Jan. 10, 1939. A. W. KEUFFEL 2,143,559

SLIDE RULE

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FIG.1.

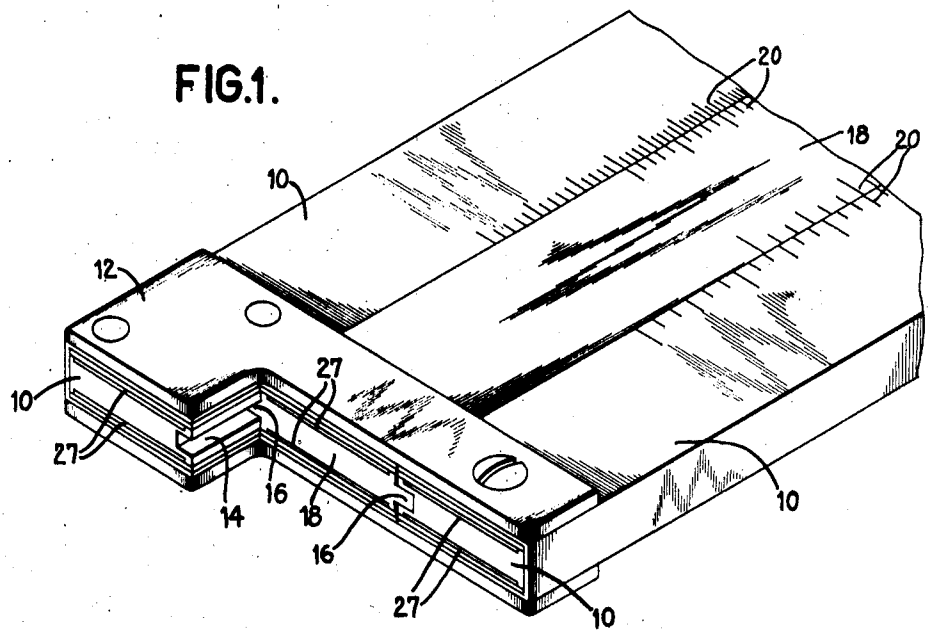


FIG.2.

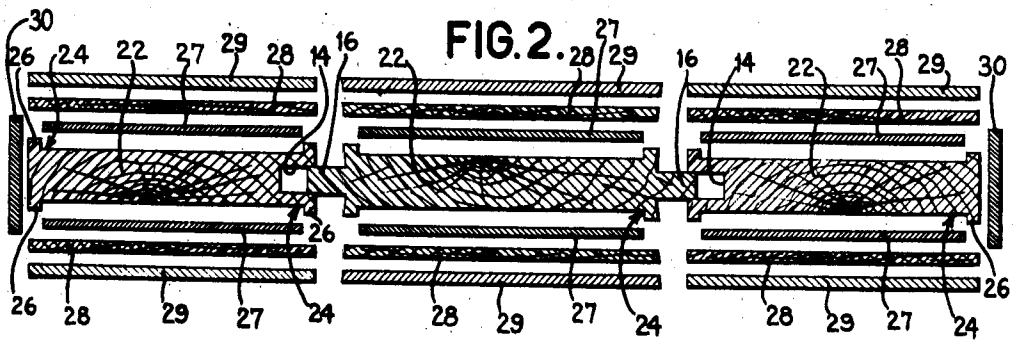
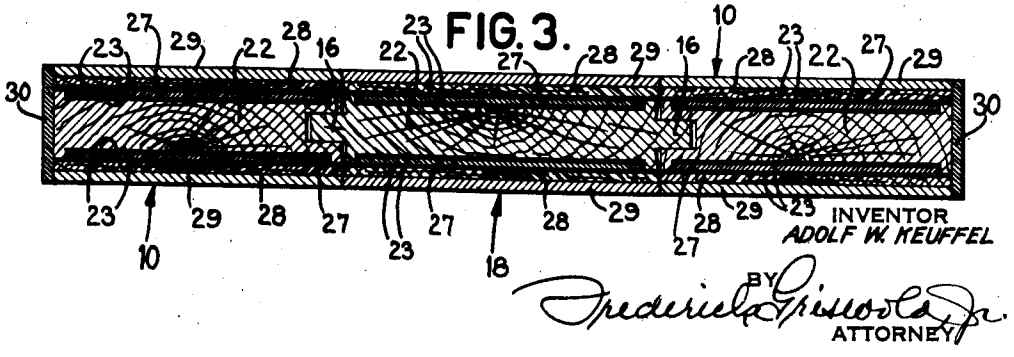


FIG.3.



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FIG.4.

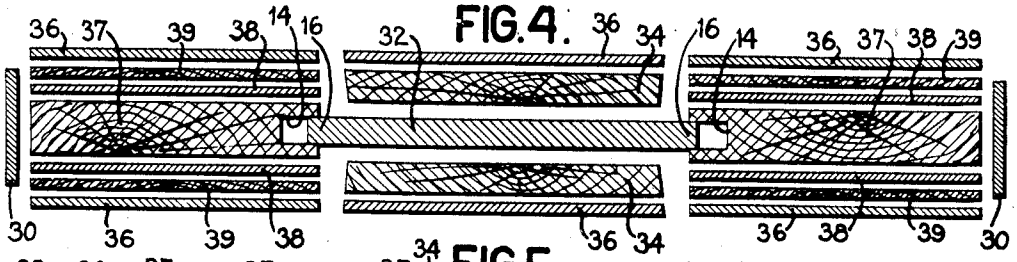


FIG.5.

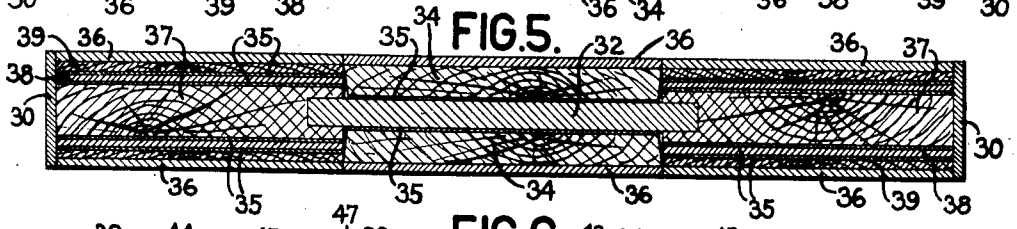


FIG.6.

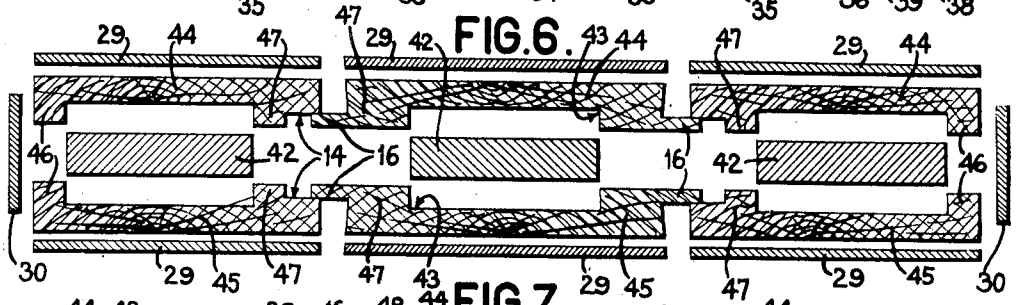


FIG.7.

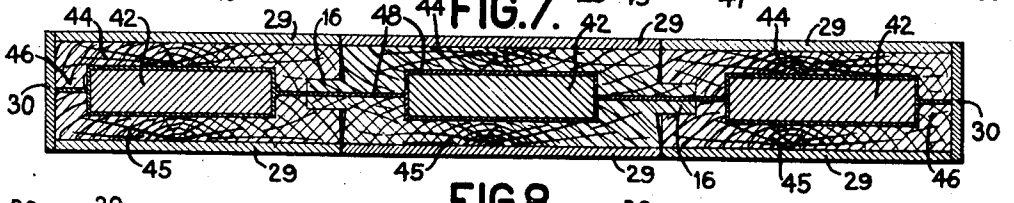


FIG.8.

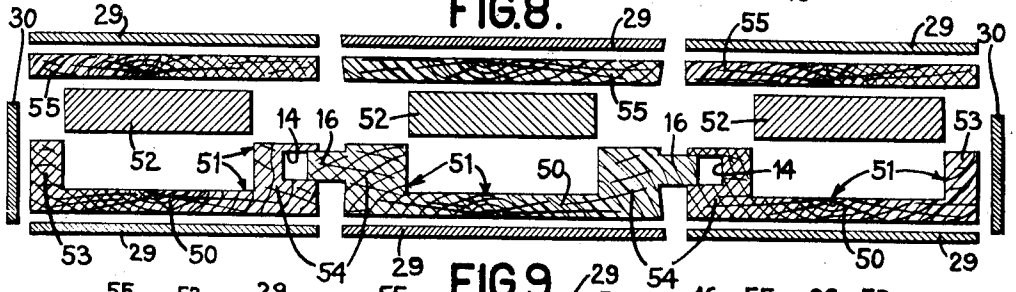
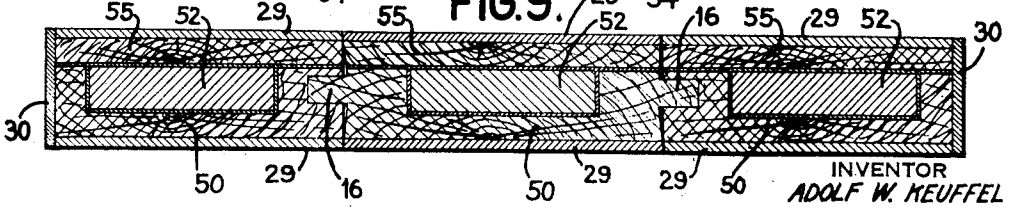


FIG.9.



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SLIDE RULE

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FIG.10.

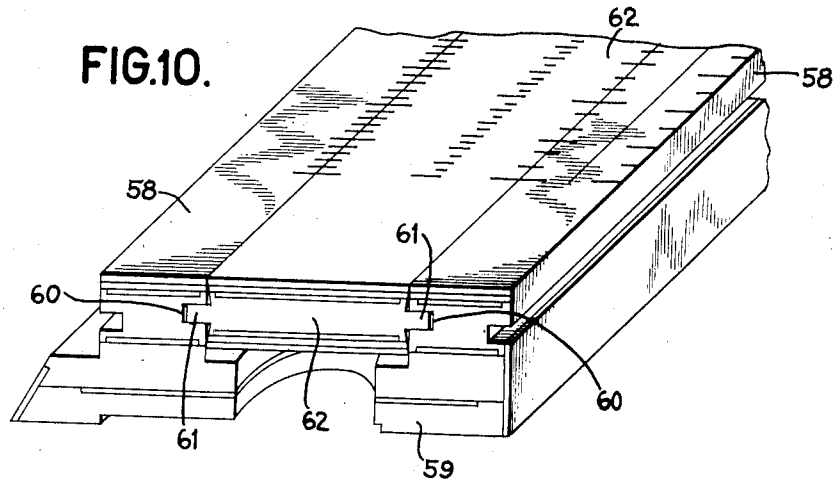


FIG.11.

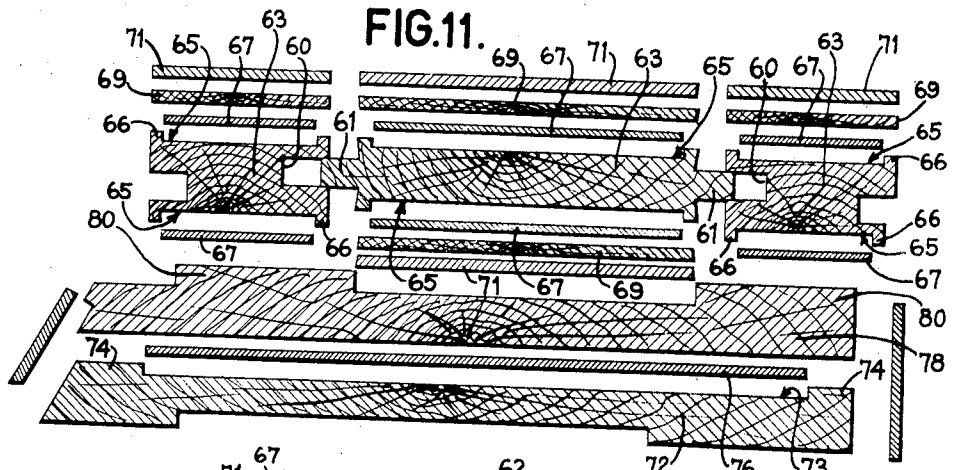


FIG.12.

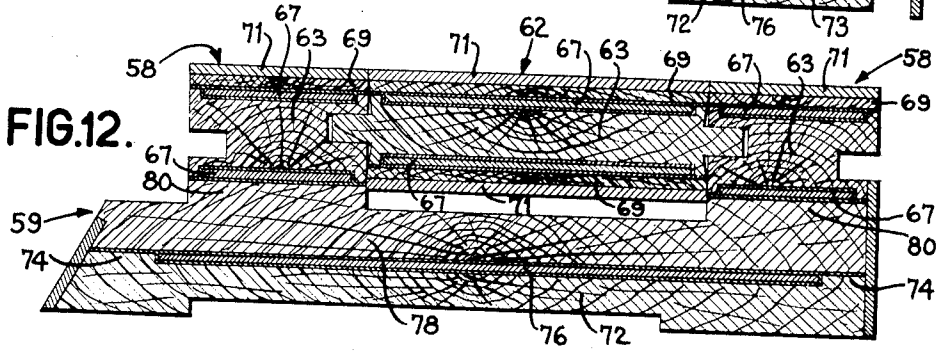
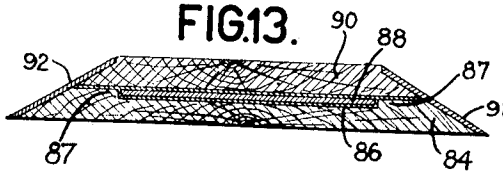


FIG.13.



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2,143,559

UNITED STATES PATENT OFFICE

2,143,559

SLIDE RULE

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Application March 20, 1935, Serial No. 11,929

19 Claims. (Cl. 235—70)

This invention relates to slide rules, straight edges, scales and similar instruments used by draughtsmen, estimators, engineers and others.

Slide rules, scales and the like are preferably made of wood since wood is readily worked to the exactness necessary in instruments of this character and readily receives a layer or facing of a composition with a cellulose derivative or the equivalent, such as Celluloid, in which the necessary graduations may be quickly and accurately engraved. It is recognized that, in spite of the great care exercised in seasoning and otherwise preparing the materials of such instruments, the dimensions of the wood and/or facing are subject to variations with atmospheric change in humidity, so that the instruments sometimes are thus caused to become inexact. It is particularly important, in slide rules, to be able to avoid this condition because the dimensions of the respective, cooperating members, under the same conditions, may vary in different degrees and the calculations made with the rule are then not at all accurate.

It has heretofore been proposed to prevent the changes in dimensions due to atmospheric conditions of scales and slide rules by forming the same of Celluloid, either with or without a metal core but it has been found difficult, if not impossible, to adhere the Celluloid to the metal and, in consequence, a complicated and expensive method of manufacture has been necessary and the construction involved has not been practical from a manufacturing standpoint.

The present invention seeks an instrument of the character described having the usual faces of Celluloid or the equivalent on which faces the scales are engraved and comprised in major part, of wood, while the dimensions of the wood and/or facing are prevented from varying due to atmospheric conditions by one or more bars or strips of metal therein. Such metal member or members may vary with changes in temperature, but such changes and their degree are well understood and may be corrected or allowed for. In a slide rule, the same metal in the several cooperating slide rule members will have the same coefficient of expansion and will vary in dimensions in a regular and equal manner so that such variations in the respective members will be equal and the graduations on the respective members will always bear the same relative relation one to another.

The eye is so sensitive to minute differences in the relative positions of graduations on the respective members of a slide rule that advantage may be taken of this to make calculations to several significant figures. However, this entails extreme accuracy in the manufacture and graduating of the scales and requires that the respective cooperating scales shall be constant at least in their relative relation. It is imperative, therefore, that the scales on both cooperating members vary in exactly the same degree.

Celluloid and other similar materials do not adhere readily to metal. Therefore, another object of the present invention is the provision of means whereby such a slide rule or other instrument having a face of Celluloid or similar material may be reenforced. To this end, a wooden member is provided with a core of metal, the wood readily adhering to the metal by means of an adhesive and the Celluloid facing of the rule being readily adhered to the wood. In carrying the invention into effect, the metal reenforcement preferably takes the form of one or more strips or bars of metal which is, or are, embedded in the wood so as to be surrounded by wood on all four surfaces and to which metal the wood is adhered, by suitable adhesive. The facing is readily adhered to the wood. Thus the wood and Celluloid are made to adhere to the metal and as the metal has by far the greatest strength in tension and compression, it is the controlling element and the dimensions assumed by the members under different atmospheric conditions will be those of the metal. That is to say, while the wood is subject to a change dependent upon the humidity of the atmosphere, since the metal is not affected by humidity the wood is prevented from any change by reason of humidity. The metal is subject to change due to variations in temperature but this change can be allowed for and is always constant so that both members will change to the same degree as a result of changes in temperature. In all events, both as to scales and slide rules, the change due to variations in temperature is very small as contrasted with changes in the dimensions of the wood and Celluloid due to variations of humidity. Thus the tendency to the greatest and uncontrolled change of dimensions of the wood and Celluloid, to wit, that due to humidity, is overcome.

While the invention is illustrated and described herein as contemplating wood as an element of the construction, it is to be understood that any fibrous material, such as paper pulp, papier-mâché, pressed wood flour or other formed product of a cellulosic nature is equally applicable, because the metal member serves as a reenforcing

or stiffening member for the scale, straight edge, slide rule or other instrument.

The invention also seeks a construction which is practical from the standpoint of ease and cheapness of manufacture and convenience and durability in use.

These and other objects of the invention and the means for their attainment will be more apparent from the following detailed description, taken in connection with the accompanying drawings illustrating various embodiments by which the invention may be realized, and in which:

Figure 1 is a view, in perspective, showing the fragmentary end portion of a slide rule upon which the scales appear on opposite faces and to which slide rule the invention is applied;

Figure 2 is an exploded view of the slide rule construction illustrated in Figure 1 and taken in a plane transverse thereto;

Figure 3 is a view of the parts of the slide rule illustrated in Figure 2, assembled, with adhesive between the several laminations;

Figure 4 is an exploded view showing a modified form taken by the invention;

Figure 5 is a transverse sectional view of a slide rule embodying the form of Figure 4;

Figure 6 is a view showing still another modification, in exploded view;

Figure 7 is a transverse sectional view of a slide rule embodying the modification of Figure 6;

Figure 8 shows stil another modification of the invention, in exploded view;

Figure 9 is a transverse sectional view of the slide rule embodying the invention of Figure 8;

Figure 10 is a view in perspective showing the application of the invention to a Mannheim type slide rule;

Figure 11 is an exploded view of the slide rule construction of Figure 10 and taken in a plane transverse thereto;

Figure 12 is a view showing the parts of the slide rule illustrated in Figure 11 assembled; and

Figure 13 illustrates the application of the invention to a scale.

While the invention has been illustrated principally as applied to a slide rule, it will be obvious, as the description proceeds, that the invention is equally applicable to any instrument bearing a scale or a straight edge in which it is sought to avoid uncontrolled variations in dimensions due to changes in atmospheric conditions. The slide rule illustrated in Figures 1 through 9 comprises side bars **10**, **10** united at either end by transverse metallic connecting members **12**, the side bars being interiorly grooved, as at **14**, within which slide the tongues or feathers **16** of the reciprocating slide **18**. In the embodiment shown, both the upper and lower faces of the side bars and slide bear scales **20**.

In the modification of Figures 1, 2 and 3, each side bar and the slide comprise generally a median body or core **22** of wood or the equivalent formed upon opposite surfaces with recesses **24** of relatively shallow depth, but preferably, for manufacturing reasons, extending the length of the rule and substantialy the width of each member, only a relatively narrow flange **26** of wood being left along each side to define the recess.

A plate, strip or bar **27** of metal, preferably hardened and tempered spring steel, of a width substantially equal to the width between the flanges **26** and of a thickness substantially equal to the depth of the depression **24** is inserted in each depression, i. e., in the upper and lower faces of the core **22**. It is secured in place by adhesive **23** so that the face of the bar **27** lies flush with the outer edges of the flanges **26**, as shown in Figure 3. The bar is of such length as to extend substantially the length of the member. Superimposed upon the bar **27**, on each side, is a plate or layer of wood **28** of the width of the member. This plate is also adhered to the flanges **26** and the metal bar by means of adhesive **23** and thus a composite member is formed with two spaced reenforcing plates of metal entirely embedded within the wood, the wood adhering to the metal readily by the adhesive. While the metal need not have a surface treatment, it is preferred to so treat the surface that it will be adherent to the greatest degree, to suitable adhesive, such adhesive being selected as will best adhere to the surface of the metal used and to the wood. Obviously, the wood is more readily adherent to adhesive.

To the upper and lower surfaces of the wooden plates **28** and also, desirably, to the outer side of each side bar **10** in overlapping relation to the core **22** and the top and bottom wooden plates **28** are layers or faces **29** and **30**, respectively, of Celluloid or equivalent material, which may be readily adhered to the wood and Celluloid by suitable adhesive in a manner well known to the art. The groove **14** on the interior side of each side bar is readily formed, after assembly, to exact size in the wooden core **22**, as will be understood. In the case of the slide **18**, the wooden core **22** is formed on each side, after assembly of the slide, with the tongue or feather **16** adapted to be received in the groove **14**. By this construction, the coacting sides of the slide and the side bars are readily formed to shape and the tongues or feathers **16** readily shaped to size to fit the readily shaped grooves **14** for a tight but sliding fit.

When either the slide or side bar is assembled in the manner illustrated, the laminations of metal are completely concealed at the side and embedded within the wood, it being immaterial from a practical standpoint whether the metal extends to and is visible at the ends. Being firmly adhere to the wood, the metal bars prevent the wood from changing in size and shape due to changes in atmospheric conditions except in the regular manner of the metal, while the wood forms a surface to which the Celluloid may be readily adhered.

In Figures 4 and 5, a construction is illustrated in which a modified slide **18** is used in connection with modified side bars **10**. Here the slide comprises a central lamination **32** of metal of material thickness, the side edges of which serve as the feather or tongues **16**. Above and below the bar **32** are laminations **34** adhered to the metal by suitable adhesive **35**. Celluloid faces **36** are adhered to the exposed faces of the wooden laminations as shown. In the side bars **10**, cores **37** of wood have metal strips or bars **38** of the same shape and area adhered to the respective sides thereof overlaid with wooden members **39** of the same shape and area to the exposed faces of which the Celluloid faces **36** are adhered. If desired, the edges of the side bars may be covered with the Celluloid strips **30** as before. After assembly, the wooden cores **37** of the side bars have the grooves **14** formed therein to receive the side edges **16** of the bar **32** of the slide, the slide being also shaped to size after assembly. While not as durable as the modification of Figures 1 to 3, it is nevertheless a serviceable construction because the grooves formed wholly in the wood permit accuracy in the formation of the grooves so that the parts slide with the proper retarded freedom.

Instead of the two spaced metal bars in the slide of Figures 1 to 3, a single heavier metal bar 42 may be used in both the side 18 and side bars 10 as illustrated in Figures 6 and 7. In this instance, the opposed surfaces of a pair of companion wooden members 44, 45 are recessed, as at 43, for a depth substantially half the thickness of the metal bar 42, the recesses extending conveniently for the length of the bar, from end to end, but terminating inwardly of the sides to define relatively narrow flanges 46 at the outer edges of the side bars when assembled and thicker portions or flanges 47 on the contacting sides of the respective members, which, after assembly, are formed with the grooves 14 in the side bars and the tongues 16 of the slide. When the two wooden halves 44, 45 are assembled upon the metal bar 42, suitable adhesive 48 (Figure 7) unites the wood and metal. The flanges 46 and 47 abut one another, thus providing wood on the outer surfaces to which facings 29 of Celluloid or the equivalent, may be caused to adhere, as well as the edge strips 30.

A further modification is shown in Figures 8 and 9 in which the lower wooden section 50 in each of the side bars and slide is formed with the recess 51 receiving the entire metal body 52, the recess being of a depth equal to the thickness of the metal bar and providing narrower flange portions 53 on the outer sides of the side bars and thicker opposing flanges 54 to enable the grooves 14 and tongues 16 to be formed wholly therein after assembly, for accuracy. Overlying the metal bar 52 and wooden side flanges 54 are wooden plates 55 overlaid with the facings 29 and 30. Adhesive, as before, secures the parts together.

The invention may also be applied to a Mannheim type slide rule as shown in Figures 10 to 12. This rule comprises generally the body member formed of the side bar portions 58, 58 carried with a base portion 59 and defining a slide rule body. The side bar members 58 are interiorly grooved as at 60 within which slide the tongues 61 of the reciprocating slide 62.

Each side bar portion 58 and the slide 62 comprises generally a median body or core 63 of wood or the equivalent formed upon opposite surfaces with recesses 65 of relatively shallow depth but extending, preferably, for manufacturing reasons, the length of the rule and substantially the width of each side bar member, only a relatively narrow flange 66 of wood being left along each side to define the recess.

A plate, strip or bar of metal 67, preferably hardened and tempered spring steel of a width substantially equal to the width between the flanges and of a thickness substantially equal to the depth of the depression is inserted in each depression 65, i. e., in the upper and lower faces of the core 63. It is secured in place by adhesive so that the face of the bar lies flush with the outer edges of the flanges, as shown in Figure 12. The bars are of such length as to extend substantially the length of the side bar members. Superimposed upon the bar on the upper side of the core 63 is a plate or layer of wood 69 of the width of the side bar member and/or slide. This plate is also adhered to the flanges and the metal bar by means of adhesive and thus a composite portion is formed with two spaced reenforcing plates of metal entirely embedded within the wood, the wood adhering to the metal readily by the adhesive. While the metal need not have surface treatment, it is preferred to treat the surface that it will be adherent to the greatest degree to suitable adhesive, such adhesive being selected as will best adhere to the surface of the metal used and to the wood. To the upper surfaces of the wooden plates 69, is conveniently a facing of Celluloid or equivalent material 71 which is readily adhered to the wood by suitable adhesive in a manner well known to the art.

The base portion 59 is also reenforced by metal and comprises a two-part member of wood or the equivalent defined by a plane parallel to the face of the rule, the lower member 72 of which is formed in its upper face with a recess 73 of relatively shallow depth extending the length of the rule and substantially the width of each member, only a relatively narrow flange 74 of wood being left along each side to define the recess. Here again, a plate, strip or bar of metal 76, preferably of hardened and tempered spring steel of a width substantially equal to the width between the flanges and of a thickness substantially equal to the depth of the depression is inserted in the depression. It is secured in place by adhesive so that the face of the bar lies flush with the outer edges of the flanges as shown in Figure 12. The bar is of such length that it extends substantially the length of the member. Superimposed upon the bar 76 is a plate or layer 78 of wood of the width of the base portion. This plate is also adhered to the flanges and the metal bar by means of adhesive and thus a composite member 59 is formed with a reenforcing plate of metal entirely embedded within the wood, the wood adhering readily to the metal. The metal may be treated as hereinbefore described. Preferably integral with the upper member 78 is a raised portion 80 along each edge formed during the final shaping of base portion 59 of the slide. This raised portion is adhered by suitable adhesive to the lower surfaces of the lower metal laminations 67 of the side bar portions and the wooden flanges 66. The slide may take the form of that illustrated in Figures 2 and 3 and like reference numerals are affixed thereto.

Obviously the general construction of a slide rule of the Mannheim type may take any of the forms illustrated in Figures 4 through 9, while the side edges of the base portion may be surfaced with Celluloid or equivalent material as is now common practice.

The application of the invention to a scale or straight edge is illustrated in Figure 13. Here again a base portion 84 of wood is formed with a recess 86 in its upper surface of relatively shallow depth but preferably, for manufacturing reasons, extending the length of the scale and substantially the width of the scale, only a relatively narrow flange 87 of wood being left along each side to define the recess. A plate. strip or bar of metal 88, preferably of hardened and tempered spring steel of a width substantially equal to the width between the flanges and of a thickness substantially equal to the depth of the depression is inserted in the depression. It is secured in place by adhesive so that the face of the bar lies flush with the outer edges of the flanges. The bar is of such length as to extend substantially the length of the member. Superimposed upon the bar 88 is a plate or layer of wood 90 also adhered to the flanges and the metal bar by a suitable adhesive. Thus a composite member is formed which can be shaped as desired and inlaid as is common practice with faces 92 of Celluloid or similar material.

It will thus be seen that a laminated metal and

wood slide rule or other scale bearing member has been provided in which the warping or change in overall dimensions is prevented by adhering the fibrous material to the metal. I am enabled to use Celluloid, the most practical material for this purpose, as the surface of the instrument on which the scales are engraved because the fibrous material permits the Celluloid to be readily adhered to it.

Various modifications will occur to those skilled in the art in the composition, configuration and disposition of the component elements going to make up the invention as a whole so long as one of the elements present in the combination is constant in its changes due to atmospheric changes and the elements adhering thereto will also be adhered to the scale bearing surface and no limitation is intended by the phraseology of the foregoing specification or illustrations in the accompanying drawings.

What is claimed is:—

1. A scale bearing member comprising a lamination of metal, a lamination on one side of material adherent to the surface of the metal by an adhesive, said last named material being also adherent to an adhesive adherent to a composition with cellulose derivative.

2. A scale bearing member comprising a lamination of metal, a lamination on one side of the metal lamination of fibrous material adherent to the surface of the metal by an adhesive and a Celluloid lamination adhered to the fibrous material by an adhesive.

3. A scale bearing member comprising a lamination of metal, a lamination of fibrous material adjacent each face of the metal and adherent to the surfaces thereof adhesive fixing said fibrous material to the metal, Celluloid adjacent each face of the fibrous material lamination and adhesive fixing the Celluloid to the fibrous material.

4. A scale bearing member comprising a lamination of metal, a lamination on each side thereof of material adherent to the surfaces of the metal by an adhesive, at least one of said last named laminations being formed with a recess to receive the metal lamination, said last named material being also adherent to an adhesive adherent to a scale bearing lamination.

5. A scale bearing member comprising a lamination of metal, a lamination on each side thereof of fibrous material, one of said fibrous material laminations being formed with a recess to receive the metal lamination, adhesive adhering the metal to the surfaces of the fibrous material and a scale bearing lamination adhered to the fibrous material by an adhesive.

6. A slide rule member comprising, in combination, a central lamination of metal, a wood lamination on each side thereof adherent to the surfaces of the metal by an adhesive, and a scale bearing lamination fixed to the wood by an adhesive adherent thereto.

7. A slide rule member comprising, in combination, a central lamination of wood recessed upon opposite surfaces, a metal lamination received in each recess and adherent therein by an adhesive, wood laminations superimposed on the metal laminations and adhered thereto and to the wood and scale bearing laminations adhered to the wood.

8. A slide rule comprising two relatively slidable members, said members being composite and comprising a wooden portion at least one face of which is recessed substantially the length of the rule, said recess being defined by longitudinally extending flange portions on either side integral with the wooden portion, a reenforcing bar of metal of a thickness substantially equal to the depth of the recess, adhesive securing the metal in the recess, a lamination of wood overlying the flanges, adhesive securing the lamination to the metal and flanges and a layer of Celluloid adhered to the wooden lamination.

9. A slide rule comprising two relatively slidable members, said members being composite and comprising a wooden portion opposed faces of which are recessed substantially the length of the rule, said recess being defined by longitudinally extending flange portions on either side integral with the wooden portion, a reenforcing bar of metal of a thickness substantially equal to the depth of the recess and disposed therein, adhesive securing the metal in the recess, laminations of wood overlying the flanges, adhesive securing the lamination to the metal and flanges and a layer of Celluloid adhered to each wooden lamination.

10. A slide rule comprising two relatively slidable members, at least one of said members comprising two juxtaposed wooden portions the proximate faces of which are substantially parallel to the faces of the rule, at least one of the proximate faces of the wooden portions being recessed, a metal bar in the recess, adhesive securing the metal bar and wooden portions together, Celluloid facings overlying two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood.

11. A slide rule comprising two relatively slidable members, said members comprising two juxtaposed wooden portions the proximate faces of which are substantially parallel to the faces of the rule, proximate faces of the wooden portions being formed with cooperating recesses, a metal bar in the recess, adhesive securing the metal bar and wooden portions together, Celluloid facings overlying two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood.

12. A slide rule comprising a slide member and side bar members, said members each comprising two juxtaposed wooden portions the proximate faces of which are substantially parallel to the faces of the rule, at least one of the proximate faces of the wooden portions being formed with a recess, a metal bar in each recess, adhesive securing the metal bar and wooden portions together, Celluloid facings overlying two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood, the wooden portions of the respective members being formed with cooperating tongue and groove portions.

13. A slide rule comprising two relatively slidable members, said members each comprising two juxtaposed wooden portions the proximate faces of which are substantially parallel to the faces of the rule, one of the proximate faces of the wooden portions being recessed, a metal bar in the recess, adhesive securing the metal bar and wooden portions together, Celluloid facings overlying at least two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood.

14. A slide rule comprising a slide member and side bar members, the side bar members each comprising a central wooden portion whereof surfaces are substantially parallel to the faces of the rule, a metal lamination on each said surface, adhesive securing the metal laminations

and wooden portion together, wooden laminations overlaying the metal laminations, adhesive securing the wooden lamination to the metal and Celluloid facings overlying two remote surfaces of the respective wooden laminations and adhered thereto by an adhesive.

15. A slide rule comprising a slide member and side bar members, the side bar members comprising a central wooden portion whereof opposite surfaces are substantially parallel to the faces of the rule, a metal lamination on each said surface, adhesive securing the metal laminations and wooden portion together, wooden laminations overlaying the metal laminations, adhesive fixing the wooden laminations to the metal, Celluloid facings overlying two remote surfaces of the respective wooden laminations, adhesive securing the Celluloid to the wood, a slide member comprising a central metal portion whereof opposite surfaces are defined by planes parallel to the faces of the rule, wooden laminations on each said surface relatively narrower than the metal portion, adhesive securing the metal portion and wooden portions together, Celluloid facings overlying two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood, said central wooden portions of the side bar members being each formed with a groove receiving the edges of the metal portion of the slide.

16. A slide rule comprising a slide member formed with tongues and a base member formed with a slideway defined by spaced side bar portions and a base portion, said base portion comprising two juxtaposed wooden portions the proximate faces of which are parallel to the face of the rule, at least one of the proximate faces of the wooden portions being recessed, a metal bar in the recess, adhesive securing the metal bar and wooden portions together, said side bar members each comprising a wooden portion formed with grooves for the tongues and whereof the surfaces of the wooden portions are parallel to the upper and lower surfaces of the rule, said respective wooden portions of the side bar portions being recessed, a metal bar in each of the last named recesses, adhesive securing the metal bar and wooden portions together, a wooden lamination on the upper surface of each side bar portion, adhesive fixing said laminations to the metal bars, Celluloid facings overlying the upper surfaces of the respective last named wooden laminations, adhesive securing the Celluloid to the wood and adhesive securing one of the wooden portions of the base portion to each metal bar in the recess in the lower surface of the respective side bar portions.

17. A slide rule comprising a slide member formed with tongues and a base member formed with a slideway defined by spaced side bar portions spaced on a base portion comprising two wooden laminations and a metal lamination interposed therebetween, adhesive securing the laminations of wood and metal together, said side bar portions each comprising two metal laminations, a wooden lamination therebetween, adhesive securing the laminations of wood and metal together, adhesive securing a metal lamination of each side bar portion to one of the first named wooden laminations, a wooden lamination on the other metal lamination of each side bar portion, a layer of Celluloid superimposed upon each of the last named wooden laminations and adhesive securing the last named laminations together.

18. A slide rule comprising two relatively slidable members, said members comprising two juxtaposed complementary wooden portions the proximate faces of which are substantially parallel to the faces of the rule and are formed, respectively, with registering recesses, a metal bar disposed between the wooden portions within the recesses, adhesive securing the metal to the wood, Celluloid facings overlaying two remote surfaces of the respective wooden portions and adhesive securing the Celluloid to the wood.

19. A slide rule comprising a wooden rule member formed with a recess on opposite faces, a metal bar of a thickness equal to the depth of the recess and disposed in each recess, wooden laminations overlying the metal bar and the sides of the recesses, respectively, adhesive securing the metal bars to the wood on all sides thereof, Celluloid facings overlaying said wooden laminations and adhesive securing the Celluloid facings to the wood.

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