

June 26, 1928.

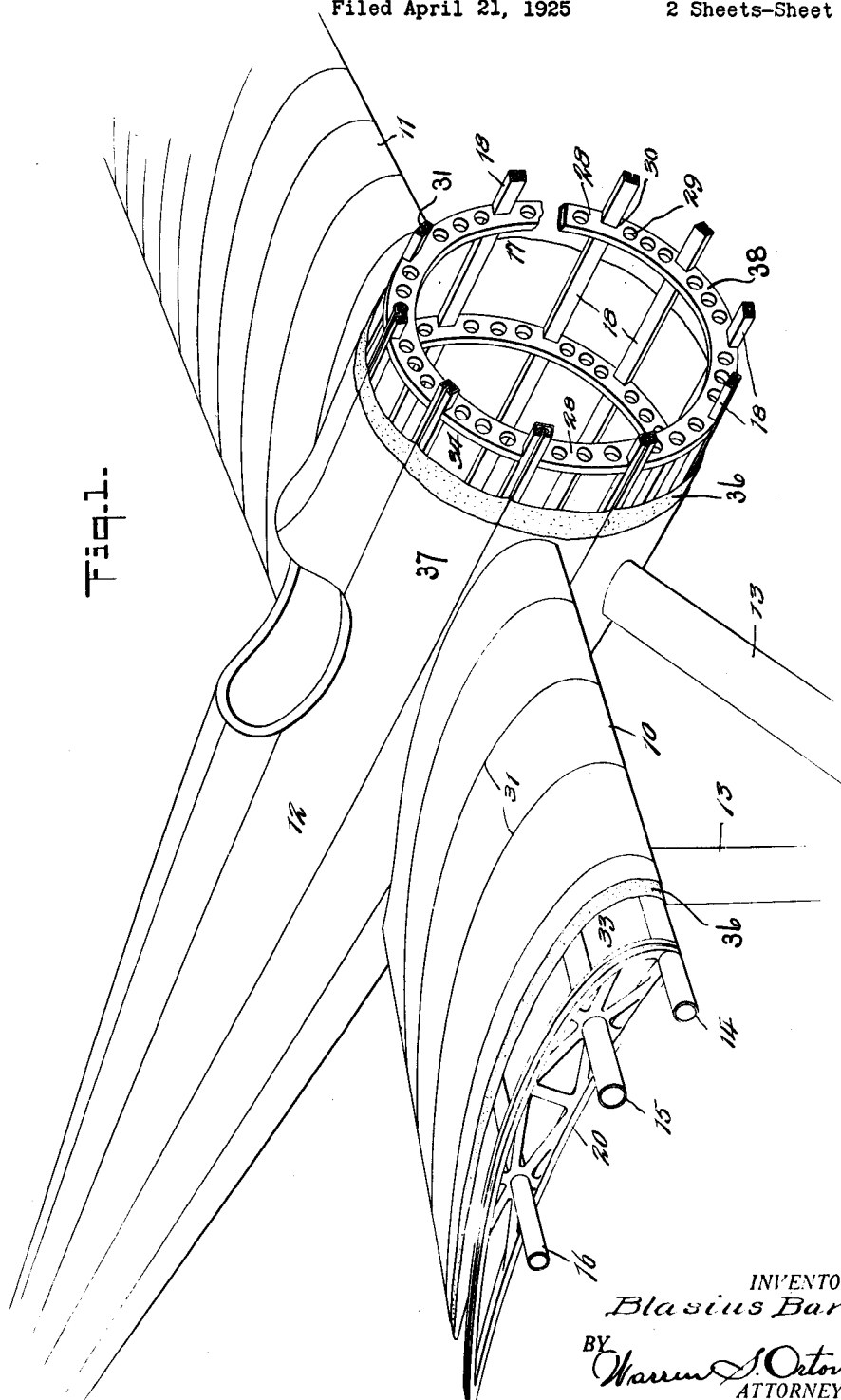
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B. BART

METAL AEROPLANE

Filed April 21, 1925

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

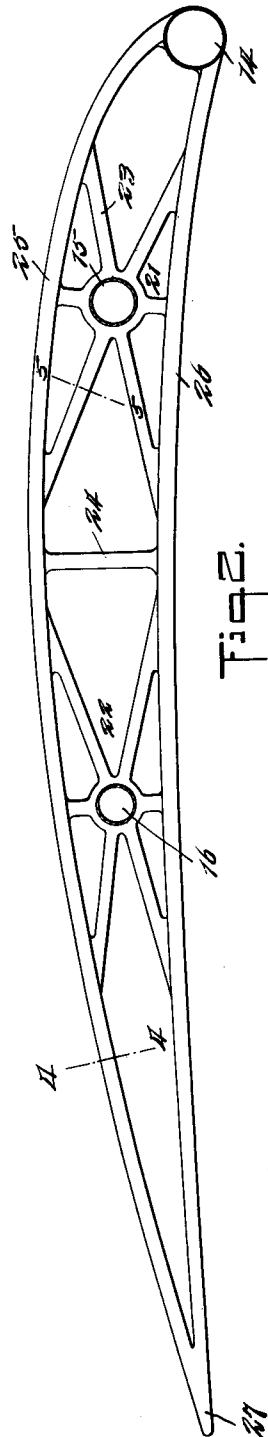


Fig. 2.

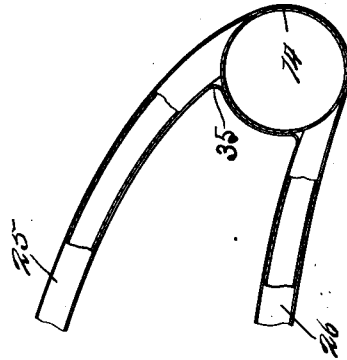


Fig. 3.

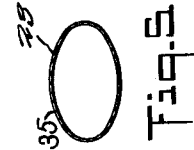


Fig. 5.

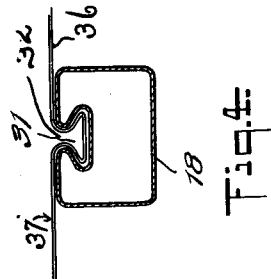


Fig. 4.

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METAL AEROPLANE.

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The invention relates to a method of forming hollow, internally reinforced structural units, and also to the units produced by the practicing of the method herein featured.

5 Due to the peculiar adaptability of the method to the construction of units which require lightness in weight with a high degree of structural strength compared to the amount of material used, the invention will
10 be described with specific reference to the wings, fuselage and other parts of an aeroplane, hereinafter identified collectively by the term aerofoil.

It is understood, however, that the invention is not specifically limited to aeroplane
15 constructions but may be practiced wherever a light, metallic, thin shelled construction is desired.

The primary object of the invention is to
20 provide an improved method for economically forming metallic structural units of any desired configuration and particularly for forming complicated or irregularly shaped bodies which may be of hollow construction to feature lightness in weight.
25

In its relation to a reinforced structural unit the invention has for an object the providing of the component parts of a reinforcing frame as separate units, and the securing of the parts permanently in fixed
30 relation as an incident of a metal depositing step which gives configuration to the fabricated unit as a whole.

Another object of the invention is to provide a fabricated structural unit which may
35 be complicated in design and provided with attachments and reinforcements secured in their co-related positions without the use of fastening means other than the elements required to provide the parts necessary to form the unit itself.
40

Another object of the invention is to provide an all metal, one piece aeroplane and/or to provide an aeroplane the aerofoils and
45 other major structural parts of which are each formed as a one piece unit and which parts are assembled free, or at least substantially free, of any fastening means.

Another object of the invention and referring particularly to the aerofoil features of the disclosure is to provide a stream lined unit, the surface of which will be in one piece and the exterior surface of which will be defined by the smooth surface characterizing
50 metallic deposits when formed electrolytically.
55

Referring to the structural features of the disclosure an object of the invention is to provide a simple form of reinforced, hollow structural unit, fabricated from units which
60 are also hollow and all of which units are designed to resist the distorting action of strains to which such units are subjected while in use, and which units as a whole will be formed of less material and therefore
65 lighter than similar constructions now known.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosure and from an inspection of the
70 accompanying drawings, and in part will be more fully set forth in the following particular description of one method of practicing the invention and in the inspection of
75 an aeroplane embodying certain mechanical features of my invention, and the invention also consists in certain new and novel modifications of the preferred method and other features of construction and combination of
80 parts hereinafter set forth and claimed.

In the accompanying drawing there is illustrated in diagrammatic form an aeroplane illustrating an instrumentality by means of which the method aspect of the invention may be practiced and also illustrating a preferred embodiment of the mechanical aspect of the invention.
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Figure 1 is a view partially in perspective of an aeroplane with parts of one of
90 the wings and parts of the fuselage broken away to show internal construction of an aeroplane fabricated by following the method hereinafter described;

Figure 2 is a view in side elevation of one
95 of the wing reinforcement units;

Figure 3 is an enlarged sectional view of the corresponding parts shown at the right hand side of Figure 2 with parts broken
100 away to show the hollow character of the component parts; and

Figures 4 and 5 are each detailed transverse sectional views taken respectively on the lines 4—4 and 5—5 of Figure 2.

In the following description and in the
105 claims, parts will be identified by specific names for convenience of expression but they are intended to be as generic in their application to similar parts as the art will permit.
110

In its general outline it is intended that the aeroplane illustrated in Figure 1 fol-

lows conventional design and include laterally extending wings 10 and 11, a longitudinally extending fuselage 12 therebetween and with vertically disposed braces 13 to connect with other associated structures, such as another similar plane where the device is intended to illustrate a bi-plane.

Referring either to the fuselage or to the wings, or even to the struts, it is to be understood that each of these component elements are separately formed as hereinafter described, assembled in their proper relative position and subjected as a whole to the metal depositing action of an electrolytic tank, so that there is finally formed, a unitary, one piece shell covering whatever may be desired of the entire structure.

Referring first to the wings 10 or 11, it will be noted that they are of similar construction and each includes three tubular members or rods extending transversely of the plane as a whole and longitudinally of its associated wings and numbered from front to rear, 14, 15 and 16. These members are circular in cross section and of varying diameter to meet the requirement of strains which they are designed to meet. These rods are formed by depositing on a suitable former, such as celluloid rod of the proper diameter, a coating of material, such as graphite or metal to prepare the surface to receive the coating of metal deposited thereon by the action of an electrolytic tank. The celluloid rod so coated is positioned in a tank, preferably containing nickel or copper electrolyte, and a thin shell of the desired metal is permitted to form on the cylindrical surface of the rod. It has been found in practice that this deposit can be extremely thin and it is herein suggested that a thickness of 0.0003 inches be formed. By gently heating the coated rods after they have been removed from the electrolytic tank, the coating and metallic shells will expand sufficient to permit the withdrawal of the celluloid rods edgewise from the formed tubing.

It is noted that the fuselage 12 is provided with an internal reinforcement 17 which includes a plurality of parallel longitudinally extending hollow tubes 18, which are not circular in cross section as is the case of the tubes used in the fabrication of the reinforcement for the wings. The tubes 18 are formed on a suitably shaped celluloid former in the same manner as has been described for the formation of the cylindrical reinforcing members and in general it will be understood that the several structural parts will be started on permanent formers whenever possible.

Reverting to the description of the wing reinforcement, it is noted that a plurality of longitudinally extending frames 20 are mounted in transversely spaced relation on

the rods 14, 15 and 16. For the most part these frames are each formed of a pair of spiders arranged in tandem with one spider 21 carried on the tube 15 and the other spider 22 similarly mounted on the tube 16. These spiders are formed as separate units and afterwards mounted on the tubes as hereinafter described.

In forming these spiders and in fact in forming any other unit having an irregularly shaped configuration which does not permit of the endwise withdrawal of the former, suitable castings are prepared to give the desired configuration. These castings are preferably formed of a non-conducting and easily meltable substance, such as wax. The wax formers are first treated by covering the same with graphite in order to receive an electrolytically deposited metal and are then positioned in the electrolytic tank and subjected to the deposition of a thin coating of nickel or copper. A deposit of the desired thickness is permitted to form on the prepared former and after suitable apertures have been made in the shell so formed, the units are gently heated to permit the wax to melt and drain therefrom.

It is preferable in designing all of the units to form the same in so far as is possible with rounded edges and in this connection it is noted that the cross section 23 of the spider is elliptical as noted in Figure 5. Making the units of greater depth than width has been found to be particularly efficacious in withstanding the strains imposed by wind pressures on the aerofoils and it is suggested that the different parts be disposed with their major axes in the plane of the line of thrust on the aerofoil. In addition to the spider shaped reinforcing units certain other units may be used and as an illustration reference is made to vertical post 24, which due to the fact that it is opened at opposite ends may be formed on a fixed shaped former such as the celluloid mentioned in the formation of the other tubes.

The wing reinforcement is outlined, top and bottom, by an upper convexly shaped stream line strut 25 and a lower slightly concaved stream lined strut 26 meeting at the tail end 27 to form the conventional configuration usual in wing constructions of aeroplanes.

The reinforcement for the wing is fabricated by assembling the necessary number of longitudinal frames on the tubes 14, 15 and 16. This is done by slipping the spiders 21 in spaced relation along the rod 15, and the spiders 22 in similar relation along the rod 16, with a spider 21 in alignment with a spider 22. The frame formed by the struts 25 and 26 are located in the plane of their respective spiders and enclosing the

same with the open end containing the forward tube 14. In order to prevent accidental slipping of the parts when so located it is suggested that they be temporarily secured in place which can be done most conveniently by spot-welding the parts at one or more points along their lines of jointure. The wing reinforcement thus fabricated is positioned in an electrolytic bath preferably of nickel and a metal deposit permitted to enclose the parts in a thin shell 35. This enclosing shell acts not only to form a one piece, homogeneous surface over the several parts of the frame but acts additionally to secure the parts in fixed position. There is effected an electrolytic welding of the parts in position to form the skeleton reinforcing frame.

In the instant case the fuselage is formed of a series of circular hollow rings 28 disposed in parallel and spaced apart longitudinally on the tubular members 18. These circular members 28 are formed similar to the manner described for the formation of the spiders. A circular wax form is molded and which wax form is preferably perforated so that the resulting units will be provided with apertures 29 extending there-through and additionally assisting to give rigidity to the structure and tend to defeat the distorting action of bending stresses. The wax form is coated with graphite, deposited in an electrolytic bath and a coating 38, preferably of nickel, forms on the exposed surface. The form is heated and through suitably formed wax outlets and air inlets the wax or other material used in molding the former is drained from the resulting hollow, ring like reinforcing element shown at 28.

In assembling the frame for the fuselage the reinforcing members 18 are set into recesses 30 formed in circumferentially spaced apart position on the outer periphery of the ring 28 and are temporarily secured preferably by means of spot welding as hereinbefore suggested. In order to form a keyway for locking the final coating shell to the reinforcement it is suggested that the outer side of certain of the units, such as tubes 18 and the struts 25 and 26 be provided with a locking groove 31 preferably of the dove tail form shown in Figure 4. This groove is provided with a constricted throat 32 but is of sufficiently large cross section to permit the formation of the final metal skin coating to extend into the groove.

Any other structural unit necessary to form the complete article is similarly constructed. The fundamental constituent part being formed by electrolytic deposition on a suitably shaped former; the several parts assembled in their proper coordinated relation and the units so assembled coated by the depositing action of an electrolytic bath.

There is finally formed a plurality of parts constituting the major units of the aeroplane, automobile, house or other structural unit to which the application of the methods herein described is applicable. These major units are then assembled in their proper relative position and are temporarily fastened together as by welding. In the instant case the reinforcements for the wings 10 and 11 are disposed on opposite sides of the reinforcements for the fuselage 12 and the reinforcing units are secured. In order to give form to the outer skin in the completed article, the interstices and other spaces between the units forming the several skeleton reinforcements are filled with a readily removable former such as wax. For instance, the spaces 33 between the reinforcements in the wing and the spaces 34 between the reinforcements in the fuselage are filled with wax and the exposed side surfaces shaped to the configuration desired of the resulting enclosing shell. The reinforcing frame thus filled with wax is prepared to receive a coating of metal deposited by electrolytic reaction as by coating with graphite. To suggest a method differing from the method hereinbefore suggested of coating the wax with graphite, it is suggested in this case as an alternative, that the entire assembly be sprayed or otherwise coated with an extremely thin coating 36 of metallic silver. On the grounds of economy it is necessary to make this silver sheet extremely thin, and merely sufficient to maintain electric contact over the entire surface. In actual practice a thin film of metallic silver almost invisible has been found to be sufficient.

The entire aeroplane thus formed is positioned in a large sized electrolytic tank and a metallic deposit 37 preferably of copper is permitted to form on the silver or other surface prepared to receive it and this copper shell covers and thus encloses the entire exposed surface. The electroplating action is continued until the desired thickness of metal is formed after which the completed aeroplane is heated to permit the wax, or other substance used in the former, to melt or drain from the enclosing shell as has been suggested in the detailed description of forming the smaller units of the construction.

It is noted that by following the method herein disclosed there is provided a hollow, internally reinforced structural unit formed in its entirety or substantially in its entirety of thin layers of electrolytically deposited metal. A structure is formed which is designed to be of light weight and yet formed to withstand powerful distorting strains. The structure is formed solely of metal shells, substantially of cardboard thickness. There are no rivets or other fas-

tening devices used. The exposed surface has the smoothness of polished metal and this is formed without any polishing or finishing operation whatsoever. There is also provided in the case of the aerofoil illustrated a stream lined surface formed of metal having an extremely low coefficient of frictional resistance to the air. The outlining surface is homogenous, continuous and of a pleasing artistic appearance.

In its application to an aeroplane, automobile or other light vehicle, there is formed an extremely light, rigid, all metal construction having enclosed within its outlining surfaces a skeleton, reinforcing frame providing all necessary rigidity and with all parts positively secured in their preset relative positions.

While I have shown and described, and have pointed out in the annexed claims, certain novel features of my invention, it will be understood that various omissions, substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

Having thus described my invention, I claim:—

1. In the art of forming thin shell, hollow metallic reinforced structural units, the method which consists in forming a plurality of hollow reinforcing members by electrolytic deposition of metal on suitable formers, removing the formers, assembling the members in correlated position to form a skeleton reinforcing frame, temporarily securing the members in such position, subjecting the frame to an electrolytic deposition to completely enclose the members in a homogeneous, continuous and thin film of metal which acts additionally to secure the members permanently in their present positions, assembling a plurality of such frames in spaced relation, temporarily filling the spaces therebetween with a removable former, covering the frame and former with a thin coating of electrolytically deposited metal, and removing the former.

2. In the art of forming thin shell, hollow metallic reinforced structural units, the method which consists in forming a plurality of hollow reinforcing members by electrolytic deposition of metal on suitable formers, removing the formers, assembling the members in correlated position to form a skeleton reinforcing frame, temporarily securing the members in such position, subjecting said frame to an electrolytic deposition to completely enclose the members in a homogeneous, continuous and thin film of metal which acts additionally to secure the members permanently in their preset positions, assembling a plurality of such frames in spaced relation, temporarily filling the

spaces therebetween with a removable former and covering the frame and former with a thin coating of electrolytically deposited metal.

3. In the art of forming thin shell, hollow metallic reinforced structural units, the method which consists in forming a plurality of hollow reinforcing members by electrolytic deposition of metal on suitable formers, removing the formers, assembling the members in correlated position to form a skeleton reinforcing frame, temporarily securing the members in such position, and subjecting the frame to an electrolytic deposition to completely enclose the members in a homogeneous, continuous and thin film of metal which acts additionally to secure the members permanently in their preset positions.

4. In the art of forming thin shell, hollow metallic reinforced structural units, the method which consists in forming a plurality of hollow reinforcing members by electrolytic deposition of metal on suitable formers, removing the formers, assembling the members in correlated position to form a skeleton reinforcing frame, temporarily securing the members in such position, subjecting the frame to an electrolytic deposition to completely enclose the members in a homogeneous, continuous and thin film of metal which acts additionally to secure the members permanently in their preset positions, assembling a plurality of such frames in spaced relation, temporarily filling the spaces therebetween with a removable former and covering the frame and former with a thin coating of electrolytically deposited metal, said coating being connected electrolytically to the frames.

5. In the art of forming a reinforced, hollow structural unit, the method which consists in assembling in their proper relative position the reinforcing elements of said unit, welding the same to temporarily secure them in such relative position, forming within the outlines of the assembly so formed a temporarily outlining surface to define the configuration of the final surface, depositing a layer of metal on said temporary surface to coat the same, subjecting the assembly so coated to the metallic depositing action of an electrolytic bath to cover the temporary outlining surface and to enclose the reinforcing assembly.

6. In the art of forming a reinforced, hollow metal structure, the method which consists in filling the interstices of a hollow reinforcing frame with a removable former shaped to define the configuration of the desired final outlining surface, coating said former surface with a metallic coating, subjecting the surface so coated to the metal depositing action of an electrolytic bath and removing the temporary former.

7. In the art of forming a reinforced, hollow metal structure, the method which consists in filling the interstices of a hollow reinforcing frame with wax, while leaving some of the frame exposed, coating the exposed surface of the wax with a metallic coating, subjecting the assembly so formed to the metal depositing action of an electrolytic bath, and heating the resulting structure to remove the wax.

8. In the art of forming hollow internally reinforced structural units, free of fastening means, the method which consists in assembling a skeleton reinforcing frame, filling the interstices thereof with a moldable former shaped to give the configuration desired of the resulting structure, treating the former surface to receive a metal coating by electrolytic deposition, subjecting the assembly so formed to the metal depositing action of an electrolytic bath to form a metal layer secured electrolytically to the frame, and removing the former.

9. In the art of forming stream lined aerofoils, the method which consists in providing a suitable reinforcement, filling the spaces within the reinforcements with a former, subjecting the same to the metal depositing action of an electrolytic bath to form a one piece thin metal shell of the desired configuration enclosing the reinforcement, and presenting an external stream line surface free of projections and fastening means.

10. In a structural unit, the combination of a fabricated internal reinforcement comprising hollow component parts electrolytically welded and a covering of electrolytically deposited metal connected to the reinforcement.

11. An aerofoil having a wind pressure receiving surface formed of copper, deposited electrolytically on a layer of silver.

12. In an aeroplane, a fabricated hollow structural part thereof including a plurality of units cooperatively associated to perform their intended functions, certain of said units being hollow, and the entire structure being formed integrally in one metallic piece.

13. In a device of the class described, the combination of an internal metallic reinforcement

of skeleton form and an enclosing metallic shell of electrolytically deposited metal, the enclosing shell being electrolytically welded to the reinforcement incidental to its disposition and being otherwise free of fastening means.

14. A structural unit including a metallic skeleton, internal reinforcing frame, a one piece metal shell enclosing the reinforcement, said shell being of electrolytically deposited metal, one piece, free of fastening means, smooth on its outer side and connected integrally with the skeleton frame to secure the parts thereof in their present relative positions.

15. A hollow aerofoil comprising a plurality of component parts each complete per se and constituting a fabricated metallic reinforcement and an enclosing thin shell of electrolytically deposited metal acting to secure the parts in fixed position relative to each other and thus cause the component parts forming the metallic reinforcement to brace themselves vertically.

16. A hollow aerofoil having hollow internal reinforcing elements and having its exposed surface defined by a one piece homogeneous coating of electrolytically deposited metal and having such rigidity as characterizes aerofoils used in aeroplanes.

17. An aerofoil including an internal reinforcement and an outlining shell both formed of copper electrolytically deposited and electrolytically welded.

18. An all metal aeroplane including internal reinforcements and an outlining shell enclosing the reinforcements, said outlining shell being formed of a layer of electrolytically deposited metal.

19. A one piece aeroplane comprising a pair of laterally extending wings and a longitudinally extending fuselage therebetween constituting an integral structure formed of electrolytically deposited metal.

Signed at New York city, in the county of New York and State of New York this 18th day of April A. D. 1925.

BLASIUS BART.