No. 767,883. PATENTED AUG. 16, 1904.

W. P. GRAFTON.

MACHINE FOR PRODUCING CRIMPED OR CORRUGATED METAL STRIPS.

APPLICATION FILED MAR. 4, 1904.

NO MODEL. 5 SHEETS—SHEET 1.

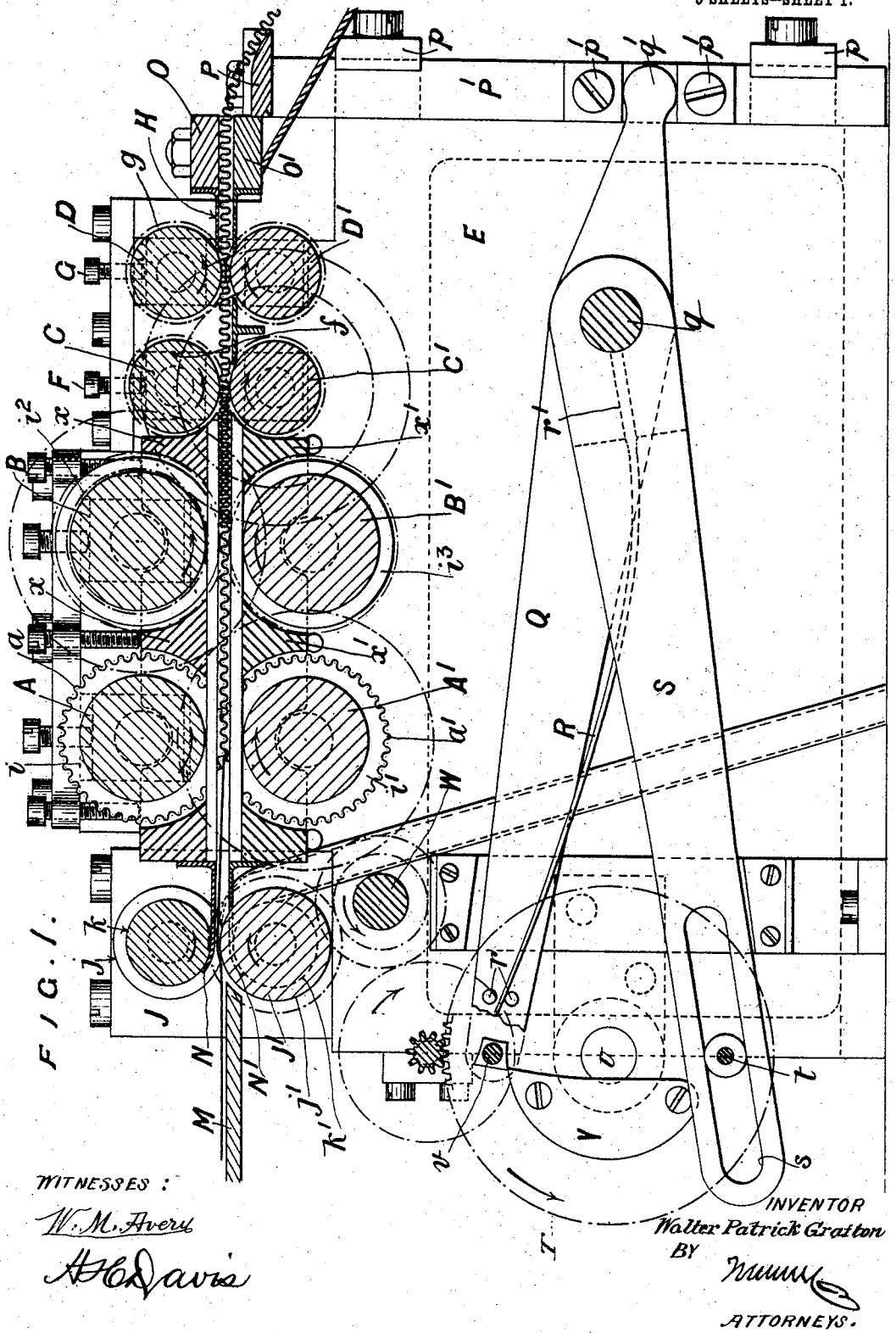

FIG. 1.

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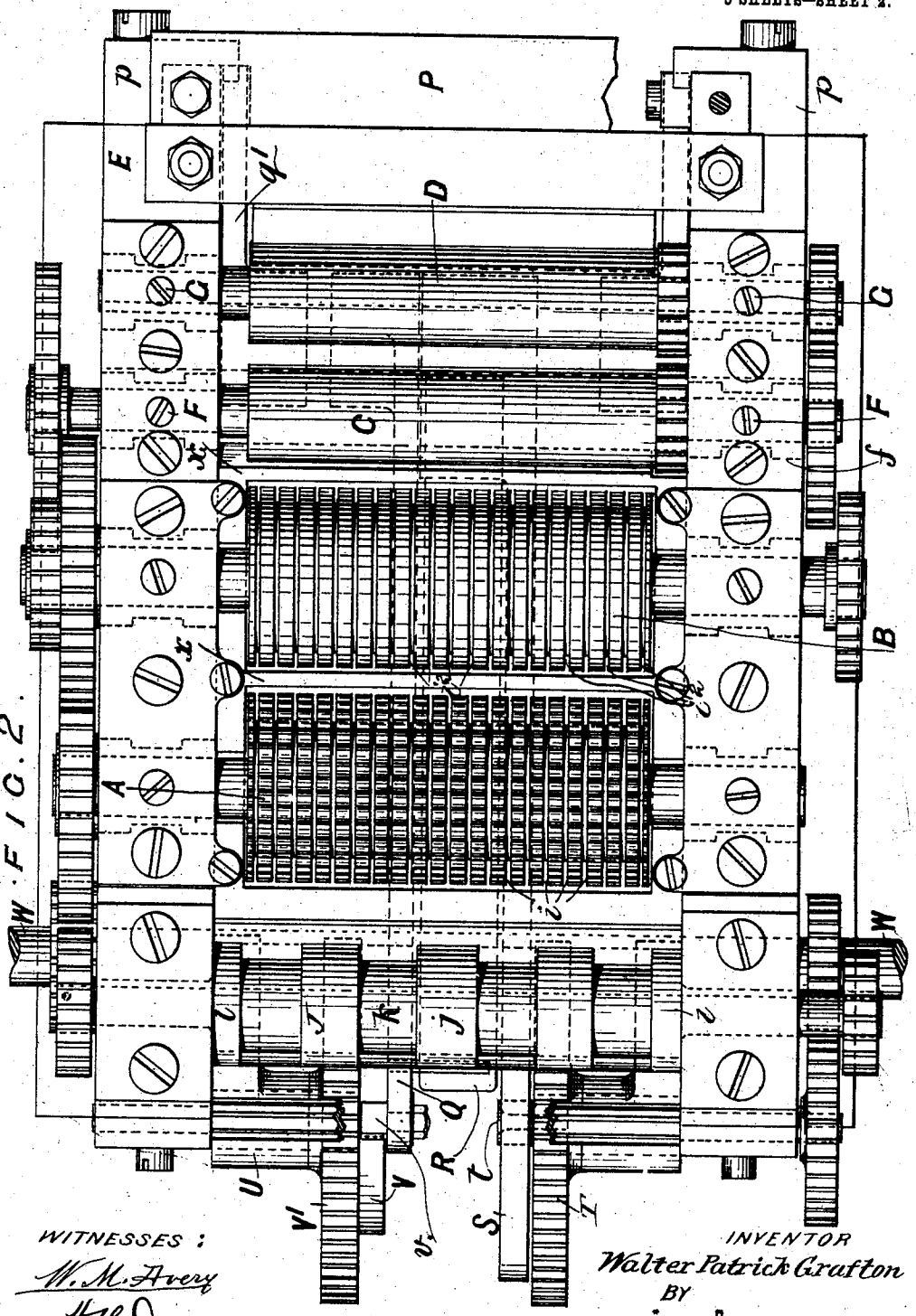
NO MODEL. 5 SHEETS—SHEET 2.

FIG. 2.



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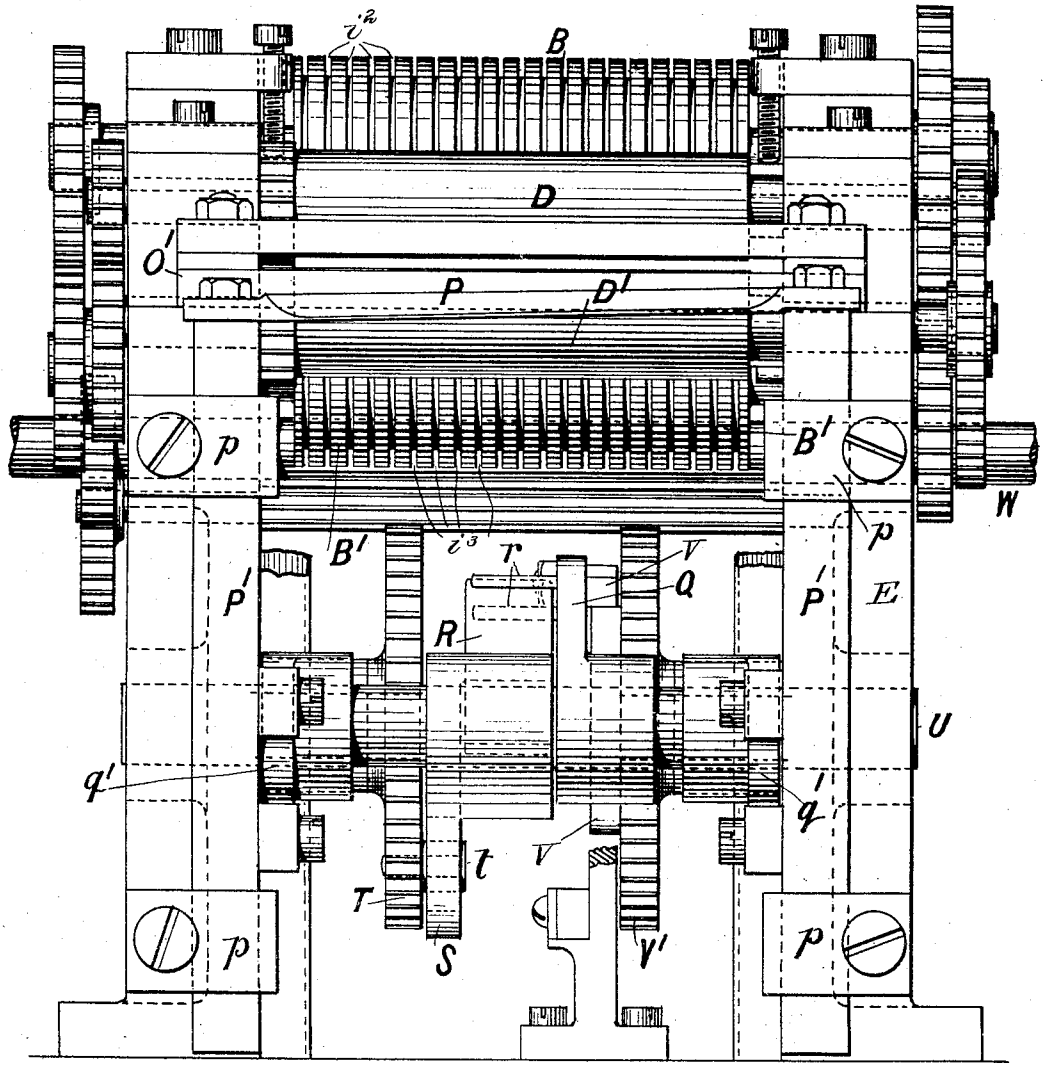
NO MODEL. 5 SHEETS—SHEET 3.

FIG. 3.



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NO MODEL. 5 SHEETS—SHEET 4.

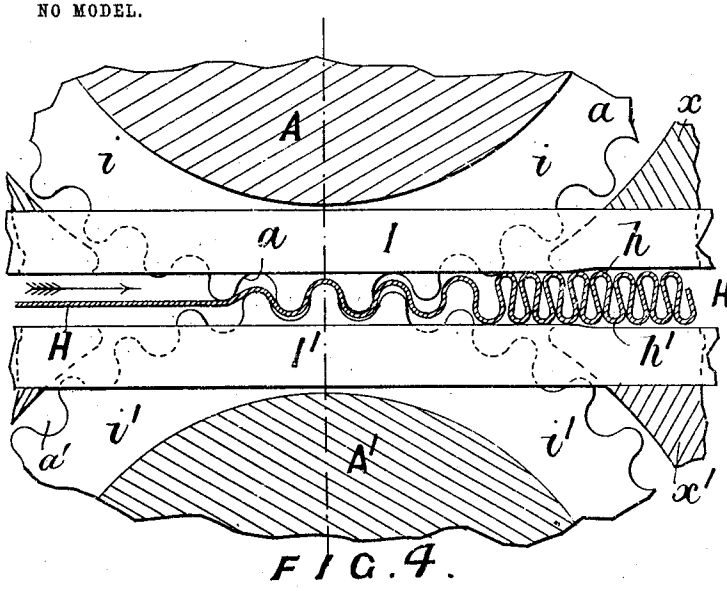


FIG. 4.

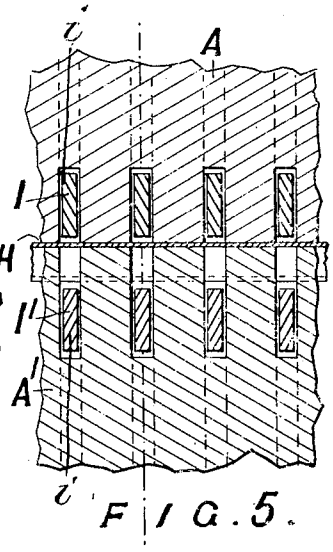


FIG. 5.

FIG. 6.

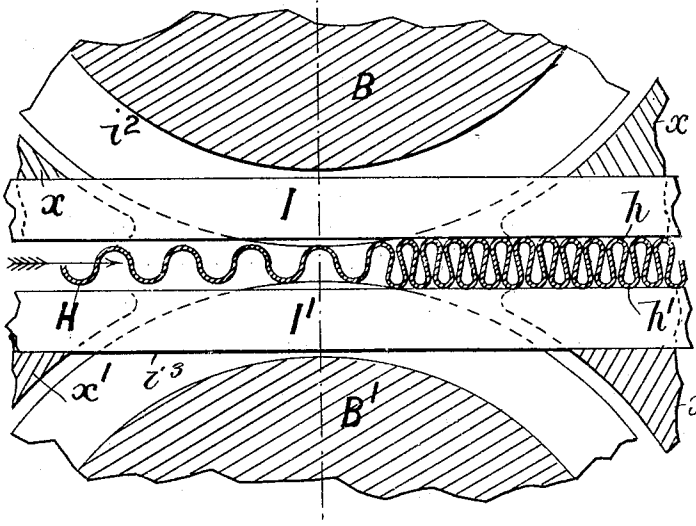
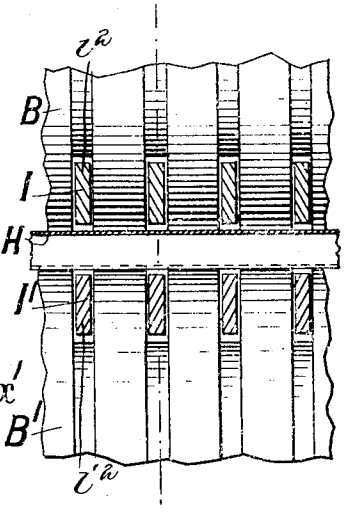


FIG. 7.



WITNESSES :

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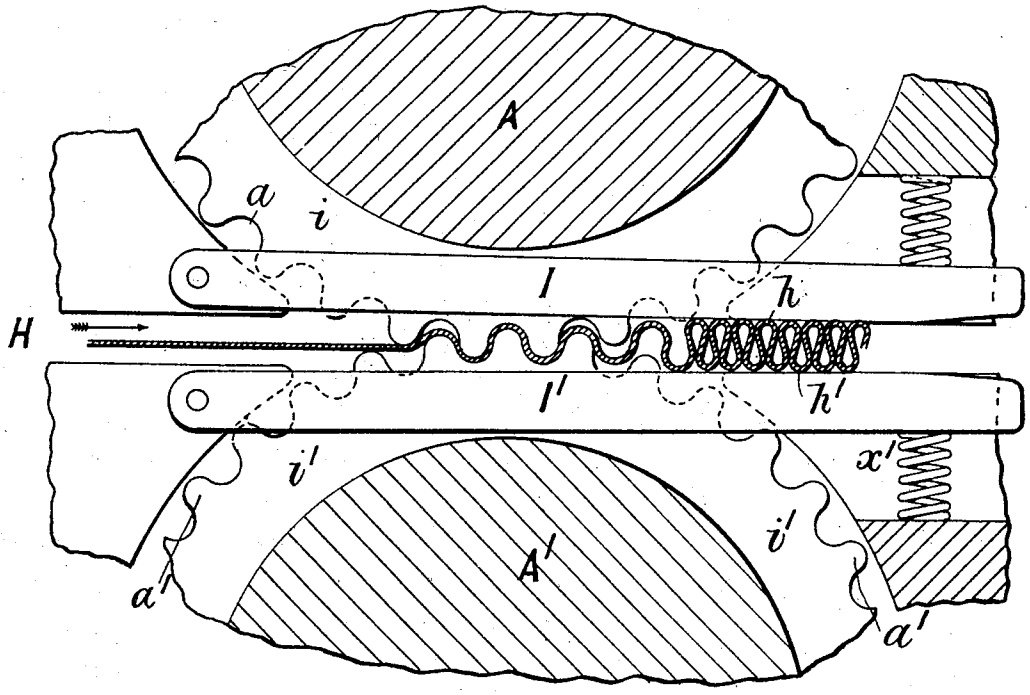
NO MODEL. 5 SHEETS—SHEET 5.

FIG. 8.



WITNESSES:

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No. 767,883. Patented August 16, 1904.

UNITED STATES PATENT OFFICE.

WALTER PATRICK GRAFTON, OF OLD CHARLTON, ENGLAND.

MACHINE FOR PRODUCING CRIMPED OR CORRUGATED METAL STRIPS.

SPECIFICATION forming part of Letters Patent No. 767,883, dated August 16, 1904.

Application filed March 4, 1904. Serial No. 196,521. (No model.)

To all whom it may concern:

Be it known that I, WALTER PATRICK GRAFTON, engineer, a subject of the King of Great Britain, residing at 82 Elliscombe road, Old Charlton, in the county of Kent, England, have invented a Machine for Producing Crimped or Corrugated Metal Strips, of which the following is a specification.

My invention relates to the continuous production of closely crimped or corrugated sheets or strips of thin lead especially adapted for use in making the electrodes of secondary batteries.

The invention consists, essentially, in mechanism for closing together the corrugations of a corrugated sheet or strip to bring the sheet or strip to the desired crimped form, the machine whereby this is effected in its preferred form comprising pairs of rolls for corrugating the material, pairs of retarding-rolls for closing together the corrugations produced by the corrugating-rolls, pairs of propelment-rolls for forcing the sheet or strip against the retarding-rolls, pairs of accelerating-rolls for opening out the previously-closed corrugations to the extent required in the final product, takers-off for the strip or sheet in its passage through the machine, means for cutting the sheets or strips into narrower strips before entering the corrugating-rolls, and means for automatically severing portions of uniform length from the final product as it passes from the machine.

My invention is illustrated in the accompanying drawings, forming part of this specification, wherein—

Figure 1 is a longitudinal vertical section, and Fig. 2 a plan, of a preferred form of the machine, Fig. 3 being an elevation of the delivery end. Fig. 4 is a detail view, partly in section and on an enlarged scale, of a modification. Fig. 5 is a vertical transverse section of the same. Fig. 6 is a detail view, on an enlarged scale, of the propelment-rolls and takers-off shown in Fig. 1; and Fig. 7 is a vertical transverse section of the same.

The corrugating-rolls A A′, propelment-rolls B B′, retarding-rolls C C′, and accelerating-rolls D D′ are each in pairs, the two members of each pair being of the same diameter. The axes of all the rolls are horizontal and parallel to one another, the one member, A B C D, of the respective pairs being directly above the other member, A′ B′ C′ D′, while the lines of bite of all the pairs are in one horizontal plane. The rolls are journaled in bearings in the side frames E of the machine and are all positively driven in a direction to cause the sheet or strip to travel continuously between the upper and lower rolls. The peripheral surfaces of the rolls A A′ are grooved longitudinally with rounded corrugations $a\,a'$, as shown on an enlarged scale in Fig. 4, the corrugations $a\,a'$ of the respective rolls intermeshing with one another, while the axes of the rolls are maintained at such a distance apart as to leave a space for the passage of the sheet or strip H of lead between the rolls. The propelment-rolls B B′ (which are not longitudinally corrugated) serve to feed forward to the retarding-rolls C C′ the corrugated strip as it leaves the corrugating-rolls A A′, thus relieving the corrugating-rolls of the duty of propulsion, which might interfere with their corrugating action.

The takers-off consist of pairs of longitudinally-extending bars I I′, forming, respectively, top and bottom guides for the sheet or strip H. These bars are fixed to transverse members $x\,x'$ of the frame E of the machine and lie in circumferential grooves $i\,i'$, respectively intersecting the teeth or corrugations $a\,a'$ in the corrugating-rolls, the acting surfaces of the bars I I′ being at or below the bottoms of the corrugations with which they intersect, so as while avoiding interference with the corrugating action to prevent the sheet or strip H from being carried round upon the periphery of either of the rolls A or A′. The taker-off bars I I′ are continued beyond the rolls A A′, so as to form guides for the corrugated sheet or strip H during its passage between the rolls B B′, which have circumferential grooves $i^2\,i^3$, respectively, for the accommodation of the bars I I′.

The rolls B B′, which (apart from the grooves $i^2\,i^3$) are plain, are of the same effective diameter as the rolls A A′, and their surface speed is the same as the pitch-line of the latter and that of the sheet or strip H, which therefore

arrives between the rolls B B′ without any alteration in the shape of the corrugations as formed by the action of the rolls A A′. At this stage, however, the corrugations are somewhat too wide and shallow to suit the purpose for which such sheets or strips are required, and it is therefore necessary to close together the corrugations to a certain extent, so as to give the finished product the required form. This result is effected by so retarding the advance of the corrugated sheet or strip as to shorten its effective length by causing successive corrugations to be folded back toward one another and being preferably produced by the application of frictional resistance to the top and bottom crests *h h′* of the corrugations. Owing, however, to the yielding but inelastic nature of the material of the sheet or strip, it is impracticable to bring the corrugations to the shape which they should have when the product is used for certain purposes by a single or direct operation in such manner as to produce a uniform effect continuously throughout the whole length of the strip, and I therefore first so retard the progress of the sheet or strip as to bring adjacent corrugations into contact with one another, (to an extent compatible with avoidance of undue diminution of the radius of curvature of the crests *h h′*,) thus bringing the sheet or strip to the form shown in the right in Figs. 4 and 6, and I subsequently accelerate the progress of the sheet or strip, so as to open out the corrugations to the extent required, as shown at the extreme right of Fig. 1. By this means I am enabled to insure the requisite degree of uniformity in the final product.

The retardation is effected, preferably, by means of the plain rolls C C′, which may be of smaller diameter and are driven at a less surface velocity than the rolls A A′ and B B′. The gudgeons of the upper roll C are journaled in blocks *f*, fitted to slide in guides in the frame E of the machine, the blocks *f* being pressed upon by regulating-screws F, so that, the roll C being forced toward the roll C′ with a suitable degree of pressure, the corrugated sheet or strip H is gripped between these rolls and allowed to pass their line of bite at a speed dependent upon the surface velocity of the rolls. For example, the ends of the bars I I′ at the exit side of the rolls A A′ (or B B′ if propelment-rolls are used) instead of being rigidly fixed may be spring-pressed, as shown in Fig. 8, the springs forcing the bars against the strip with pressure sufficient to arrest its progress to the desired degree. In consequence of the accumulation (resulting from such retardation) of the sheet or strip in the distance separating the rolls C C′ from the rolls B B′ the crests *h h′* of the corrugations are forced, respectively, upward and downward until they meet the guides I I′, and the effective length of the strip is at same time diminished until the flanks of adjacent corrugations in both the upper and lower series are brought into contact with one another, as shown toward the right-hand side in Figs. 4 and 6. It will be obvious that the distance apart of the upper and lower guide-bars I and I′ in that part of their length between the rolls B B′ and the rolls C C′ should be so adjusted as to accommodate the vertical distance between the upper crests *h* and the lower crests *h′* of the corrugations when the latter are closed together, as in Fig. 6, this vertical distance being of course somewhat greater than that separating the rolls B B′.

The subsequent acceleration of the progress of the sheet or strip H is effected by means of a second pair of plain rolls D D′, driven at a geater surface velocity than the rolls C C′. The gudgeons of the upper roll D are journaled in blocks *g*, fitted to slide in vertical guides in the machine-frame E and pressed upon by regulating-screws G, so that the sheet or strip H being gripped by the rolls D D′ is caused to pass from between them at a rate corresponding to their surface speed, which is so proportioned to that of the rolls C C′ as to effect the separation of adjacent corrugations in both the upper and lower series to the extent necessary to bring the sheet or strip to the form shown at the extreme right-hand side in Fig. 1.

It may in some cases, as understood with regard to the example illustrated in Fig. 4, be permissible to omit the propelment-rolls B B′, and it will be obvious that should it be desired to produce a sheet or strip of the form shown to the right in Figs. 4 and 6 the accelerating-rolls D D′ would not be required.

The machine as above described is adapted for crimping either a single sheet or strip of material or a number of strips passed side by side between the rolls. For subdividing the strip or sheet longitudinally into narrower strips before it enters the machine I may employ a pair of upper and lower cutting-rolls J J′, mounted in advance of and parallel to the corrugating-rolls A A′ and journaled in bearings in the side frames E, each roll comprising a number of sections of lengths equal to the width of the strips into which the sheet is to be divided and of alternately larger and smaller diameter, a section *j* of larger diameter in the upper roll J meshing with a section *k′* of smaller diameter in the lower roll J′, while a section *k* of smaller diameter in the upper roll meshes with one of larger diameter *j′* in the lower roll. The short end sections *l l′*, as shown in Fig. 2, serve for the purpose of trimming the edges of the sheet. The mean diameter of both rolls J J′ is the same, and their axes are preferably placed, as shown, at equal distances above and below the plane wherein lies the common line of bite of all the other rolls, the cutting-rolls being

positively driven at a mean peripheral velocity equal to the speed at which the strips are fed to the corrugating-rolls A A′. The sections of the rolls J J′ intersect with one another sufficiently to cause the sheet H as it passes from the feed-table M to be divided longitudinally on lines coinciding with the bounding edges of the sections, which thus act continuously as dies and bed-cutters, the individual strips being severed from the sheet by forcing alternate widths upward above and downward beneath the mean line of bite of the rolls.

N N′ represent takers-off for the rolls J J′, respectively, each consisting of a blade of a width corresponding to the width of a strip and lying in the bottom of the groove formed by the lesser diameter *k* or *k′* of the corresponding roll, as shown in Fig. 1. Beyond the rolls J J′ the takers-off N N′ are continued, as shown, at a distance apart corresponding to that separating the top and bottom guides I I′, so that the strips are continuously guided from the point where they leave the cutting-rolls J J′ to that where they enter between the retarding-rolls C C′.

The means of automatically severing portions of uniform length from the finished, crimped, or corrugated sheet or strip as the latter leaves the rolls D D′ comprises a pair of upper and lower stationary bed-cutters O O′, between which the sheet or strip passes on leaving the rolls and a guillotine-knife P, cutting in both directions of its stroke against one or other of the bed-cutters, together with mechanism for so actuating the knife P as to impart to it a quick cutting stroke upward against the upper bed-cutter O and downward against the lower one O′ alternately, the knife having a period of rest between the strokes sufficient to permit the passage between the bed-cutters O O′ of the required length of the corrugated material to be severed.

The knife P is carried by a slide P′, fitted to reciprocate vertically in guides *p* on the frame E, a sudden movement upward and downward alternately at regular intervals being communicated to the slide by means of a rock-lever Q, fulcrumed on a transverse axis *q* and engaging by the circular cam-shaped end *q′* of its shorter arm between bearing-surfaces *p′* on the slide, there being preferably a pair of such lever-arms *q′*, one at either end of the slide P′, as shown in Fig. 3. The longer arm of the lever Q receives motion from the spring R, whose free end engages between studs *r* on the lever and whose other end is fixed, as at *r′*, to the boss of a second rock-lever S, pivoted about the axis *q* independently of the lever Q.

The lever S is caused to vibrate by means of a stud and roller *t* on a wheel T, fast on a transverse shaft U, which through the medium of suitable gearing is rotated through one half-revolution during the passage of each successive length of corrugated material to be severed by the knife P, the stud and roller *t* engaging in a slot *s* in the lever.

By means of a cam V of approximately semicircular form, as shown, which engages with a stud *v* on the end of the lever Q and which is carried by a wheel V′ on the shaft U, the lever Q is held at one extremity of its range of angular movement, while the length of material to be severed by the knife P is passing between the bed-cutters O O′, during which time the lever S is being moved to the opposite extremity of its range of angular movement, so as to strain the spring R. At the moment when the required length of material has passed beyond the bed-cutters O O′ the lever Q is released, whereupon it is moved suddenly by the spring to the other extremity of its range of movement and is immediately thereafter locked in such position by the reëngagement of the semicircular portion of the cam V with the stud *v*, this action being repeated for the movement in opposite directions alternately.

By suitably varying the ratio of the gearing through which the shaft U derives motion from the main shaft W of the machine the length of finished, crimped, or corrugated material severed from the sheet or strip at each vibration of the lever Q may be correspondingly varied to any desired extent.

I claim—

1. A machine for the continuous production of closely crimped or corrugated sheets or strips of thin lead consisting in the combination with a pair of rolls for transversely corrugating the material of a device interposed in the path of the sheet and serving to so retard the advance of the corrugated sheets as to cause the corrugations to be folded against one another, and a pair of guide-bars received in circumferential grooves in the corrugating-rolls and serving to strip the corrugated material from the rolls and to constrain it to pass to the retarding device, substantially as specified.

2. In a machine for the continuous production of closely crimped or corrugated sheets or strips of thin lead, the combination with a pair of corrugating-rolls and with means for guiding the corrugated material as it leaves the rolls, of a retarding device interposed in the path of the corrugated material and consisting of a pair of plain rolls adapted to bear upon the upper and under surfaces of the corrugated sheet and driven at a less peripheral speed than the mean peripheral speed of the corrugating-rolls.

3. The employment in combination for closing together the corrugations of a corrugated sheet or strip of thin lead in a continuous manner, of a pair of propelment-rolls, a device for retarding the progress of the material as it leaves said rolls, and top and bottom bars received in grooves in the propelment-

rolls and forming guides for the material in its passage from the rolls to the retarding device.

4. A machine for the continuous production of closely crimped or corrugated sheets or strips of thin lead, consisting in the combination with a pair of rolls for transversely corrugating the material, of a device interposed in the path of the sheet and serving to so retard the advance of the corrugated sheets as to cause the corrugations to be folded against one another, a pair of guide-bars received in circumferential grooves in the corrugating-rolls and serving to strip the corrugated material from the rolls and to constrain it to pass to the retarding device, and a propelment device consisting of a pair of plain rolls interposed in the path of the corrugated sheet between the corrugating-rolls and the retarding device and driven at the same peripheral speed as the mean peripheral speed of the corrugating-rolls, substantially as specified.

5. A machine for the continuous production of closely crimped or corrugated sheets or strips of thin lead consisting in the combination with a pair of rolls for transversely corrugating the material, of a device interposed in the path of the sheet and serving to so retard the advance of the corrugated sheets as to cause the corrugations to be folded against one another, and a pair of guide-bars received in circumferential grooves in the corrugating-rolls and serving to strip the corrugated material from the rolls and to constrain it to pass to the retarding device, and an accelerating device for partially opening out the corrugations partially closed together by the retarding device consisting of a pair of plain rolls interposed in the path of the corrugated sheet as it leaves the retarding device and positively rotated at a peripheral speed greater than that at which the corrugated sheet leaves the retarding device, substantially as specified.

6. A machine for the continuous production of closely crimped or corrugated sheets of thin lead consisting in the combination with a pair of rolls for transversely corrugating the material, of a device interposed in the path of the sheet and serving to so retard the advance of the corrugated sheets as to cause the corrugations to be folded against one another and a pair of guide-bars received in circumferential grooves in the corrugating-rolls and serving to strip the corrugated material from the rolls and to constrain it to pass to the retarding device, and an accelerating device for partially opening out the corrugations partially closed together by the retarding device consisting of a pair of plain rolls interposed in the path of the corrugated sheet as it leaves the retarding device and positively rotated at a peripheral speed greater than that at which the corrugated sheet leaves the retarding device, and a propelment device consisting of a pair of plain rolls interposed in the path of the corrugated sheet between the corrugating-rolls and the retarding device and driven at the same peripheral speed as the mean peripheral speed of the corrugating-rolls, substantially as specified.

7. The combination with a pair of intermeshing corrugating-rolls for transversely corrugating a sheet or strip of thin lead, of means for longitudinally dividing the sheet or strip into narrower strips on its way to the corrugating-rolls, consisting of a pair of cutting-rolls formed of mutually-intersecting sections of widths corresponding to the widths of the strips to be produced, and of relatively greater and lesser diameter, in combination with takers-off for the two rolls consisting of blades lying at the bottom of the grooves in the rolls formed by the section of lesser diameter, substantially as specified.

8. A machine for the simultaneous production of a plurality of transversely-corrugated strips from a continuous sheet of lead or like material consisting of the combination of a pair of intermeshing positively-driven corrugating-rolls; a pair of propelment-rolls positively driven at the same peripheral speed as the mean peripheral speed of the corrugating-rolls; a pair of retarding-rolls positively driven at a less peripheral speed than the propelment-rolls; a pair of accelerating-rolls positively driven at a greater peripheral speed than the retarding-rolls; a cutting device for longitudinally dividing the sheet before it enters between the corrugating-rolls; and means for taking off the strips from the cutting devices and from the corrugating-rolls and for guiding the strips in their passage from the cutting device to the retarding-rolls, substantially as specified.

9. A machine for the simultaneous production of a plurality of transversely-corrugated strips from a continuous sheet of lead or like material consisting of the combination of a pair of intermeshing positively-driven corrugating-rolls; a pair of propelment-rolls positively driven at the same peripheral speed as the mean peripheral speed of the corrugating-rolls; a pair of retarding-rolls positively driven at a less peripheral speed than the propelment-rolls; a pair of accelerating-rolls positively driven at a greater peripheral speed than the retarding-rolls; a cutting device for longitudinally dividing the sheet before it enters between the corrugating-rolls; means for taking off the strips from the cutting devices and from the corrugating-rolls and for guiding the strips in their passage from the cutting device to the retarding-rolls; and an intermittently-actuated cutting device for severing predetermined lengths from all the corrugated strips simultaneously.

10. The combination with a machine for the continuous production of transversely-corrugated sheet-lead of a device for severing pre-

determined lengths from the sheet consisting of a pair of bed-cutters between which the corrugated sheet is caused to pass, and of a double-acting guillotine-knife mounted to act against the one and the other of the bed-cutters alternately and operated intermittently in opposite directions so as to coact alternately with the respective bed-cutters, substantially as specified.

11. The combination with a machine for the continuous production of transversely-corrugated sheet-lead, of a device for severing predetermined lengths from the sheet consisting of a pair of bed-cutters between which the corrugated sheet is caused to pass, and of a double-acting guillotine-knife mounted to act against the one and the other of the bed-cutters alternately and operated intermittently in opposite directions by a rock-lever, said rock-lever being forced in opposite directions alternately by a spring carried by a vibrating arm and alternately held at opposite extremities of its angular movement and released therefrom by a cam, substantially as specified.

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Witnesses:
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F. L. RAND.