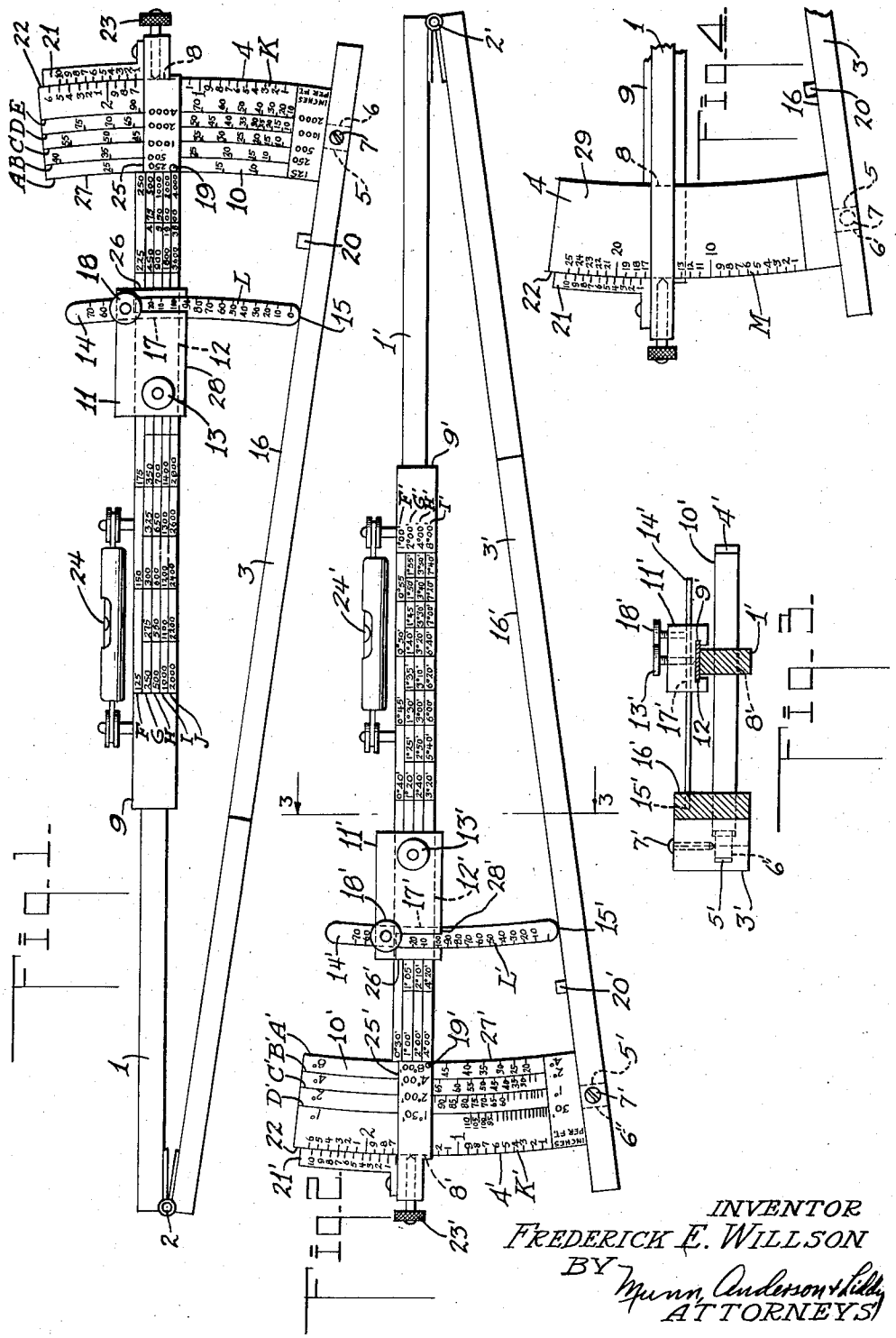
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APPARATUS FOR SETTING SUPERELEVATIONS FOR CURVES OF VARIOUS RADII AND SPEEDS FOR HIGHWAYS AND RAILROADS

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APPARATUS FOR SETTING SUPERELEVATIONS FOR CURVES OF VARIOUS RADII AND SPEEDS FOR HIGHWAYS AND RAILROADS

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An object of my invention is to provide a speed clinometer that is especially adapted for use in setting superelevations on curves in connection with highways and railroad construction and maintenance, these superelevations being given by the device without the need of making any mathematical calculations. The device will give the correct superelevations on a curve of a given radius and will also show the proportionate theoretical speed at which the vehicle can move around the curve in perfect equilibrium.

The device will also give the angle of superelevation, the rate of inclination angle in inches and fractions of a foot and the gradients in percentage for theoretical rate of superelevations for curves of various radii and proportionate speeds in one setting of the apparatus. It is further possible to set the intermediate superelevations along approaches to curves from neutral or a level point to the point of full superelevation. The instrument will give the speed in miles per hour for a given inclination angle if the radius is known.

The device can also be used for giving the superelevations on railroad track curves and in this instance the radius lengths are given in terms of degree of curve instead of in terms of feet of radius. The gradient of superelevation across a roadway and a gradient along the center line of the roadway can be computed and compared with the instrument for the purpose of giving drainage data. The device will give the angle of equilibrium horizontally and vertically of a body moving in a circular path in curves of various radii and proportionate speeds without mathematical calculations.

The device is extremely simple in construction and is durable and efficient for the purpose intended.

Other objects and advantages will appear in the following specification, and the novel features of the device will be particularly pointed out in the appended claims.

My invention is illustrated in the accompanying drawing forming a part of this application, in which

Figure 1 is a side elevation of the device used for giving superelevations in highway construction and maintenance;

Figure 2 is a side elevation of a device similar to that shown in Figure 1, but is marked in terms of degree of curve for giving superelevations for railroad track curves;

Figure 3 is a section along the line 3—3 of Figure 2, and it is also a similar section through Figure 1; and

Figure 4 is a view of the obverse side of a portion of the device shown in Figure 1.

In carrying out my invention I provide a radius arm 1 that is hinged at 2 to a lower radius arm 3, see Figure 1. The arm 3 carries an arcuate segment 4 that has a projection 5 entering an opening 6 in the arm 3 and held in place by a screw 7. The arm 1 is slotted at 8 for slidably receiving the arcuate segment 4.

The arm 1 carries a plate 9 that is permanently secured thereto and the plate extends over the surface 10 of the segment 4 for a purpose hereinafter described. A carriage 11 is slidably mounted on the plate 9 and Figure 1 illustrates how the carriage is grooved at 12 for slidably receiving the plate 9. The carriage 11 is locked in adjusted position by means of a screw 13 that frictionally engages with the plate 9 when the screw is tightened.

The carriage 11 also carries a segment arc 14 that has an end 15 designed to contact with an edge 16 of the lower arm 3. The segment arc 14 is slidable in a groove 17 in the carriage 11 and is adjustably secured in place by means of a screw 18. The screw 18 when loosened permits the segment arc 14 to be moved along the groove 17 into the desired position. A stop 19 carried by the plate 9 limits the movement of the carriage 11 in one direction. A stop 20 carried by the arm 3 limits the movement of the arm 3 toward the arm 1. A vernier 21 is mounted on the arm 1 and has an edge contacting with the outer edge 22 of the segment 4. A set screw 23 carried by the arm 1 locks the arm in adjusted position on the segment 4. The arm 1 carries a spirit level indicated generally at 24.

The surface 10 of the segment 4 has a plurality of scales marked thereon and for convenience these scales are lettered from A to E inclusive. The scales are marked for miles per hour and A represents a curve having a radius from 125 to 250 feet, while the scale B represents a radius from 250 to 500 feet. In like manner the scale C represents a radius from 500 to 1000 feet, the scale D a radius from 1000 to 2000 feet, and the scale E a radius from 2000 to 4000 feet. Each of the scales from A to E inclusive has numbers thereon indicating the travel of a vehicle in miles per hour.

On the plate 9 I show another set of scales F to J inclusive, that give the radius of curves in terms of feet and cooperate with the scales A to E inclusive. For example, the scale F indicates

radii from 125 to 250 feet with each graduation indicating 2½ feet, and is to be used in connection with the scale A in a manner hereinafter described. The scale G is to be used with the scale B that indicates radii from 250 to 500 feet with each graduation indicating 5 feet. The scale H represents radii from 500 feet to 1000 feet with graduations indicating 10 feet, and is used with the scale C, while the scale I represents radii from 1000 feet to 2000 feet with graduations indicating 20 feet and is to be used with the scale D. The scale J indicates radii from 2000 to 4000 feet with graduations indicating 40 feet and is to be used with the scale E.

The segment 4 in addition to carrying the scales A to E inclusive has on its face 10 a scale K that reads to inches and fractions per foot and is used to indicate the desired superelevations. The segment arc 14 has a scale L marked thereon and is graduated to read to feet. Readings for curves with radii in terms of feet are taken where the edge 26 intersects the desired number on any one of the scales F, G, H, I or J. Readings for miles per hour and inches and fractions per foot for superelevations are taken where edge 25 intersects scales A, B, C, D or E on the segment 4.

Before giving an example of how to use the instrument it is best to set forth the problem solved which is the tangent of the angle of equilibrium horizontally and vertically, whereby:

The centrifugal force due to bodies moving in a circular path is where,

W=weight of body in pounds.
V=velocity in feet per second.
R=radius of curve in feet.
g=acceleration due to gravity.

For equilibrium horizontally and vertically.

$$\text{sine } O = \frac{W}{g} \times \frac{V^2}{R}$$

$$\text{cosine } O = W.$$

Hence dividing the first equation by the second,

$$\frac{\frac{W}{g} \times \frac{V^2}{R}}{W} = \frac{V^2}{gR} = \text{tang } O$$

which is the equivalent of scale K.

Suppose we are given as an example a curve with a radius of 850' and a speed of 40 miles per hour. In setting the apparatus shown in Figure 1 for a curve with a radius of 850 feet and to find the superelevation for a speed of 40 miles per hour, the arm 1 is moved so that the edge 25 on the plate 9 is set at a graduation 40 on the scale C. This setting is the theoretical superelevation for a speed of 40 miles per hour on a curve with a radius of 1000 feet. After this setting has been made, the thumb screw 23 is tightened for securing the arm 1 to the segment 4. The carriage 11 is now moved so that its edge 26 coincides with an edge 27 of the segment 4. To accomplish this the carriage is merely moved until the edge 26 strikes the stop 19. The thumb screw 13 is now tightened to prevent the carriage from accidental movement.

Segment arc 14 is then moved in the carriage 11 until the end 15 strikes the edge 16 of the lower radius arm 3 and then the thumb screw 18 is locked in position. This gives the proper setting for the segment arc 14 in the carriage 11. The thumb screws 23, and 13 are now released and the carriage 11 is moved along the radius arm 1 until the edge 26 intersects graduation 850 on the scale H, shown on the plate 9. The thumb screw 13 is again clamped to lock the carriage 11 from further movement, and the edge 16 of the arm 3 is brought into contact with the end 15 of the segment arc 14 which is still held clamped to the carriage 11. The thumb screw 23 is now clamped into position on the segment 4 and this completes the operation. The angle made between the arms 1 and 3 is the correct superelevation for the problem given. The arm 1 is now brought into a level position by aid of the spirit level 24, and the angle made between the arms 3 and 1 is the correct angle of superelevation for a speed of 40 miles per hour, on a curve having a radius of 850 feet.

It should be noted that settings in the instrument may be made for standard radii of 250, 500, 1000, 2000 and 4000 feet and direct readings may be made independent of the use of the segment arm 14. In order to set intermediate superelevations for reversed curves or curves curving in opposite directions and connected with a short tangent necessitating the extension of the point of full superelevation beyond the point of curve or inside the point of tangent, as well as the point of reverse curve, the apparatus is set for the superelevation of the main curve, which is the full superelevation, and then the thumb screw 23 locks the arm 1 to the segment 4. The scale L on the segment arc 14 is set to the length of a run-off or distance from the point of full superelevation to a neutral or level point in terms of feet and then the thumb screw 18 is turned to clamp the segment arc 14 to the carriage 11. The carriage 11 is now moved along the radius arm 1 to where the end 15 of the segment arc 14 contacts with the edge 16 of the lower radius arm 3 and then the thumb screw 13 is clamped, locking the carriage to the plate 9.

The thumb screws 23 and 18 are now released and the edge 28 of the carriage 11 is set to the desired distance in feet on the scale L. The thumb screw 23 is now clamped and locks the arm 1 to the segment 4. The instrument is now ready with the aid of the spirit level 24 to set a superelevation for that intermediate distance on the run-off indicated by the scale L of the segment arc 14. Other distances are set in like manner.

It is further possible to solve problems with the instrument in which the curves have a radii greater than 4000 feet. For example, where the radius of the curve may be 4000 to 8000 feet, in length, divide the radius by 4 and the speed of the vehicle by 2 and then set the instrument in accordance with the reduced radius and reduced speed. The angle arrived at by the arms 1 and 3 will give the correct superelevation. For curves with radii less than 125 feet, the radius must be multiplied by 4 and the speed of the vehicle multiplied by 2 and then these figures can be set on the proper scales of the device. The device is designed to be used with a straight edge and can be applied to a track gage. When used on highways, the device may be placed on a straight edge 6 or 7 feet in length. In setting grades or header boards it is necessary to level out from the center line grade and the placing of a stake indicating the level, will give the correct grade on the inclination line or superelevation.

In Figure 4 I show the obverse side 29 of the segment 4. The vernier 21 is used for the scale K shown in Figure 1, and is also used for a scale M on the obverse surface 29. The gradient scale M is graduated to read in feet and decimal fractions for superelevations giving gradients in percentage and can be used for comparison with center line grades which might affect drainage and

necessitate crowning at the center of the roadway. The use of the scale M will give the gradient of the superelevation in terms of percentage or feet per 100 feet as a comparison with the center line or profile gradients. Both verniers 21 cooperate with the scales K and M on opposite sides of the segment 4 and read from a common point starting from the radius arm 1.

For curves on grades where two slopes are to be considered i. e., the super across the road-bed and the center line or profile grade, both of which affect drainage, the necessity might arise of putting a crown in the center of the roadway instead of a flat surface for curves which is the present practice. This change is made in the highway only where problems of proper drainage arise as where the curves are on a heavy grade. An engineer on the field has in his possession all of the center line notes and if he wishes to know the gradient of the super all that is necessary is to read the clinometer. The device takes the place of the standard clinometer.

In Figure 2 I show identically the same device as in Figure 1 except that the scales are used for railroad track construction rather than for highway construction. Since the parts are identical in construction the same reference numerals will be given except that they will be primed in order to distinguish them from the numbers and letters shown in Figure 1.

Scale F' is graduated for curves from 30 minutes to 1 degree with interval graduations reading to 5 minutes, and is used in connection with the miles per hour scale D'. Scale G' is graduated for curves from 1 degree to 2 degrees with interval graduations reading to 5 minutes, and this scale is used in connection with the miles per hour scale C'. In like manner, scale H' is graduated for curves from 2 degrees to 4 degrees with interval graduations reading to 10 minutes, and is used in connection with the miles per hour scale B'. The last scale I' is graduated for curves from 4 degrees to 8 degrees with interval graduations reading to 20 minutes and is used in connection with the miles per hour scale A'.

Readings for curves in terms of degree of curve are taken where the edge 26' of the carriage 11' intersects the degree and minute on the desired scale F', G', H', or I'. Readings for miles per hour and inches and fractions per foot for superelevations are taken where the edge 25' intersects scales A', B', C', or D' on segment 4'.

In using the instrument, shown in Figure 2, let us assume that we have a 6° curve to be superelevated for a speed of 35 miles per hour. The arm 1' is moved until the edge 25' registers with a graduation 35 on a scale A' that reads from 4° to 3°. The thumb screw 23' is now set and this locks the arm 1' to the segment 4'. The carriage 11' is now moved out to where its edge 26' coincides with the edge 27' of the segment 4 or until the edge 26' strikes the stop 19'. The thumb screw 13' is now tightened which will lock the scale against movement. The lower end 15' of the segment arc 14' is brought into abutting relation with the edge 16' of the lower radius arm 3' and the thumb screw 18' is clamped in position.

The thumb screws 23' and 13' are now released and the carriage 11' is moved back to where the edge 26' intersects the 6° graduation on a scale I' whereupon the thumb screw 13' is manipulated to lock the carriage 11' in place. The lower end 15' of the segment arc 14' is now set on the edge 16' of the lower radius arm 3' by moving the arm 3' thereagainst, and the thumb screw 23' is again clamped in position. The instrument is now ready to indicate the desired superelevation and this is accomplished by leveling the arm 1' in accordance with the spirit level 24'. The superelevation indicated by the arm 3' is the correct one for a 6° curve with a speed of 35 miles per hour.

For curves from 8° to 16°, divide the degree of curve by 4 and multiply the speed by 2, setting the result on corresponding scales on the device shown in Figure 2. In this way the instrument can be used for degrees of curve greater than that shown in the plate 9'.

While I have shown only the preferred form of my invention, it should be understood that various changes or modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A device of the type described comprising an arm having scales thereon indicating curves of different radii, a second arm pivoted to the first and having an arcuate segment with scales thereon indicating miles per hour, the scales on the segment being used in connection with the scales on the first arm to show the speed at which a vehicle can move around a given curve in perfect equilibrium, and the first arm being movable over the scales on the segment.

2. A device of the type described comprising an arm having scales thereon indicating curves of different radii, a second arm pivoted to the first and having an arcuate segment with scales thereon indicating miles per hour, the scales on the segment being used in connection with the scales on the first arm to show the speed at which a vehicle can move around a given curve in perfect equilibrium, and the first arm being movable over the scales on the segment, a carriage movable over the scales on the first arm, and a second arcuate segment slidable in the carriage and being graduated to indicate distance.

3. A device of the type described comprising an arm having scales thereon indicating curves of different radii, a second arm pivoted to the first and having an arcuate segment with scales thereon indicating miles per hour, the scales on the segment being used in connection with the scales on the first arm to show the speed at which a vehicle can move around a given curve in perfect equilibrium, and the first arm being movable over the scales on the segment, another scale on the segment and indicating superelevation heights, and a vernier carried by the first arm and used in connection with said last named scale.

4. A device of the type described comprising an arm having scales thereon indicating curves of different radii, a second arm pivoted to the first and having an arcuate segment with scales thereon indicating miles per hour, the scales on the segment being used in connection with the scales on the first arm to show the speed at which a vehicle can move around a given curve in perfect equilibrium, and the first arm being movable over the scales on the segment, the obverse side of the segment having a gradient scale indicating heights, and a vernier carried by the first arm and used with the gradient scale.

5. A device of the type described comprising an arm, said arm having a plurality of scales indicating curves of various radii, a second arm hinged to the first and carrying a segment, said first arm having an opening for slidably receiving the segment, said segment having on one face thereof a plurality of scales equal in number to

the first named scales, the second set of scales indicating speed in miles per hour and being associated with said first named scales to show the speed at which a vehicle can move around a given curve in perfect equilibrium, said first named arm being movable over the second set of scales, and means for locking the first arm to the segment.

6. A device of the type described comprising an arm, said arm having a plurality of scales indicating curves of various radii, a second arm hinged to the first and carrying a segment, said first arm having an opening for slidably receiving the segment, said segment having on one face thereof a plurality of scales equal in number to the first named scales, the second set of scales indicating speed in miles per hour and being associated with said first named scales to show the speed at which a vehicle can move around a given curve in perfect equilibrium, said first named arm being movable over the second set of scales, and means for locking the first arm to the segment, a carriage movable over the first set of scales, means for securing the carriage to the first arm, a second arcuate segment carried by the carriage and designed to contact with the second arm, said second segment having a scale thereon indicating feet, and means for securing the second segment to the carriage.

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