Sept. 11, 1923. 1,467,536

C. DORNIER

RIVETING MACHINE

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Fig. 1.

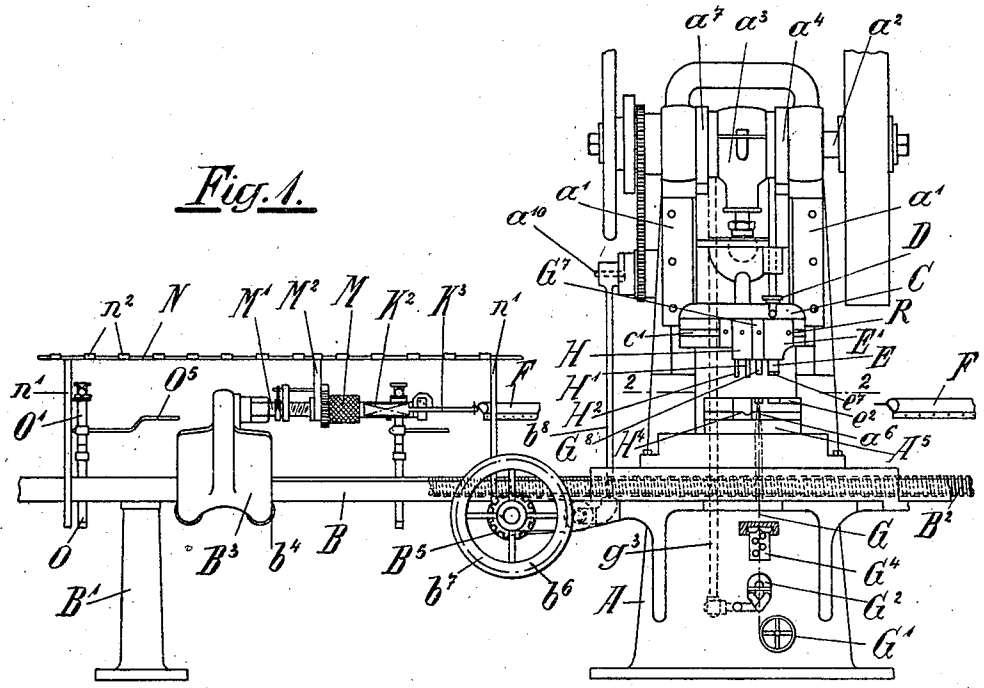


Fig. 2.

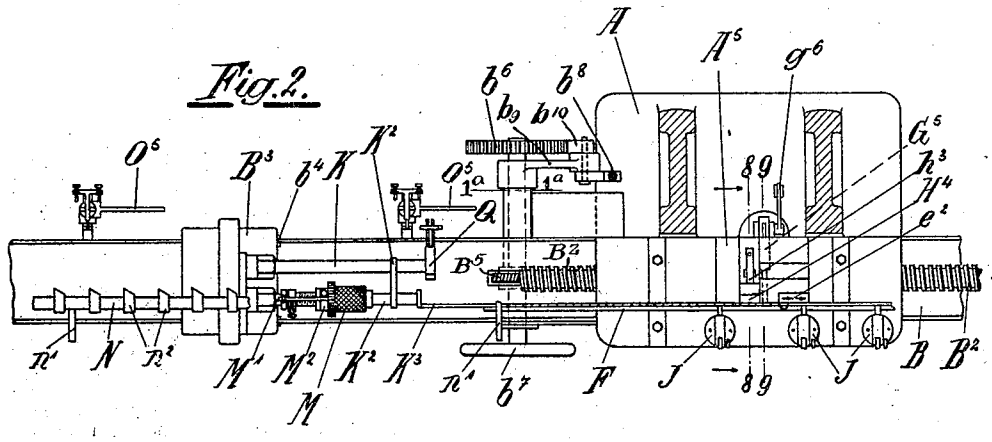
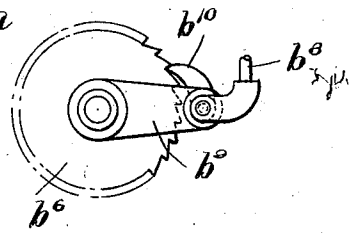


Fig. 1a



INVENTOR:

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Fig. 3.

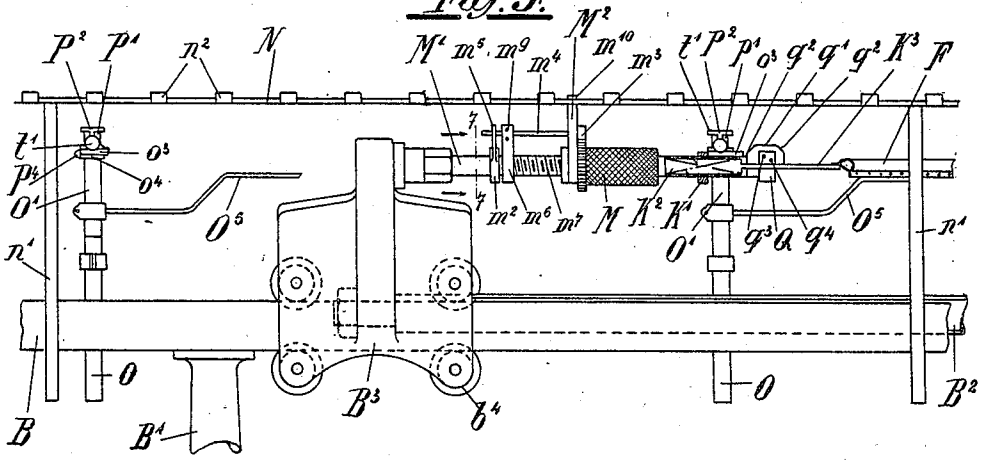
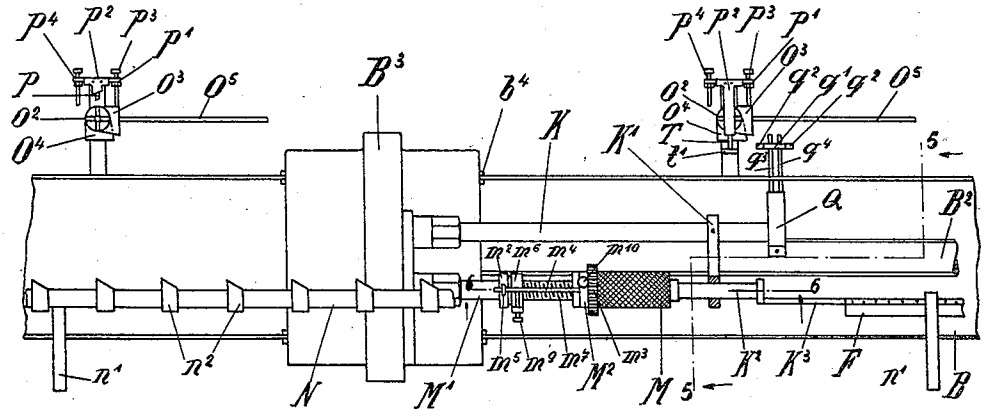


Fig. 4.



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Fig. 5.

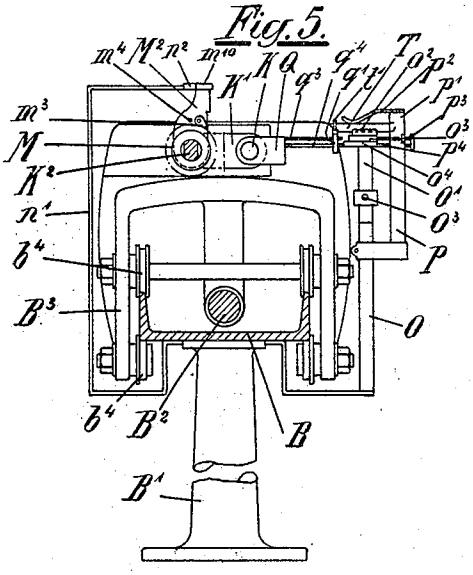


Fig. 10.

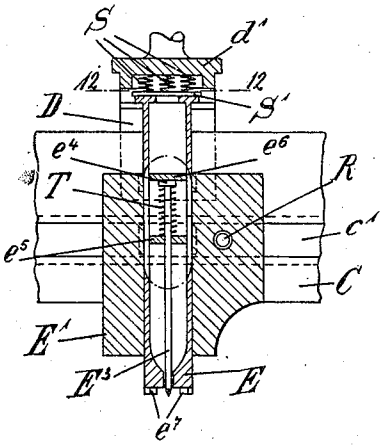


Fig. 11.

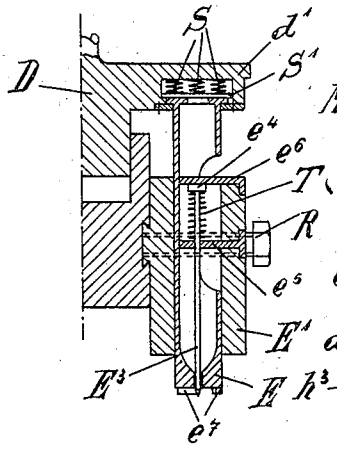


Fig. 6.

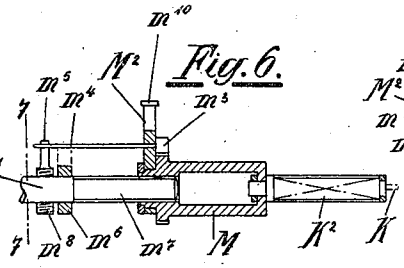


Fig. 7.

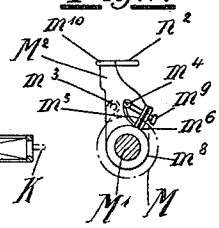


Fig. 8.

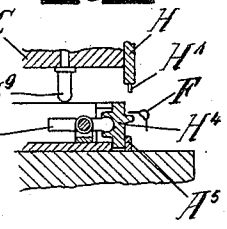


Fig. 9.

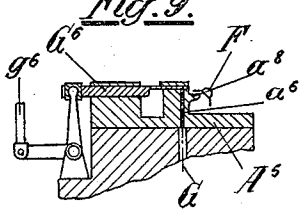


Fig. 12.

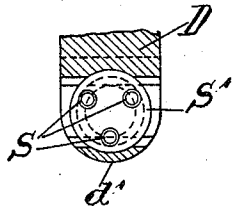
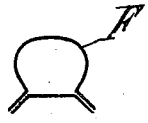


Fig. 13.



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Fig. 14.

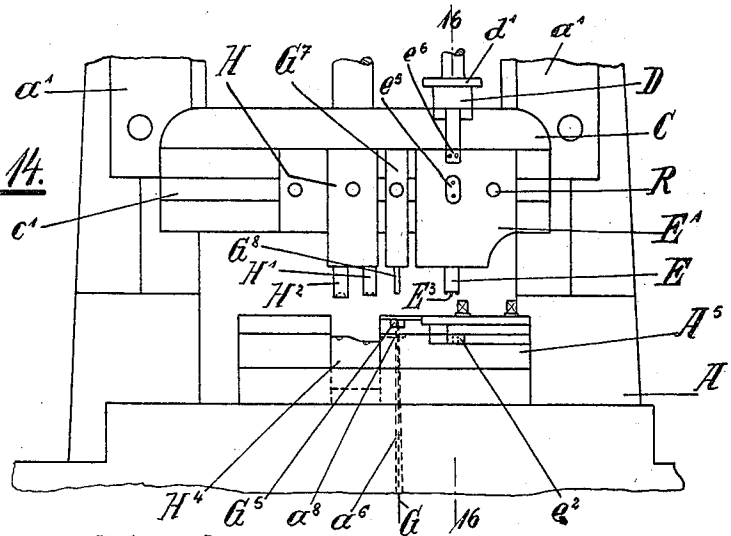


Fig. 15.

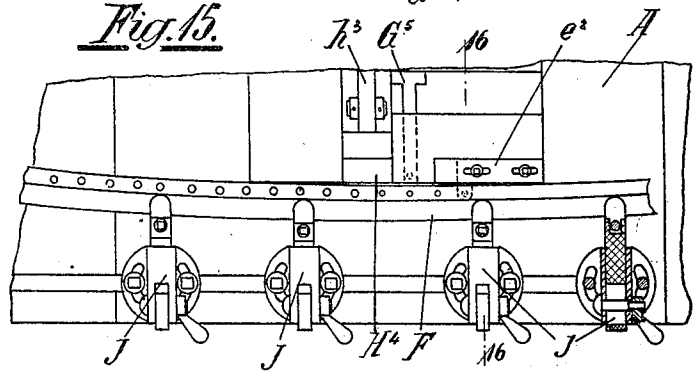


Fig. 16.

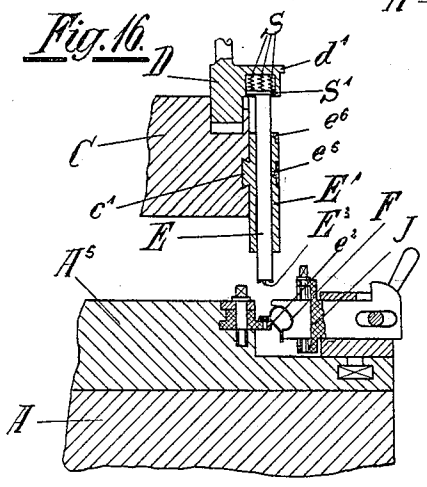


Fig. 17.

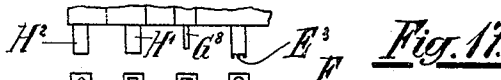
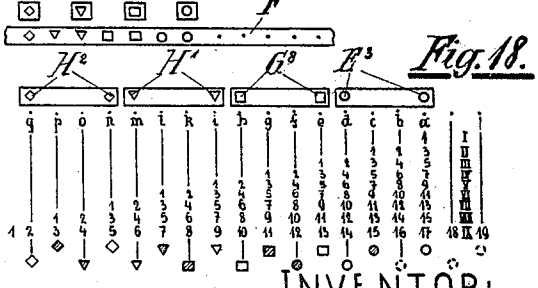


Fig. 18.



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Patented Sept. 11, 1923. 1,467,536

UNITED STATES PATENT OFFICE.

CLAUDE DORNIER, OF FRIEDRICHSHAFEN, GERMANY, ASSIGNOR TO THE FIRM DORNIER-METALLBAUTEN, GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG, OF FRIEDRICHSHAFEN, A. B., GERMANY.

RIVETING MACHINE.

Application filed June 28, 1920 Serial No. 392,560.

To all whom it may concern:

Be it known that I, CLAUDE DORNIER, a citizen of the German Empire, residing at Friedrichshafen a/B., Germany, have invented certain new and useful Improvements in Riveting Machines, of which the following is a specification.

My invention refers to the manufacture of riveting connections and concerns a machine allowing to automatically produce riveted plate seams of any length.

The machine forming the object of the present invention and the working process obtained by its means can be applied to riveting of any pitch required, but special advantages are offered in producing thin-walled small-pitch riveting connections. For by employing this machine closed or open bar-shaped hollow bodies of any length and of very thin plate can be made, which are remarkable for their great accuracy of pitch sometimes not wider than a few millimeters and for the particularly high resistance of their sections. To obtain sections of equal moments of inertia (as such are produced by this peculiar automatically progressing riveting in rows by means of a machine according to the invention) is impossible with rolled profiles to be had in the trade until now, since their sections are as far as their manufacture is concerned, subject to certain limitations not applying to the present process.

Thus the object of the invention is a machine for producing long riveted plate seams and especially riveted sectional bars, in which the parts that are to be connected enter the machine unpunched, and are under permanent influence of a feed appliance automatically and continuously driven by the machine according to the required pitch. Moreover in a rythmically moving slide all tools are combined, which are needed for punching, for introducing the rivet shaft into its hole and for finishing the connection by shaping the head.

In the further course of perfection of this invention in the joint slide another tool has been provided for thin plates, which adjusts the small rivet shafts as to their position relatively to the thin plates to be riveted and secures them in adjusted position by a moderate clenching.

Furthermore the machine has been arranged so that either at regular intervals or in individual cases required holes punched e. g. for fastening struts or other connections later on may be left unriveted or unpunched.

Moreover certain appliances are provided by which in punching and afterwards in riveting an uncalled-for twisting or turning of the bar-shaped body is prevented, which would be caused by an uneven stretching of the material due to the thinness of the plate and to the small pitch. By experimenting on sectional bars having a length of about 7.5 m. and 12.5 mm. riveting pitch, the bending bars to be described later being left out, it has been ascertained that punching alone caused the bar to warp to a rise of 250 mm., punching and riveting to a rise of 500 mm.; this proves that punching and riveting participate fairly equally in stretching and bending.

Further experiments have been made to the end of passing the bars through the machine and thereby producing an artificial counter-bend, some others being treated without bending. For this purpose four bending bars were provided, two of which were arranged within the punching and riveting tools and two outside. In the first case these four bending bars were employed simultaneously, the ones outside projecting about 1.5 mm. farther than those inside. In the second case the outside bars were left out altogether. In the first case the punched and riveted bar left the machine straight, in the second case with a warp of 120 mm. rise. In this manner the success of an artificial counter-bend was proved.

An arrangement of the machine especially useful for very long rows of rivets consists according to the invention in using for the feed motion of the parts undergoing the riveting a screw spindle reversible as to the general transport motion. In spite thereof with small pitches comprising e. g. a few centimeters or even millimeters only and with riveting seams several meters long the prescribed distance between the first

and the last rivet hole can be approximately maintained only on account of the unavoidable stretching. In some cases this does not matter; but when the highest accuracy is required, as e. g. in making boom members and girders for air craft, the stretching of the material caused by the punching and riveting process must be taken into consideration.

In developing this invention further this is effected in an especially simple manner meeting all other requirements by influencing the feed appliance by a compensating arrangement, which in progressing automatically compensates the small deviations from the pitch caused by the stretching of the material during punching and riveting and differing according to the material and to the chosen shape of profile or number and distribution of the rows of rivets.

In the drawings affixed to this specification and forming part thereof, a modification of a riveting machine according to the present invention is illustrated by way of example. This is a machine especially suited for producing riveted hollow girders possessing walls very thin as compared to the other dimensions of the section. It has been assumed that a boom member destined for air craft and highly accurate is to be made by means of two continuous seams of rivets from two sectional strips of thin steel plate. The machine to be described shows all peculiarities previously mentioned and some more, which are comprised within the range of the invention.

In the drawings:—

Fig. 1 is a longitudinal front view of the middle part of the complete machine,

Fig. 1^a is a sectional view of the feed mechanism on the line 1^a—1^a in Fig. 2.

Fig. 2 is a plan, partly in section along line 2—2 in Fig. 1.

Fig. 3 a front view enlarged in comparison to Fig. 1 and showing the part of the machine where the compensating appliance is treated.

Fig. 4 is the corresponding plan,

Fig. 5 a section along line 5—5 in Fig. 4, again on a larger scale.

Fig. 6 a longitudinal section along line 6—6 in Fig. 4 showing a detail.

Fig. 7 a transversal section along line 7—7 in Figs. 3 and 6.

Figs. 8 and 9 are vertical partial sections along lines 8—8 and 9—9 in Fig. 2 on a larger scale.

Figs. 10–12 details of the riveting machine on a highly enlarged scale.

Fig. 13 a section across a profile strip immediately before riveting.

Fig. 14 on a larger scale a longitudinal view corresponding to Figs. 1 and 2 of the part of the machine comprising the means employed for producing the counterbend and the individual tools for punching the profile bar, for introducing, adjusting and firstly clenching the rivet and for shaping the head.

Fig. 15 a corresponding plan.

Fig. 16 a vertical section along line 16—16 in Figs. 14 and 15.

Figs. 17 and 18 a diagram of the working process of the machine.

One of the chief parts of the combined machine shown in the drawings is the actual riveting machine A containing the tools for punching the profiled steel plate strips, for introducing and cutting off the riveting material in wire-shape, for introducing the rivet shafts into the rivet holes, for adjusting the rivet shafts and for finishing the riveting connection, and besides containing the parts operating the feed motion. Another chief part of the combined plant is formed by a machine bed B extending about equally far on both sides of the riveting machine A; this bed serves to support the most essential parts of the feed motion, the appliances for producing an absolutely exact pitch and as a general bearing and support of the unpunched plate strips and of the riveted profile bar. The middle table-shaped part of the machine bed B is rigidly connected with the riveting machine. Here there are arranged most of the appliances securing a good joining and introducing of the unpunched profile strips into the riveting machine and the appliances counter-acting the one-sided stretching of the plate caused by the punching and riveting and generating a turning or twisting of the finished profile bar.

The intrinsic riveting machine A is in its outer appearance and in its work substantially very much like the eccentric presses or punches known, but shows as compared to these certain peculiarities important for the exploitation of the idea of the invention: on guide bars a^1 there glides a main slide C, which is connected by means of a universal joint with a main eccentric a^3 arranged on the driving shaft a^2. In the main slide C an auxiliary slide D is guided, which is driven by an auxiliary eccentric a^4 arranged also upon driving shaft a^2.

The auxiliary slide governs the vertical motion of a plate clamp E fitted with three thumbs e^7 and serving to clamp the plates during the punching and riveting. In order to allow for the varying properties of the material of the profile strips F to be riveted and for the variable pitch, the plate clamp E is not rigidly connected with the auxiliary slide D, as can be gleaned from Figs. 10–12. It is guided laterally by a tool holder E^1, which due to a horizontal guiding groove C^1 provided in the main slide C can be shifted laterally within certain limits, but after being adjusted is rigidly fastened to

the main slide C by a set-screw R and thus forms with it a unit. The upper part of the plate clamp E is inserted in the front part d^1 of the auxiliary slide D, in which some space is provided for this purpose, so that it is positively entrained in every upward stroke of the latter. On the other hand it is influenced by springs S also arranged in the front d^1 of the auxiliary slide D and acting on a transmission plate S^1. These tend to press the plate clamp E permanently downwards and during the down stroke of the auxiliary slide press the profile strips F together elastically or press them upon some abutment e^2. The latter is arranged upon a table-shaped top plate A^5 of the riveting machine and allows of being shifted sideways.

The substantially tube-shaped plate clamp E and its abutment e^2 serve at the same time for receiving a punch E^3, which at the bottom is guided accurately in the lower part of the plate clamp, on top in an interchangeable guiding plate e^5 resting on the tool holder E^1. The upper end of the punch E^3 is formed with a head e^4 pressed against an upper pressure face e^6 of the tool holder E^1 by a spring T pressing from underneath. Thus the extracting of the punch from the punched profile strip F is not effected rigidly but elastically. All other parts of the punch are somewhat thicker than its free bottom end, which does the punching. As the shaft is comparatively long the thin punching end cannot run out. On the other hand there is no danger of jamming and thus of a breaking of the punch supported on the one hand in the main slide C or in the guide plate e^5 rigidly connected with this during working and on the other hand in the plate clamp E possessing a comparative motion relatively to it. Thus it is possible to punch thousands of rivet holes of 2 or less millimeters diameter in high class steel before the punch wants renewing.

As soon as in the up-stroke of the auxiliary slide D the profile strips F shortly before relieved from the punch E^3 are no more under the elastic pressure of the plate clamp E, they are shifted the distance of one rivet at a time from right to left (referring to Figs. 1, 2, 3, 4) by some device described later. In order to simplify the drawing, a rivet hole is assumed to be just in the position needed for introducing the rivet shaft.

A short distance behind this rivet hole (Figs. 1, 2 and 9), which in the modification illustrated has a distance laterally of two pitch units from the punch E^3, the table-shaped top plate A^5 possesses a slender slightly conical opening a^6. Its upper part is formed preferably by a nozzle interchangeable (not shown in the drawing) which has a bore corresponding to the diameter of the wire. The opening a^6 continues downwards in case A and serves as guiding channel for a riveting wire G running off a reel G^1 arranged in the bottom of the riveting machine. A push clamp G^2 controlled by an eccentric a^7 and a transmission rod g^3 pushes upwards in each stroke a piece of the wire G corresponding to the required shaft length. Above the push clamp the riveting wire G is lead through a stretching appliance G^4 constructed at the same time as an arresting appliance acting from one side.

For cutting off and transporting the wire bit used as rivet shaft a knife G^5 is provided which is shaped as a flat slide (Figs. 2 and 9), whose motion is commanded from driving shaft a^2 by means of a gear g^6. In the position of rest of the knife (Fig. 9) an opening made for receiving the free wire end is disposed exactly above the conical opening a^6, so that the wire pushed upwards by the push clamp G^2 meets with no resistance. During the ensuing up-stroke of rod g^6 the knife G^5 is shifted forwards, cuts off the wire end and transports it to immediately above the rivet hole mentioned above of profile strip F. While then the knife does not move for a while, the main slide C sinks down. In its guiding groove c^1 it has a holding piece G^7 with an inserted pin G^8. The pin presses the cut-off wire bit from the opening of the knife into the rivet hole underneath and then is entrained by the main slide going up, while knife G^5 is pulled back so as to cut off another bit during the next stroke of the machine. To prevent the rivet shaft —which is in no way clenched until now— from falling out, the top plate A^5 has a guide bar a^8 narrowly underneath the profile strips F.

When the next feed stroke the pair of profile strips with the rivet shaft has advanced another rivet distance, the rivet shaft comes within reach of a straightening and clenching tool H^1 and H^4 acting from both sides, i. e. from above and from underneath. The upper and lower part of this tool are hollowed out like a cup and when moving towards each other straighten and afterwards clench the rivet shaft from both ends in its right position relatively to the plates. After another feed movement the slightly clenched rivet shaft comes within reach of a header made in two parts.

In the construction illustrated (especially Figs. 1, 2, 8 and 14) both tools are shaped very similarly as to their original outward appearance. The guiding groove c^1 of the main slide C contains a tool holder H in which, displaced one rivet distance, a clencher H^1 and a header H^2 are inserted. At a certain distance below them there is an upholder H^4 moving vertically in the top plate showing a corresponding hole. It is fitted

with the necessary counter forms for straightening and clenching and for heading the lower half of the rivet. Its working stroke directed upwards is worked by a two-arm lever h^3 as soon as its free end is pressed downwards by a governing bolt a^9 (Fig. 8) arranged on the main slide C.

In order to keep the unpunched profile strips in the correct mutual position, also with relation to the tools just described, apart from the known and not shown support by vertical and horizontal rollers (if required by rollers in slanting position as well) certain adjustable clamping appliances are provided. They consist of the clamping bolts J, three of which are schematically shown in Fig. 2, while in Fig. 1 they have been left out for clearness' sake.

The clamping bolts encircle by their interchangeable jaws fitted to match the individual profiles completely or partly the unpunched and sometimes highly spring-like profile strips and the first part of the riveted profile bar. They can be turned and shifted in many ways and are adjusted differently to match the handled material. But invariably they are arranged so that not only the parts to be joined are exactly underneath the tools, but that the profile strips arrive underneath the tools with some side tension or counter-bend. This positive deviation from the straight line demanded in the finished work piece is done according to the invention by means of the adjustable clamping appliances, so that under the influence of the one-sided stretching connected with punching and riveting a body is formed with a row of rivets running absolutely straight. The counter-bend is mostly rather small, so that in Fig. 2 the mutual deviation of the axes of the three clamping bolts cannot be gleaned.

In order to ensure the even transport of the profile strips according to the invention, all direct pulling or pushing of the profile strips by means of clamps, pinches, etc. has been avoided and the riveted profile bar is fed forwards by a separate pulling appliance.

The machine bed consists substantially of a long sturdy channeled girder B (Figs. 1 and 2), which is supported on both sides of the riveting machine A by supporting posts B^1, and whose middle part is rigidly fastened on the bottom side of the table of the riveting machine. In the girder B a sturdy screw spindle B^2 of a length equalling about half the length of the girder is shiftably but in general non-rotary supported. Both ends of the screw spindle B^2 are fastened non-shiftably in a carriage B^3 each. The carriage B^3 can roll along the girder B by means of wheels b^4. In the left carriage the head end of the profile bar F is made fast under insertion of a compensation device. To begin with, the compensation device should be imagined to be out of action. Then the head of the profile bar is in rigid connection with the left hand carriage B^3.

For working the feed motion a tooth wheel B^5 rests underneath the girder B shortly before the riveting machine A. On the same shaft are arranged a ratchet wheel b^6 and a hand wheel b^7. The former is advanced by means of a pawl b^{10} carried by a link b^9 rocking about the axle of wheels b^6, b^7 and an adjustable transmission gear b^8 from a commanding shaft a^{10} at every stroke of the machine. The screw spindle B^2 serving as a gear rack is driven forwards the distance of one rivet at every stroke and pulls the profile bar F to the left the same distance by means of the carriage B^3.

It would be very difficult or impossible to manufacture a real gear rack according to the processes used for the purpose which possesses an absolutely exact pitch on account of its great length of 10 meters and more. For this reason according to the invention a screw spindle has been chosen, as into this a very exact thread can be cut without any great difficulties. Thus even in using a pitch of a few millimeters the greatest accuracy of the single rivet distances as an exact distance between the first and the last rivet hole is obtained. A further advantage consists in the fact that, when one side of the screw spindle is worn out, it can be turned a certain angle and thus a completely new gear rack is obtained.

If the screw spindle just mentioned is not to be used as gear rack, it can be employed as a compensation device, which in progressing automatically corrects the minor faults of the pitch caused by the stretching of the material during the punching and riveting and by similar sources of error. If e. g. the riveting pitch be 20 mm. and there be a deviation of 0.03 mm. between two rivets, the figure is very small in itself, but according to the very large number of rivets in a profile bar of 10 meters the resulting deviation is 15 mm. Thus with long girders it is out of question to observe exact end dimensions. In order to obtain any required degree of accuracy as to end dimensions the screw spindle can be turned after every stroke of e. g. after 10 strokes of the main slide C by means of a separate ratchet gear for a certain amount in such a manner that the actual feed of the spindle is made as an average 0.03 mm. larger than it would be without the turning motion of the screw spindle.

In the specimen construction this kind of compensation has not been employed, so that the comparatively heavy spindle B^2—which cannot easily be turned—rests generally non-rotary in carriage B^3. The compensation is

done instead by means of the appliance described in the following, which scarcely requires any transporting work (Figs. 3–7).

The left hand carriage B^3 (Fig. 4) has about at the centre height of the profile bar F a supporting rod K arranged in parallel to the spindle B^2 upon which near its free end a guiding piece K^1 is rigidly fastened. In this guiding piece K^1 a short draw-bar K^2 rests, which by means of a bar-shaped extension K^3 is firmly connected with the head of profile bar F. On the front end of draw-bar K^2 a nut M of a micrometer screw is arranged rotary but non-shiftably which partly forms a ratchet wheel. The bolt M^1 belonging to this nut and equally arranged in parallel to the screw spindle B^2 is rigidly fastened in the upper part of carriage B^3. When nut M is turned relatively to the end of the bolt fitted with thread m^7 this nut M changes its distance from carriage B^3. Upon nut M a driver M^2 turns, which on the one hand possesses a pawl m^3 and on the other hand a return pin m^4 rigidly connected with it. The return pin slides in the free end of a strong spiral spring m^5, whose case m^8 is rigidly connected with the micrometer-screw bolt M^1. The spiral spring tends to press the return pin against a set-screw m^9 (Fig. 7) serving as adjustable limiting piece provided in a limiting collar m^6, which can be jammed upon the screw-bolt M^1. If the return pin m^4 rests against the set-screw m^9 in its normal position, the driver M^2 fitted with a roller m^{10} on its upper end slides along a guiding bar N on top, which is arranged in parallel to screw spindle B^2 above the part of girder B carrying the carriage B^3 and extends over the whole length of this part of the girder. Bent bar supports n^1 fastened at certain intervals on girder B (on the left in Fig. 5) hold the guiding bar N in position. The guide bar has on its upper side at regular intervals, e. g. 100 mm., trapesoid bosses n^2. Whenever the driver M^2 in feeding hits against such a boss with its roller m^{10}, it is turned against the tension of spring m^5 a certain amount and carries the ratchet wheel or nut M by means of the pawl m^3, thus displacing the nut a little relatively to the screw-bolt M^1. After passing the boss n^2 the driver M^2 is turned into home position by the return pin m^4 under the tension of spiral spring m^5, while the pawl glides over the ratchet wheel of nut M without feeding. It can be seen at once that in this way the profile bar F is displaced a little relatively to the screw-spindle B^2 at regular intervals corresponding to the intersections of guiding bar N by the bosses n^2. Thus any deviation from the pitch caused by some reason can be compensated with the accuracy required in rivet seams of any length. The compensation device is otherwise constructed so that by its working the pitch can as well be enlarged—e. g. if the feed has been chosen insufficent—as also be reduced.

The great advantage of the compensation device just described would partly be brought to nought, if not all injurious sagging of the riveted profile bar F could be prevented with the same degree of accuracy. For this purpose in further developing the invention a special kind of supports have been provided, which according to the progressing of the profile bar insert themselves automatically and during the return motion of the carriage, e. g. if a second or third row of rivets is to be made, are automatically removed as well.

For this purpose at intervals and out of reach of the carriage B^3 (Fig. 5) bent supporting posts O are rigidly fastened on the U-section B. Each supporting post has a pillar head O^1 turning upon a vertical axis, whose lower end has an arm O^5 for supporting the riveted profile strip. It is now necessary to swivel arm O^5, which happens to be within reach of carriage B^3, from its position parallel to the screw spindle B^2 into the position vertical to it and thereby below the profile strip.

The pillar head has in its top portion two horizontal notches o^2 standing perpendicular on one another. A bent support is fastened on post O, whose arm P is parallel to post O is at its free end changed into a spring rest p^1. A blade spring p^2 attached to this presses permanently a carrier T with roller t^1 turning in the upper part of arm P upon the pillar head O^1. It tends to hold the latter in either of the two limit positions, in which the notch o^2 runs in parallel to screw-spindle B^2, while the other stands at right angles and serves as an abutment for the carrier T. Underneath the notches the pillar head is constructed in the shape of an angular catch like the reverse catch of a planing machine, whose arms o^3 and o^4 in parallel to either of the notches o^2 are arranged in two planes one above the other. The arm parallel to screw spindle B^2, e. g. o^3, hits with its outer edge against a screw corresponding to it, e. g. p^3, two of which are provided as adjustable stops p^3 and p^4 on spring rest p^1. On the inner edge of this arm o^3 a driver pin q^3 just fails to catch, which is combined with another driver pin q^4 arranged somewhat farther below in a pin holder Q. On the pair of driver pins q^3, q^4 a slide q^1 (Fig. 3) is fastened, which possesses two slanting faces q^2. The pin holder Q is clamped tightly upon the free end of the supporting rod K. The other arm o^4 being at right angles to the screw spindle is in the way of the second driver pin q^4.

As may be seen from Fig. 4 and 5, each of the catch arms o^3, o^4 is in the home position shown in Fig. 4, when the pair of driver

pins q^3, q^4 is on its right, i. e. between it and the riveting machine A. When during the feed motion carriage B^3 and with it the pair of pins q^3, q^4 and the slide q^1 moves to the left, the carrier T, after the carriage B^3 has passed, is lifted by means of the slide q^1, i. e. its left slanting face, and of roller t^1, from the corresponding notch o^2 of the pillar head and thus this latter is released. Now the catch o^3, o^4 is turned by the bottom driver pin q^4 in the direction of the clock hand about 90°, whereupon the carrier snaps into the other notch facing it, and thus secures it against being turned any further. The catch remains in this "on" position until carriage B^3 after finishing a row of rivets is being pulled back to the right by means of hand wheel b^7 or rather the pin holder Q always keeping in advance for the length of the supporting rod K, which by means of the upper driver pin q^3 turns it back into the home position shown in Fig. 4.

In parallel to arm o^2 and pointing in the same direction a support o^5 is clamped on pillar head o^1 underneath the catches o^3, o^4 (Figs. 1 and 2), which preferably on its free end has a supporting roller for the profile strip F; the roller is not shown in the drawing. According to the description the supports swivel in and out absolutely automatically and safely without any detrimental influence to the machine bed, to the feed appliance or to the compensation device.

In all details of the whole machinery adjusting devices are provided where required, which within certain limits given by the size of the machine and its special application allow to adapt it to the individual kind of riveting connections, which are to be made. Though the modification shown and described is especially destined for making thin-walled riveted hollow bars, it may be employed without any substantial alteration for connecting large sheets of plate by single or several rows of rivets. By a machine constructed correspondingly larger without any substantial modifications of its construction, riveting of structural parts can be done, as are used in the erection of buildings, in bridge constructions and in the construction of railway lines. It is not difficult to manufacture e. g. girders and posts for architecture, long-stretched booms for bridges and shipbuilding and riveted frame parts for locomotives and other vehicles by means of a machine representing the object of the invention, because such a machine can always be put to great use where a large number of rivets have to be produced in continuous rows.

If in a machine only a few, as it were, standardized pitches are used, the separate tool holders, which in the modification shown are to be put in position separately on the main slide, can be combined in one tool holder for one pitch and equally the counter tools can be arranged on plates interchangeable as a whole. The latter is especially advisable in the case where the pitch and the rivet diameter are small and the difficulties for arranging and adjusting them accurately are accordingly great. Besides with very small pitches the distance of the separate tools can be made equal to several single rivet distances, as mentioned above, without practically reducing the velocity of the riveting process. As shown more especially in Figs. 1, 2, 14 and 15, the tools for introducing G^8, slight clenching H^1 and heading H^2 follow one another at distances equal to the rivet distance, while the more complicated punching tool E^3 is two rivet distances apart from the introducing tool G^8. If the pitch is reduced further, the distance between two tools following one another directly E^3, G^8, H^1 and H^2 can easily be chosen equal to twice the rivet distance, as shown in Fig. 17. The upper part of this figure corresponds to a partial view similar to that in Fig. 1 and 14. The middle part signifies the arrangement of each one of the tools for punching, introducing, first clenching and heading by means of $a\bigcirc$, $a\square$, $a\bigtriangledown$, and $a\Diamond$ as an independent unit. The lower part shows a piece of a bar F, whose pitch corresponds to half the distance of two tools following one another. It can be seen at once that some point of the bar happening to be arranged underneath a certain tool will get under the next tool after the second feed movement but that after setting the machine to work each tool comes into action once at every feed movement. With small pitches and accordingly thin plates the velocity of riveting can even be enlarged e. g. doubled, if each tool is provided twice in direct series corresponding to the threefold rivet distance and the feed is made twice the rivet distance.

This is proved by the schematical Figure 18, which in the first line shows two identical tools E^3 for punching ($\bigcirc$), G^8, for introducing ($\square$), H^1 for slightly clenching ($\bigtriangledown$) and H^2 for heading ($\Diamond$). As the series a, b . . . p, q of the pitch underneath shows, the two tools of the same kind follow each other at three rivet distances, while the adjoining tools of different kinds have a distance of a single rivet. The triangle of figures shows that in the beginning (in position I) only spot I is punched by the punch of series a, while the punched spot I and the unpunched spot 2 are below series c and b. After another feed movement of double rivet distance in position III the spots 2 and 5 are punched simultaneously by the punching tools of series d and a, and into the punched spot I a rivet shaft is introduced by the intro-

ducing tool of series *e*. The punched spot 3 and the unpunched spot 4 are below the rows *c* and *b* free from tools.

After 8 feed movements of double rivet distance in position IX the spots 14 and 17 are punched simultaneously, the holes 10 and 13 provided with a rivet shaft each, the rivet shafts of spots 6 and 9 are slightly clenched and those of spots 2 and 5 headed, as the lower row shows by the non-hatched signs. In spots 1 and 3 the heading had taken place already in positions VII and VIII. After the next feed movement the rivets of spots 4 and 7 will be headed, those of spots 8 and 11 slightly clenched, those of spots 12 and 15 provided with rivet shafts and spots 16 and 19 punched, etc. Thus after each further feed movement of double rivet distance all eight tools work together in such a way that each time two rivets are made. Though two simultaneous rivetings are displaced for three units the individual pairs supplement each other so—as shown in Fig. 18—that a continuous riveting is done, as in position VII the rivet 1, in position VIII the rivet 3, in position IX the rivets 2 and 5, in the next position the rivets 4 and 7, then the rivets 6 and 9 etc. are finished.

Though the invention concerns in the first line the especially advantageous production of long straight lines of rivets, it can be applied at once to the production of rows of rivets, arranged in a circle. If for instance two junk rings are to be riveted upon one another, it is advisable to clamp them upon a circular table rotary upon an axle, whose distance from the riveting machine can be varied, and commanded correspondingly by the feed motion of the riveting machine. Naturally the separate tools provided in the riveting machine must be arranged in the mantle face of the circle of the rivet holes made at the time, if they all are to work at every stroke of the machine. As in this case separate tool holders are needed for every riveting circle and every pitch, it is advisable to provide the slide with an automatically turned revolving tool box, so that the individual tools work one after another. In a similar manner the idea of the mechanically progressing motion of the work piece, of its punching, of the introduction of the riveting wire and of finishing the riveting connection can be realized as well in rows of rivets, in which the single rivet shafts have a radial direction. For straight rows of rivets the use of a revolving tool box is equally feasible but apart from a few special cases less advantageous, as generally only one tool works at the same time and thus the riveting process is carried out somewhat slower.

Besides the drive of the tool slides can, instead of by means of eccentrics, be done in any other way, e. g. by hydraulic action. On the other hand the rivet holes need not, as in the modification described, be made by punching, but especially in thick plates they can be bored mechanically, if the material is to be treated especially tenderly.

In order to be able to leave out rivet holes in certain places, it is advisable to provide a disengaging device for the push clamps (not shown in the drawings), so that the cutting and introducing appliance strikes empty. Equally, if the material is not to be punched in certain places of the pitch, the punching machinery can be disengaged. If between this and the counter face of the main slide a removable presser piece is inserted, punching can be prevented most easily by removing it. But care has to be taken that simultaneously with setting the punching tool out of action the appliance for the introduction of the rivets is set out of action too. If such pass-over places occur at regular intervals, when e. g. boom members are riveted which later on are to be united to some girder or lattice work by inserting filling bars, it is advisable to provide further governing devices, which work automatically the engaging and disengaging of certain tools.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:—

1. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier and a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier.

2. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier and means in front of said tool carrier for slightly bending the workpiece.

3. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier and means for compensating the elongation of the workpiece resulting from the punching and riveting operations.

4. In a riveting machine in combination,

a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier and adjustable guides gripping the workpiece disposed in front of said tool carrier so as to slightly bend the workpiece.

5. In a riveting machine in combination, a workpiece carrier, a stationary screw spindle and means in gear with said spindle for carrying said workpiece carrier along said spindle.

6. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means comprising a stationary screw spindle for automatically carrying the workpiece step by step past said tool carrier and a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier.

7. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier, a nut, means for intermittently turning said nut and a screw bolt in gear with said nut and connected with the workpiece.

8. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier and means for throwing one of said tools out at predetermined intervals.

9. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier and a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier, said tools being spaced apart for the distance of more than one step.

10. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier and a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier, part of said tools being provided in a plurality of specimens and being spaced apart for the distance of more than one step.

11. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier, and workpiece supporting members movably arranged in the path of the work-piece.

12. In a riveting machine in combination, a tool carrier adapted to reciprocate relatively to the workpiece, means for automatically carrying the workpiece step by step, past said tool carrier, a punch, a rivet head forming tool, a rivet inserting tool and a tool for adjusting and clenching the inserted rivet on said tool carrier, workpiece supporting members arranged near the path of the workpiece and means for temporarily throwing said members in operative position, when the work advances.

In testimony whereof I affix my signature.

CLAUDE DORNIER.