Oct. 28, 1930. R. A. LEWIS ET AL 1,779,607

METHOD OF FORMING METAL BODIES

Filed April 11, 1927 4 Sheets-Sheet 1

Fig. 1.

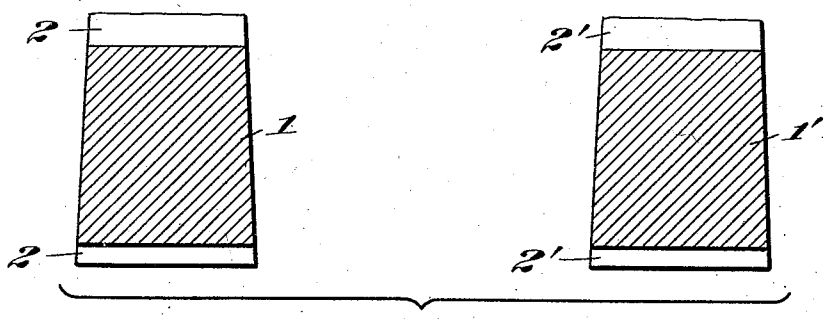


Fig. 2.

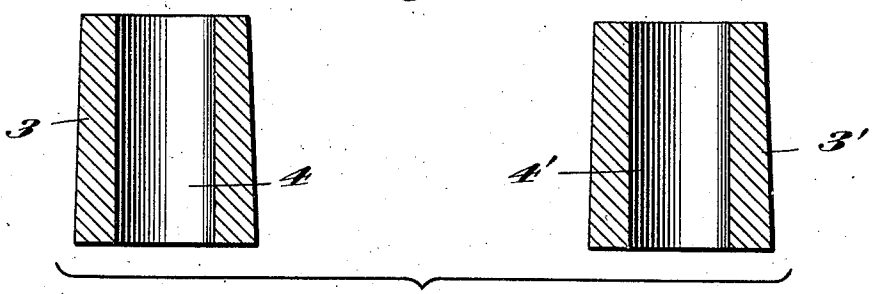
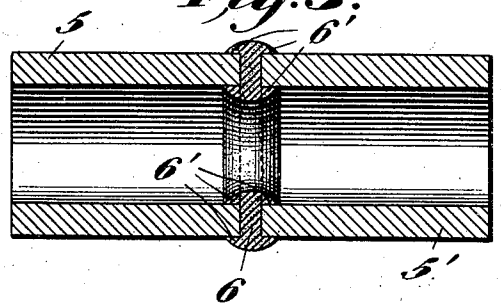


Fig. 3.



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Fig. 4.

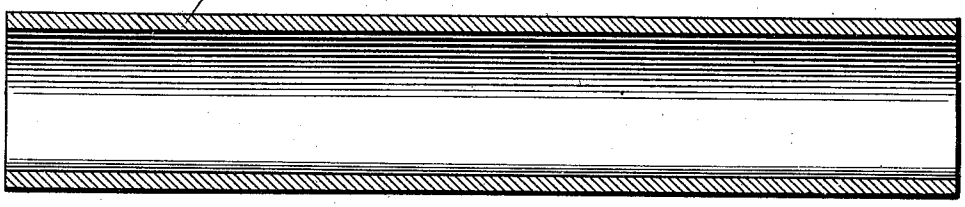


Fig. 5.

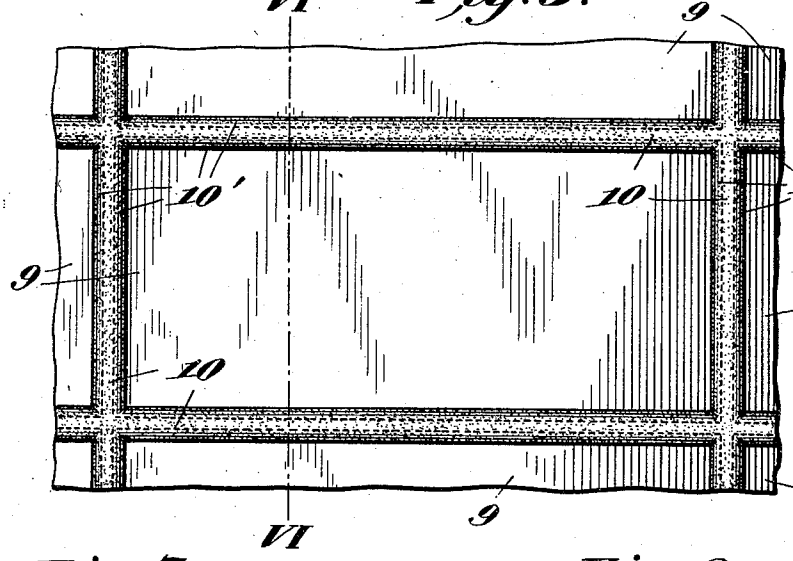


Fig. 6.

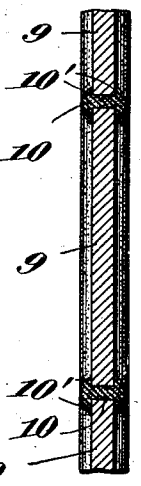


Fig. 7.

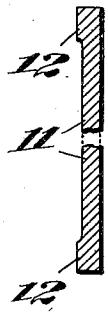
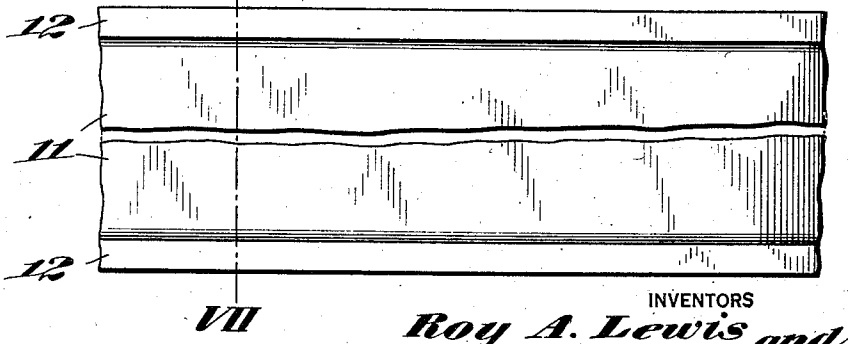


Fig. 8.



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METHOD OF FORMING METAL BODIES

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Fig. 9.

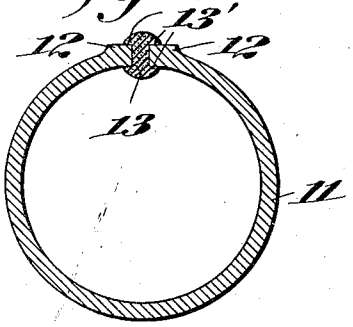


Fig. 10.

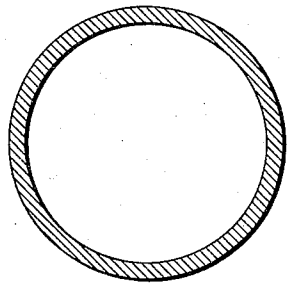


Fig. 11.

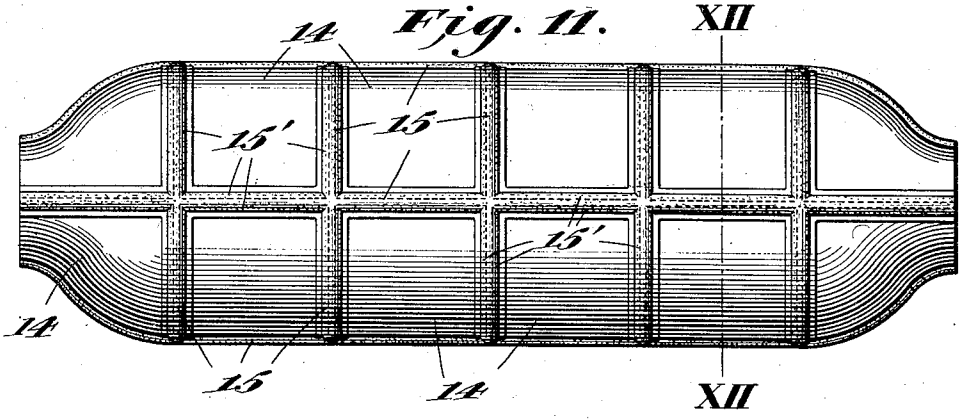


Fig. 12.

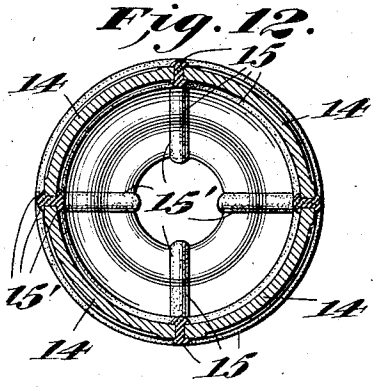
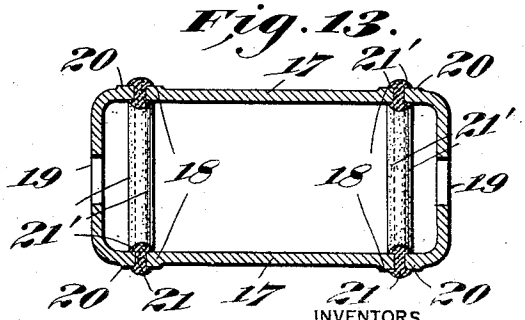


Fig. 13.



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METHOD OF FORMING METAL BODIES

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Fig. 14.

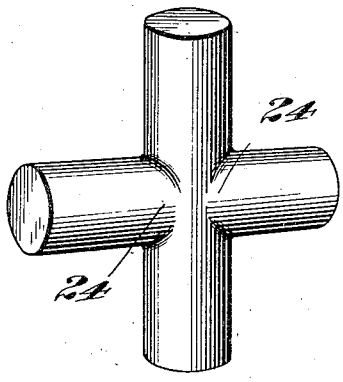


Fig. 15.

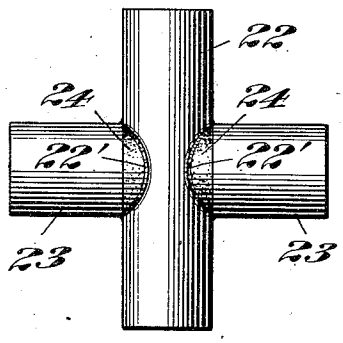


Fig. 16.

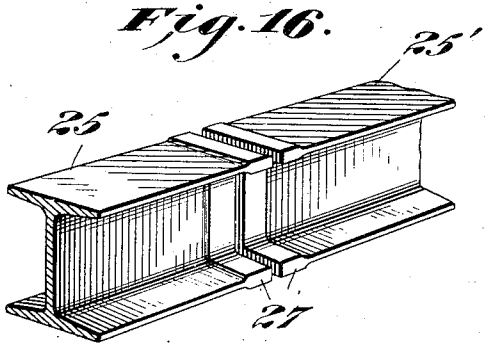


Fig. 17.

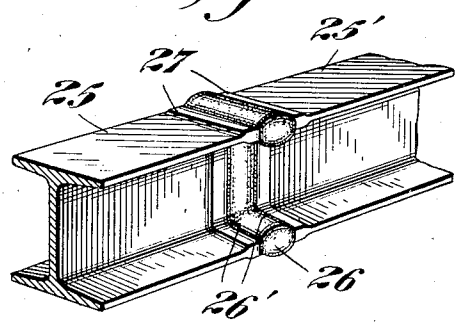
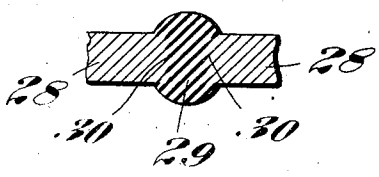


Fig. 18.



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UNITED STATES PATENT OFFICE

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METHOD OF FORMING METAL BODIES

Application filed April 11, 1927. Serial No. 182,881.

Our invention is directed to the production of shaped metal bodies, either of large size or of complicated form, the material of which is to have the characteristics of worked metal.

In the ordinary methods of shaping metals, whether by casting or by mechanical working the difficulties increase both with size and with complexity of form. Many exceedingly ingenious devices have been devised for solving the problem by casting, where intricacy of form only is involved, but such expedients are obviously very expensive. Moreover, as is well known, cast metal does not have the advantageous qualities possessed by bodies which have been subjected to mechanical working, whether it be forging, rolling, pressing, or any other equivalent kneading-like operation.

When it comes to the problem of great size, the difficulties are still harder to overcome. In fact, there are distinct limits to practice as it is conducted at present beyond which it is impossible to go. The capacities of the various apparatus used have distinct limitations which impose definite limits to the size of bodies which can be cast. For example, cranes, open hearth furnaces, pits, ingot moulds, etc., in ordinary practice are of certain capacities which cannot be easily exceeded. Even if certain of these devices could be made of greater size or capacity, such changes in practice would be decidedly costly, and the utility to be derived from such innovations would be problematical.

As casting is an essential step in the preparation of any large object, even though later on the cast material is to be worked, the handicap in the manufacture of exceedingly large objects is readily apparent.

As an example of what is now being done in the way of making large objects of steel, and the obstacles in the way of increasing the size thereof, consider the following: It is very desirable to make very large tublar vessels to be used in certain chemical and physical operations, as, for example, distilling. Such bodies must be capable of resisting great stresses and accordingly should be made of worked metal. In addition it is desirable that there be very few joints, it being preferable that the object be one-piece if possible. Vessels of this sort have been made weighing 125 tons. To make one of this size, an ingot of 250 tons is cast; this is pierced and enlarged by working on presses, and then forged, while hot, to a length of from 50 to 55 feet.

Making bodies of this great weight, or those of a considerably lesser weight even, is an extremely arduous undertaking; the equipment is cumbersome and expensive; it is subjected to great strain and wear; and the labor costs are high.

To go substantially higher in weight, under present practice, is nearly impossible. Yet science and the arts demand tubular or other shaped bodies of a much greater size, even multiples of the present maximum weight, which are wholly outside the means of present equipment. The primary purpose of our invention is to solve these difficulties, whether due to size or complexity of form, and to secure objects which have the desirable characteristics of worked metal.

We attain this end by casting the metal which is to enter the object in several ingots, instead of in one as at present, next working the ingots to partially reduce and shape them, then positioning these worked body elements adjacent each other and joining them by casting material of approximately the same composition as these body elements between adjacent portions thereof, and finally working the entire blank thus resulting to the proper dimensions. Consequently, we escape the restriction imposed by the limited amount of metal which may be obtained in any one casting, by the device of making several, distinct castings, each to contain but a fraction of the total metal to be in the finished body. Moreover, since the entire blank is worked the resulting body possesses the characteristics of worked metal throughout. By this method, the joints between the separate body elements are practically or completely eliminated, the cast material of the joints acquiring the same general physical characteristics as the remainder of the body.

Of course, the broad idea is not new with

us of joining one piece of metal to another piece of metal by a casting operation, and working the resulting body. This is old in the well known composite metal art where one metal is joined to a different metal by casting or some other operation and the resulting composite metal forged or rolled to obtain a body having certain of the advantageous characteristics of both metals. It is also old to weld one element to another and to hammer the joint. But, so far as we know, the prior art does not disclose the formation of an extremely large or intricate body by building up such a body by means of separate elements thereof, joining them and then so working as to make a practically one-piece, uniform body having the characteristics of worked metal throughout.

Accordingly, our invention broadly consists in forming several body elements, positioning these elements adjacent to each other, joining them and then working to finished dimensions so that the material thereof is worked throughout. More specifically, it consists in preparing a plurality of ingots of approximately the same composition, positioning them adjacent each other, casting metal of approximately the same composition between adjacent portions thereof and then mechanically working the resulting blank so that the material of the joints between the original body elements is brought to substantially the same state as that in the remainder of the body.

To illustrate our invention, several embodiments thereof will be briefly described, but it should be clearly understood that the inventive thought is not to be limited by these examples except as specifically so done by certain of the claims.

Referring to the drawings:

Figs. 1 to 4 inclusive represent our invention as applied to the production of a large tubular body, Fig. 1 showing vertical sections of the cast ingots for forming body elements; Fig. 2 showing these ingots, pierced and enlarged; Fig. 3 showing portions of these body elements joined by means of cast material and Fig. 4 representing the finished tubular body after it has been mechanically worked to the desired dimensions.

Figs. 5 to 10 inclusive, are to illustrate a different mode of building a large tubular body, Fig. 5 showing a plan view of several flat body elements positioned relative to each other and joined by cast material; Fig. 6 showing a cross section through line VI—VI of Fig. 5; Fig. 7 giving a cross sectional view of the plate, with upset edges, prepared from the blank of the preceding figures; Fig. 8 giving a plan view of the same body; Fig. 9 presenting a cross sectional view of the body of Fig. 8, bent so that the upset ends are adjacent to each other, and joined by material cast therebetween; and Fig. 10 showing a cross sectional view of this body taken through the cast joint when worked to finished form.

Figs. 11 and 12 show, respectively, a cross section and a longitudinal view of a cylindrical blank made up of curved body elements joined by material cast therebetween, prior to the final reduction.

Fig. 13 shows a longitudinal section of a blank indicating the application of our invention to the joining of heads to a shell in the formation of a boiler drum.

Figs. 14 and 15 represent respectively, a perspective view of a forged T and a cross sectional view of the blank before the final forging, showing the separate elements of the T joined by the cast material.

Figs. 16 and 17 represent our invention applied to the joining of beams, Fig. 16 showing two beams positioned end to end, preliminary to joining; and Fig. 17 showing the beams joined by metal cast therebetween, preliminary to the ultimate mechanical working.

Fig. 18 represents a joint between two body elements, indicating that there is more or less interpenetration of the cast metal and that of the adjacent portions of the united elements.

First describing the invention as illustrated in Figures 1 to 4 inclusive: In constructing the tubular body 7 shown in Fig. 4, the ingots 1 and 1′ are first cast, having a combined weight of say 500 tons after the top and bottom discards 2 and 2′ have been made, to eliminate the defective material. The ingots are blocked to flatten the ends and are then pierced.

Next the pierced ingots are press forged on an enlarging bar to increase their dimensions including the diameter of the opening. The treatment thus far of each ingot is substantially the same as in present practice.

Following this, the resulting bodies 3 and 3′, having the openings 4 and 4′, are hot worked, as by forging on a mandrel, to reduce the material and lengthen to a substantial degree but less than is desired for the finished body.

The resulting body elements 5 and 5′ are positioned end to end adjacent to each other and joined by casting material of substantially the same composition as that of the body elements therebetween. This may be effectively done by means of the ordinary "thermite" casting. The joint 6 produced as a result of this step should be thicker than the walls of the body elements, portions 6′ overlapping the adjacent regions of the body elements. The blank thus produced is then subjected to a forging operation by ordinary practice, reducing the entire mass of the blank, including the joint 6 to form the finished body 7 indicated in Fig. 4.

As a result of this final working and reduction the material of the body is substantially

uniform throughout, the joints as such being practically eliminated. It will be noted that the casting of the joints 6, thicker than the walls of elements 5 and 5′, necessitates the joints being given a greater amount of working during the final reduction than is given during that step to the body elements 5 and 5′. For best results this is necessary in view of the fact that the only mechanical working which the joints receive is during the final step whereas the body elements have already been subjected to a working and partial reduction in a preceding step. This mode of procedure promotes the effective elimination of the joint as such and produces a substantially uniform structure of the metal.

Obviously more than two body elements may be involved and they may be of substantially different sizes than here specified. Advantageously, for many purposes, much smaller ingots may be cast, using a correspondingly greater number thereof.

In Figs. 5 to 10 inclusive, we show how our invention may be utilized in two different ways in the manufacture of a large tubular body. First, a plurality of body elements are joined and worked in accordance with the principles of our invention to form a more or less flat structure; this is curved to tubular shape, and then the principles of our invention are again applied in joining the adjacent edges, and in working the joint to produce the finished body.

As shown in Figs. 5 and 6, a plurality of plate like elements 9, which have been previously worked are positioned adjacent each other and joined by casting, as indicated at 10 to form a large sheet. As in the preceding embodiment of our invention, the joints are provided with the overlapping portions 10′. The resulting blank is now worked, as by forging or rolling so as to reduce the material of the entire mass thereof, whereby the joints are eliminated as in the preceding example and a flat body 11 is produced, the material of which is substantially uniform throughout.

While, for the purpose of illustrating our invention, this flat body, thus produced is further treated to make a tubular body, it is obvious that this kind of body may have other utilities. It may be altered in shape as will shortly be indicated, or it may be used unchanged, as a flat, plate-like body. So far as our actual invention broadly is concerned, it may be considered to be a finished body, regardless of how it is subsequently utilized.

Returning to our illustration, the sides of this plate 11 are now upset as indicated at 12. Next this sheet 11 is bent to tubular form, the upset portions 12 being brought adjacent to each other and joined by a thermitic casting as indicated at 13, the cast material of the joint overlapping, as indicated at 13′, the adjacent portions of body 11. The resulting blank is subjected to mechanical working, as forging, at the joint and the enlarged portions 12 of body 11, until the material thereof has been reduced to the same degree as the remaining portions of body 11.

In thus joining the two portions of body 11, it will be noted that the principle of the invention is employed in that the metal of both the joined portions and the cast material are simultaneously worked so as to practically eliminate the joint as such. In this case, as in the preceding examples, the assembled materials are simultaneously worked and reduced to make them substantially uniform both in structure and in properties.

A variation of the process just described is illustrated in Figs. 11 and 12. Instead of joining a plurality of worked sheets and then bending the resulting product as shown in Figs. 5 to 10, in this variation a series of body elements 14 in the form of curved heavy plates or slabs are positioned relative to each other as indicated in these figures. They are then joined by casting as in the preceding examples, here as there, the cast joints 15 being provided with the overlapping bead 15′. The entire structure is then forged, or mechanically worked in any other way, to reduce both the plates and the joints to produce a uniform condition of material throughout the body.

The method of union of two parts such as is indicated in Fig. 10 may be utilized to join two previously formed elements. Here this mode of procedure is applied to the fastening of heads to boiler drums. The method commonly employed heretofore, has been to rivet these parts together, but due to the large size now demanded and the necessarily increased thickness of the shells of these drums, rivets are becoming more and more unsafe. In accordance with our invention the shell 17, preferably prepared in accordance with the methods of preceding examples, is provided with thickened or upset portions 18. Shells 19 provided with correspondingly thickened portions 20 are disposed at the ends of shell 17 the thickened portions of these bodies being adjacent to each other. They are then joined by thermitically casting metal of substantially the same composition as that of the united elements to form joints 21, having portions 21′ partially overlapping the thickened portions 18 and 20. The joints are now forged to reduce both the cast material and that of the thickened portions of the body elements. Thus is produced a boiler drum having heads integral with the rest of the shell,—virtually a one-piece body.

The examples already given have been primarily directed to the solution of the problem of great size in worked bodies. The method however is equally applicable to the

solution of difficulties incident to the forming of special shaped bodies. Heretofore, to prepare an object of a shape such as shown in Fig. 14 it was necessary either to cast it, with the consequent defects of metal structure and unsatisfactory physical characteristics inherent in bodies so produced, or to prepare it by a drop forge process in which enormous pressure would be necessary in order to force the material into all portions of properly shaped dies. By means of our invention it is possible to utilize the convenience of casting parts of such a body and then so joining such parts as to get the advantages of worked structure.

Referring to Fig. 15, separate body elements 22 and 23 are cast, element 22 being provided with the concave depressions 22′. These elements are preferably mechanically worked to reduce them to a certain extent but to a size less than that desired in the finished body. Elements 23 are then placed adjacent element 22 and material of substantially the same composition thermitically cast to form the joint 24. The resulting blank is then forged to reduce the material of both the joints and body elements so as to produce the finished body, substantially uniform throughout.

More or less finished structural elements, as beams, girders and the like may be united, utilizing the principles of our invention. In Figs. 16 and 17, we show the uniting of beams 25 and 25′. As in the methods shown in Figs. 10, 12 and 14, the adjacent parts of the members to be joined are provided with the thickened portions 27. Metal is then cast at 26 to join the members, there being the overlapping portions 26′. The joint thus produced is mechanically worked as in the preceding examples to produce a uniform condition of the material, the joint being partially eliminated. While we have here illustrated the union of two beams which are in a finished or nearly finished state, it is obvious that the body elements might have been joined when they were at a stage much less finished than that shown. For example, real advantages would accrue from joining bloom blanks, by the method just outlined, and then working the entire structure thus resulting to fashion the finished product.

In joining the body elements, in any application of our invention, the metal cast between them should be highly heated in order that a sound casting be produced, homogeneous and thoroughly united to the metal of the adjacent portions of the body elements. This may be advantageously done, as already indicated, by utilization of the aluminothermic type of reaction. In view of the fact that casting operations involving the use of this reaction are so well known, details will not be presented here.

In Figs. 3, 6, 9, 12 and 13 a sharp line of demarcation is given between the representation of the cast metal and that of the joined body elements. This is done merely for clearly showing the general relationship of parts, and obviously does not correspond to the actual physical state thereof. Fig. 18 is intended to indicate that the cast metal 29 is confluent at 30 with the metal of body elements 28.

While the composition of the steel, or other metal, cast between the body elements to join them will usually be as closely as possible like that of the elements themselves, obviously for some purposes it may be desirable to alter it somewhat; in some cases to a substantial degree even.

Then too, while the composition of the different body elements will usually be the same, it is within the spirit of our invention to vary them appreciably.

It is desired to clearly differentiate between our invention and the processes involved in making composite metal structures. The purposes of those processes are different from those of this invention. There, as above indicated, it is desired to obtain a composite material having the combined attributes of the several components. Here, the object is to build up a large or complicated structure by means of several elements. Whether or not these several elements have the same composition or not the significant relationship between them is spatial, and not as component parts of one material, as in the composite metal art.

The essential feature of our invention is that the ultimate body or object is made by assembling several body elements, joining them, as by depositing metal between them, and then so working the blank as to produce a body, the material of which will have the physical characteristics of worked metal and in which the joints as a distinct structure have been eliminated. By this it is not meant that the original joints might not be determinable, as for example by metalligrophic observation, but it is intended to mean that for all essential and practical purposes the material of the joints has been brought into the same condition as that of the remaining portions of the body.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. A process for forming a worked metallic body, comprising the steps of positioning a plurality of metal body elements adjacent to each other, casting metal between the adjacent portions thereof to join them and thereby form a blank of approximately the desired form of the finished body, and then mechanically working the entire blank including the metal of the joints.

2. A process for forming a worked metal-

lic body, comprising the steps of positioning a plurality of metal body elements of approximately the same composition, adjacent to each other, casting metal of approximately the same composition as the bodies, between the adjacent portions thereof to unite them and thereby form a blank of approximately the desired form of the finished body, and then mechanically working the entire blank including the metal of the joints.

3. A process for forming a worked steel body, comprising positioning a plurality of metal body elements adjacent to each other, these bodies having approximately the same composition, casting metal by a thermite reaction between the adjacent portions thereof to join them and thereby form a blank of approximately the desired form of the finished body, and then forging the blank including the joints to finished form.

4. A process for forming a worked, metallic body, comprising the steps of forming a plurality of metallic body elements, mechanically working these body elements to reduce them to a degree less than that desired in the finished structure, positioning them adjacent to each other, casting metal between the adjacent portions thereof to join them and thereby form a blank of approximately the desired form of the finished body, and then mechanically working the entire blank including the joints to finished form.

5. A process for forming a worked, metal body, comprising the steps of positioning a plurality of metal body elements of approximately the same composition, adjacent to each other, casting metal of approximately the same composition as the bodies between the adjacent portions thereof to unite them to form a blank of approximately the same form as that of the finished structure, such cast joints being of greater thickness than the body elements, and then reducing the entire material of the blanks to form the finished structure.

6. A process for forming a worked, metallic body, comprising the steps of mechanically working a plurality of metal body elements to reduce them, the body elements having approximately the same composition, positioning them adjacent to each other, casting metal of approximately the same composition as the body elements between adjacent portions thereof to unite them, the cast joints being of greater thickness than the bodies, and then working the entire material of the blank.

7. The process of uniting two metallic bodies comprising the steps of positioning one body adjacent to the other, the adjacent portions of these bodies being larger than they are to be in the finished structure, casting metal between the adjacent portions of the two bodies to join them, and mechanically working the joint and adjacent portions to reduce to the desired size.

8. A process of forming seamless, tubular, steel bodies, comprising the steps of casting ingots of metal of approximately the same composition, piercing these ingots, mechanically working to form tubular blanks, positioning the blanks end to end, adjacent to each other, casting steel of the same composition between adjacent blanks to join them, the cast joints being thicker than the adjoining material of the blanks, and then mechanically working the tubular body throughout its mass to reduce it to the desired dimensions.

9. A process of forming seamless, tubular, bodies, comprising the steps of casting ingots of approximately the same composition, piercing these ingots, forging to form tubular blanks, positioning the blanks end to end adjacent to each other, casting by means of a thermite reaction, metal of approximately the same composition between adjacent blanks to join them, the cast joints being thicker than the adjacent material of the blanks, and then forging the body thus produced throughout its mass and reducing to the desired dimensions.

10. A process of forming a metallic body, comprising the steps of mechanically working a plurality of metal body elements to reduce them, positioning them adjacent to each other in substantially the same relation to each other that they are to have in the finished body, joining them to form a blank of approximately the form of the finished body, and mechanically working the blank to reduce the material thereof, the material of the joint and adjacent portions of the bodies being reduced to a greater degree than the remaining portions.

In testimony whereof we hereunto affix our signatures.

ROY A. LEWIS.
JOHN M. SYLVESTER.