entirely practicable to continue the operation through mills F and G, if not through H, to the end—to wit, a rod or other small section.

It will be observed that in the plan view of mill E, I have shown six stands of rolls and the engine *n* coupled direct. Whether the engine be coupled direct or geared or belted depends upon the speed required at mill E, and whether it shall be coupled or not depends upon the kind of engine employed.

It is apparent that the principle of my system requires at mill E a much greater speed than at mill D, and this may be obtained as desired. By my disposition of the engine *n*, however, I design to obtain power both for the shears *l* and *m* and for the reels *b' c' d'*.

Mill G is of recent invention, as illustrated in application Serial No. 144,508, filed by me October 2, 1884. Mills F and H are of construction illustrated in the application hereinbefore referred to, Serial No. 148,572, filed by me November 22, 1884. The method of transmitting power therein shown, by means of belts and pulleys, makes the continuous arrangement, as shown at mills F and H, entirely practicable, and provides for a successively-accelerated speed throughout the whole train of each mill.

It will be observed that the three engines *t*, *v*, and *w*, which respectively actuate mills F, G, and H, are not directly coupled thereto. I have herein represented mills F and H as differing in slight details from each other, but as substantially the same in principle. In each

y represents an overhead or underground shafting, which by the belt-and-pulley system transmits driving power from the shafts of the last stand of rolls in the continuous train to the two stands of rolls *a'*, coupled together in line with but independently from said last stand; but in the several stands in each continuous train I employ repeaters, which provide for either an overfeed or an underfeed of the metal, as the case may be, said repeaters being of recent invention by W. W. McCallip, as illustrated in application Serial No. 145,543, filed by him October 15, 1884.

By my system of the transmission of power from one central point a successively-accelerated speed may be given to each stand of rolls. In the mill G it will be seen that, while the same system of the transmission of power is employed as in mills F and H, there are certain modifications as respects the arrangement and placing of the various stands. In this mill the first three stands of rolls are placed in the usual position. The billet is entered at the first stand, and is thereafter automatically repeated up to and, if desired, including the finishing-pass of the train. Between the several stands in each of the three lines the usual well-known repeater is employed; but between the several lines I employ the McCallip combined underfeed and overfeed repeater, hereinbefore referred to. In this mill it will be readily seen that by employing but three stands in each line the metal is throughout the entire operation continued in its forward course.

Particular attention is now called to the practice hereinafter involved. In detailing this practice I have reference to the results to be obtained. Whether the product from below may in a substantial degree be cared for by mills F, G, and H depends entirely upon circumstances. I state that, starting from an ordinary sized ingot at mill B, the whole, or the substantial part thereof, may be successfully reduced to a wire rod at one heat and by one continuous operation. Starting from an ordinary three-rail ingot, however, at mill A, it is very apparent that mills F, G, and H will not be able to care for the weight of metal coming up. As it is my purpose, however, in this description to meet any emergency which may arise and to point out the peculiar advantage pertaining to the practice, whether the initial ingot be large or small, I shall describe the practice I employ in each case.

When starting with a large-sized or three-rail ingot, my practice is, if the billet presented by mill E is in proper condition, to repeat the same by the ordinary method, in sections of suitable length, to mills F and G, and, if possible, to mill H. These sections will be the first three cut off by the shears *l* or *m*. The remaining portion of the oncoming bloom will be subdivided by said shears into desired lengths, and should as soon as possible follow the first three sections through their respective passes in mill E. These last sections should in all cases be coiled if it is desired to reduce them by subsequent operations to rods, bars, hoops, or other like small sections; hence in working even ingots so large in the beginning that they will overwhelm the capacity of the finishing-mills I have shown the initial heat of the whole mass will not be lost. The two or three forward sections of this mass may with the same heat be reduced to the desired, or at least to the commercial, product, while the balance of the mass—to wit, the billet delivered by the finishing-pass of mill E, after the delivery of the first two or three sections—will be cared for, as herein described. If the operation is commenced at mill B with an ordinary-sized rail-ingot, it will be found, the conditions all being favorable, that the first three sections presented to mill E by the delivery of mill D and the intermediate shearing and handling can by my system of mills F, G, and H be reduced to a rod at the initial heat. If, however, the billet, as it is delivered from the finishing-passes of mill E is not, because of stoppage or difficulty that may have occurred below, of proper heat to be passed to either of the mills F, G, or H, it should be treated in the same manner as the excess of product coming up from the large or three-rail ingot—that is to say, (and this practice pertains to both cases,) whenever a billet is being delivered by any of the delivering-passes of mill E, which is not in proper condition to be passed to either of the mills F, G, or H, or which, by reason of these mills being engaged, cannot be taken by them, the same is to be carried to reels *b' c' d'* and coiled.

Conveniently placed with respect to the delivering-passes of mill E are the three powerful reels *b' c' d'*. These reels are to be employed in the same manner as ordinary rod-reels as the billet is being delivered from the passes of mill E. If, however, the billet by mill E is being presented in proper condition for further reduction, I design that it shall be repeated from its appropriate finishing-pass of said mill to entering-pass of mill F. The second section, if in like condition, is to be repeated from its appropriate finishing-pass to the entering-pass of mill G, and, in like manner, the third section, if in proper condition, is to be repeated or conducted automatically, or otherwise, from its appropriate finishing-pass to the entering-pass of mill H.

In the production of an inch-square billet by the delivering pass or passes of mill E from a seven-inch-square ingot at mill B it will generally be found that the condition of the first and second sections will admit of their being repeated, as proposed, into mills F and G. Section 3, however, may not be in such condition, and this, as hereinbefore provided, should be carried to the reel and coiled.

In Fig. 1 I have represented mill E as having six stands, provided with the usual well-known repeater, the two stands, respectively at the extreme right and left of the train, being connected by similar repeaters, *o'*, severally

to mills F and G. In Figs. 2 and 3 I have represented mill E as having five stands, and as the same is my preferred construction I recommend the following practice.

It will be seen by following the dotted line *x* in Fig. 2 that I enter the first section cut off and presented in pass 10 of stand *g'*. From this, as will be seen in Fig. 3, I repeat to pass 8 or 5, stand *f'*, again repeat from this to pass 3 or 2, stand *e'*, as shown in Fig. 2, and there finish. Dotted line *x'* shows the course of the second section. Stuck in at pass 11, stand *g'*, Fig. 2, it is repeated to pass 13 or 16, stand *h'*, Fig. 3, repeated to pass 18 or 19, stand *l'*, Fig. 3, and finished. Dotted line x^2 shows the course of the third section. Stuck in at pass 7 or 6 of stand *f'*, Fig. 2, it is repeated to pass 9 or 12, stand *g'*, Fig. 3, from thence repeated to pass 14 or 15, stand *h'*, Fig. 2, and finished. By this method and practice it will be seen that I accomplish with five stands of rolls what would in common practice require nine stands. Even the four stands *e'*, *g'*, *h'*, and *f'* will accomplish the work; but the employment of five stands, as shown, I consider the best practice. If the oncoming bloom shall by shears *l* or *m* be subdivided into more than three sections, it will doubtless be found most convenient and practicable for section 4 to follow section 3, as under favorable circumstances sections 1 and 2 will go direct to the rod-mills, while section 3 may be coiled. I also recommend that in the mill E the rolls used should not be over twelve inches in diameter and of greater length than are usually employed in such a mill.

If in the course of the operation of this system any of the mills, on the complete working of which the desired results of the system depend, should, by reason of breakage or otherwise, be stopped, provision has been made for the operation of such mills as are not thereby especially affected—as, for instance, if the mills have been for several days as a whole working successfully, the blooming-mills and the billet-mill E will undoubtedly have produced more or a greater product than can be cared for by mills F, G, and H. The excess of product is supposed to have been coiled and held in readiness for reheating. If anything shall occur to stop any of the mills below mill E, mills F, G, and H may draw upon this surplus production. This will provide for a subsequent stoppage of mill E. If the stoppage occurs by reason of trouble with mill E, the mills below may continue their operation and the product produced by mill D may be sheared into lengths suitable to be cared for by the mills above, or into any other desired sections. Such product may be stocked, in order to provide against any stoppage which may thereafter occur at the mills below. Provision has been made by furnace *c* for the reheating of the long blooms which may be produced by mill D and sheared, as described, into desirable lengths by shears *l* and *m*.

In the production by my system of a rod from an ingot with its initial heat it is evident that in severing or subdividing by shears *l* and *m* the oncoming bloom into suitable lengths good judgment must be used. If automatic mechanism is employed, it must be so adapted that such lengths only as can be properly cared for by the finishing-mills above shall be cut off.

With respect to such sections or portions of the billet produced by mill E, when charged, properly reheated, and placed in the box *p'*, I recommend that the speed of the rod-mill upon the insertion of the end of the billet should be moderate, that when the billet shall have entered all of the passes of the rod-mill the speed of the mill be accelerated to the highest possible safe limit, and that as the billet is about being finished the speed of the mill should be reduced to receive the next billet. This practice in working ordinary-sized billets would be impracticable; but with billets having from eight to ten times the amount of metal will be productive of very desirable results.

The box *p'*, referred to, which is more fully shown in Fig. 5, is designated as a heat-retaining box. It is to receive a coil of metal taken from one of the billet-coil furnaces, and to retain the heat thereof from loss by radiation while the metal is being fed into its rod-mill. I sink this box in the floor of the mill, so that when the cover *r'* is closed the whole shall be about flush with the floor. Upon the side facing the entering-pass of the rod-mill is a funnel-shaped aperture, *s'*, through which the billet is presented to the rolls. The box is provided with a spindle, *t'*. If this box is in constant use, it will be found that it will be sufficiently heated by radiation from the coils. If not in constant use, however, I recommend that it be heated, as desired, by any of the well-known processes.

I design to make furnace *c* of such length that it shall be capable of receiving the entire length of an old steel rail, in order that if it is desired to reduce such a product to the billet form by any of the modern processes the same may be commenced at mill D, at which mill, proper provision having been made to effect this result, it may be reduced to a rectangular form, and as delivered in the direction of mill E may be subdivided by shears *l* and *m*, as hereinbefore provided. Old-rail shears *v'* are located in proximity to this furnace for use in cropping off the jagged ends of such rails. Reels *w'* are provided near the finishing points of each of the three rod-mills, upon which the product of the latter are coiled.

The foregoing is intended to set forth the principle of my invention and the best method at present known to me for carrying out the same. Attention has not herein been given to details, nor to many matters which pertain to mechanical adaptation and practical working. Such considerations as the size of pulleys, length of belts, diameter of rolls, proportion of parts, and analogous points are well understood in the art of mill-rolling, and are not at-

tempted to be set forth herein or shown in the drawings.

Certain features of invention shown in this application do not constitute a part of the latter, inasmuch as said features of invention form the subject-matter of certain other applications of mine for United States Patents now pending, as witnessed, respectively, in application Serial No. 233,925, filed April 6, 1887, application Serial No. 233,926, filed April 6, 1887, application Serial No. 233,581, filed April 6, 1887, and hence all claims upon said features of invention are rested in said other applications.

Other forms of embodying and using the principle of my invention may be employed in substitution for the specific form herein shown. It will therefore be understood that omissions, substitutions, and changes may be made as regards the forms and parts herein set forth, provided the principles of construction embraced in the following claim are retained and employed.

I therefore particularly point out and distinctly claim as my invention—

A rolling-mill having in combination the following elements: first, mechanism for rolling an ingot to billet form; second, a shearing mechanism by which to divide the elongated billet into a series of sections, two or more in number, each of convenient length for subsequent manipulation; third, two or more rod-trains conveniently located for the alternate feeding into one or the other of the successive sections so produced; fourth, a coiling mechanism conveniently located for the reeling of the additional or extra billet-sections; fifth, a heat-retaining device in which temporarily to store the coiled sections and suitably arranged for the feeding of such sections therefrom into one or other of the rod-trains when the latter are not otherwise employed, substantially as set forth.

In testimony that I claim the foregoing to be my invention I have hereunto set my hand this 14th day of August, A. D. 1885.

CLIFTON B. BEACH.

Witnesses:

T. B. HALL,

JNO. G. HALL.