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(54) **Weighing Platforms**

(57) Weighing platform structure 10 comprising a frame 12 positionable in a road surface and a weighing platform 28 supported on the frame by a plurality of load cells whereby vehicles driven over the platform will cause variations in the electrical characteristics of the cells to permit measurement of the load of such vehicles. The cells are removable by sideward movement thereof into bays 32*a*, 32*b* at opposite ends of the frame. Means is provided for selectively raising the opposite ends of the platform to permit such removal, this means including bolts which are screwable down to press against a part of the frame and raise the corresponding end of the platform 28. The bays 32*a*, 32*b* are covered by plates 34, 36 at opposite ends of the platform. The platform is connected to the frame by pivotal links 48, 50.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

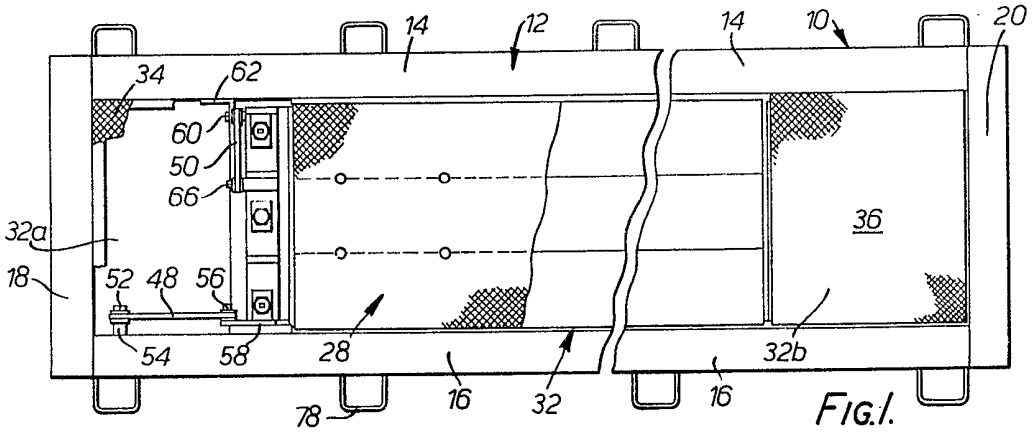

FIG.1.

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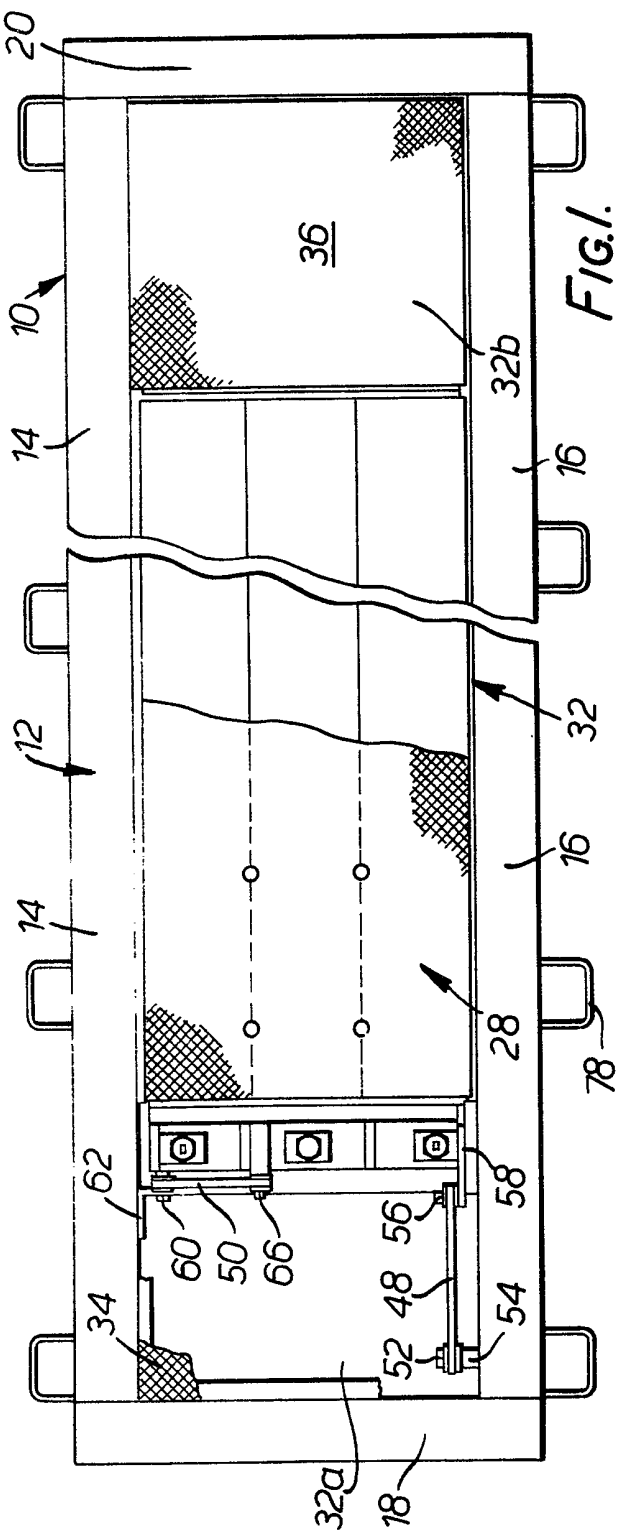

FIG.1.

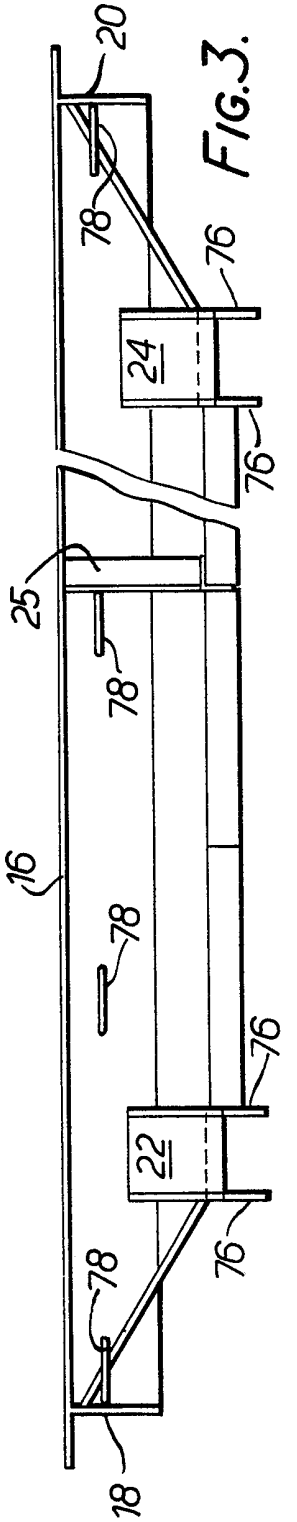

FIG.3.

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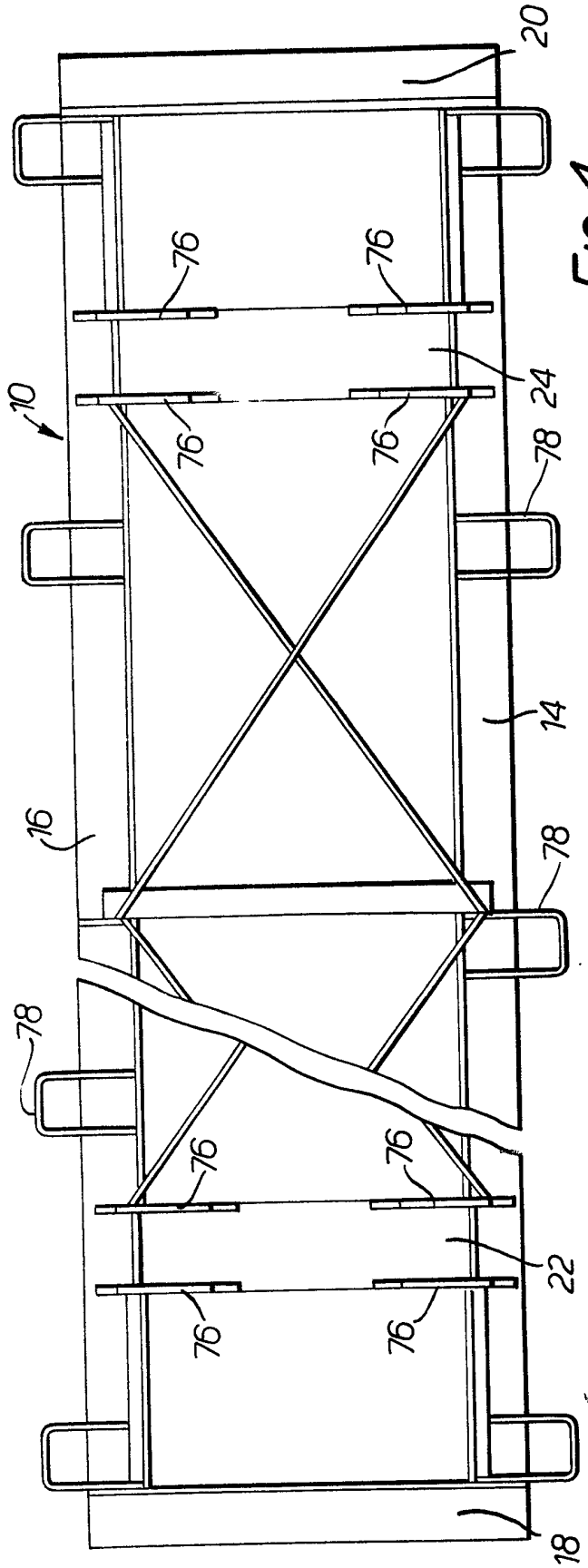

FIG. 4.

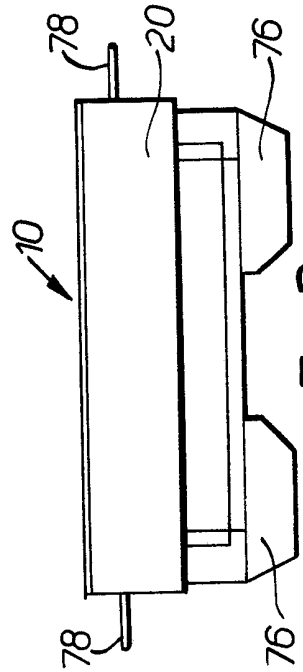

FIG. 2.

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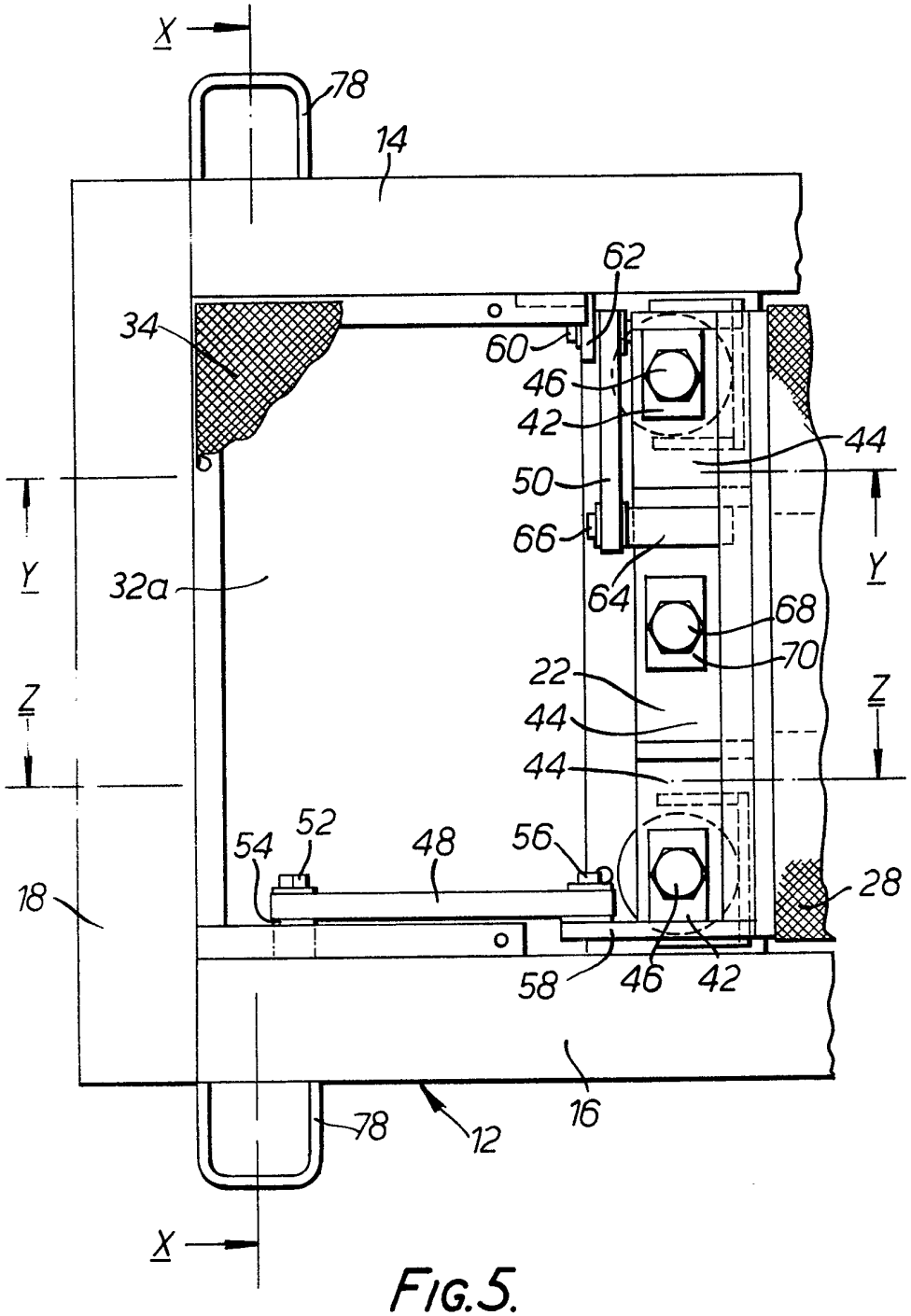

FIG.5.

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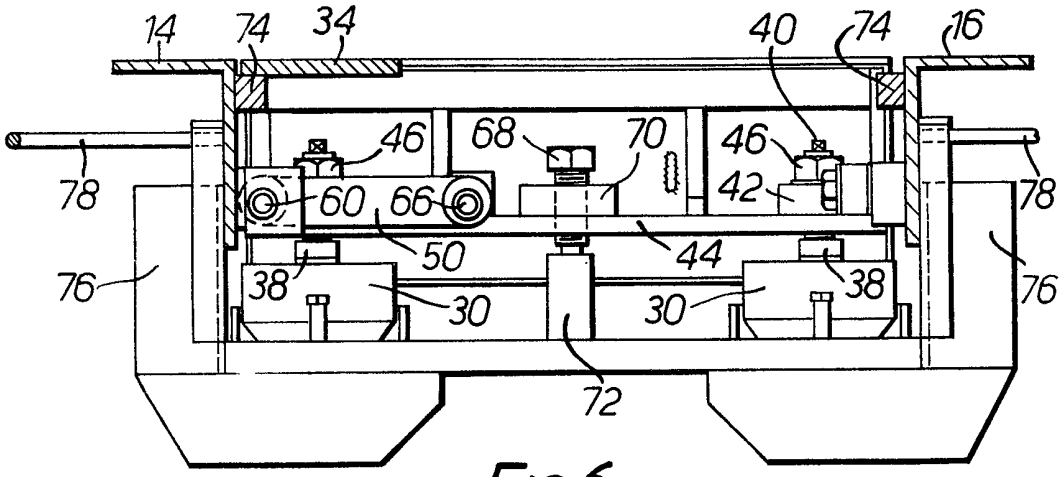

FIG. 6.

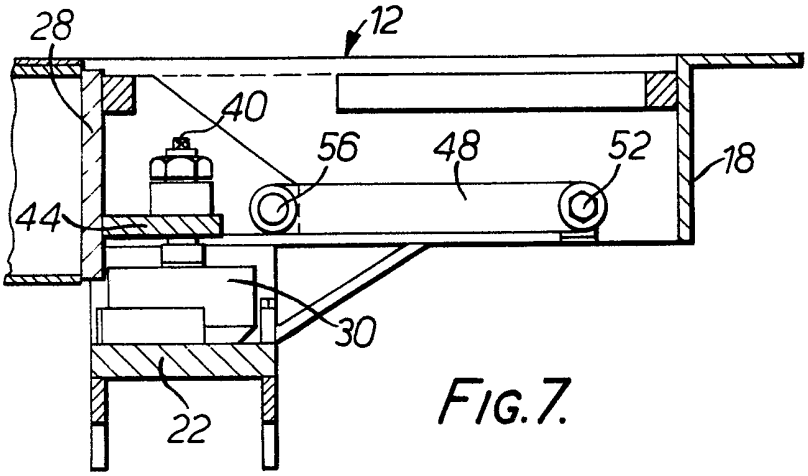

FIG. 7.

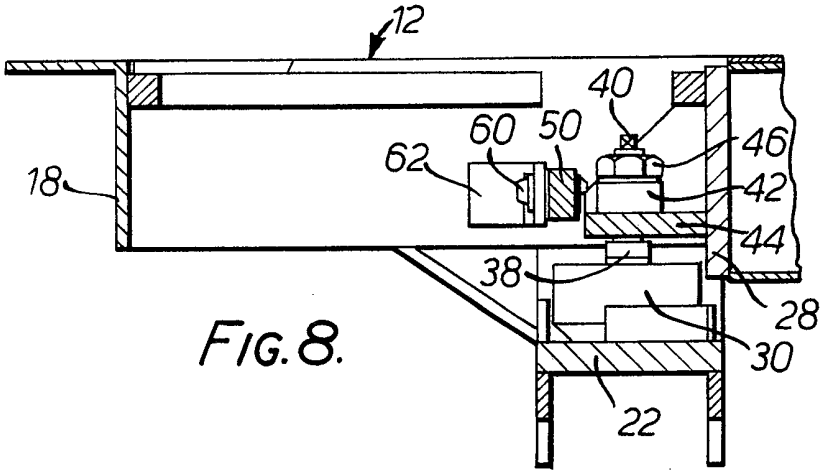

FIG. 8.

SPECIFICATION

Improved Weighing Apparatus and System of Weighing Objects

This invention relates to weighing apparatus and a system for weighing objects, particularly road vehicles and also to a method of preserving roads or like vehicle paths from deterioration.

Policing of axle loading of vehicles using roads in a road network is usually carried out by authorities responsible for the roads in order to deter users from loading vehicles to an extent such that damage to the roads might be caused. The testing has in the past been effected by the use of weighbridges, usually at fixed locations in the road network. Normally, these weighbridges are positioned at stations adjacent to major roads and vehicles are diverted from the roads to the weighbridges, often on a substantially random basis, for checking of axle loads. A difficulty with this system is that the fixed locations of weighbridges become well known to vehicle drivers who frequently use the road system and it is often possible for users to choose alternative routes in the network in order to avoid load checking. Because of the cost of erecting, maintaining and manning a full scale weighbridge, it has not been found feasible to avoid this difficulty by building a large number of weighbridges of the conventional type. A particular diffeculty in this connection is that weighbridge stations are prone to damage by vandals and, since it is not feasible to continuously man stations, special and costly precautions must be taken to render it difficult for vandals to put stations out of action.

It has been proposed to avoid the above difficulty by using weighing apparatus of the type employing a weighing platform with load cells attached thereto, the cells usually being fitted with sensors in the form of electrical strain gauges, and providing mobile electrical instrumentation apparatus equipped to transport the weighing platform to and from prepared platform supporting structures located at testing sites appropriately positioned around the road network. In this case, although a number of supporting structures, usually embedded in specially prepared diversion roads must be provided, only one operative platform, with its associated load cells and electronic instrumentation is necessary, whilst the platform, expensive load cells and instrumentation need not be left at unattended testing sites. In this system, each supporting structure is normally covered with a dummy load plate when not in use for load measurement, this dummy load plate being removed and replaced with an active plate when measurement at the site in question is to be undertaken.

The above system has the additional advantage that, because the costs of preparing each site are relatively small, it is possible to provide a large number of these which can be rendered active on, say, a random basis, thereby making it difficult for persons attempting to negotiate roads in the network to predict a route which will with any certainty avoid an active test site. However, a difficulty with this system is that the active load plate is relatively bulky and quite heavy, making its handling difficult. Further, because of its bulk the load plate will normally need to be towed on a trailer so that the movements of the load plate about the road network are readily apparent to users of the roads. Thus, persons using the road network can often predict in advance which testing site in the network is to be put into use at any particular time so that some of the element of surprise offered by the system is not realised.

An object of the invention is to provide a system of testing axle loads in a road or like network and which at least partly avoids the above difficulty and also to provide a weighing platform construction usable in the system.

The invention provides a weighing platform support comprising weighing platform support means positionable on or in a road surface, a weighing platform and a plurality of load cells between the weighing platform and support means, said load cells being responsive to load on the weighing platform to vary an electrical characteristic of the load cells whereby measurement of such electrical characteristic permits at least approximate measurement of the load over a range of such loads, characterised in that means is provided for raising the platform relative to the support means to enable removal of the load cells from the structure. Normally the support means and platform provide opposed bearing surfaces between which the load cells are located. Preferably the support means is upwardly open and presents an upper opening within which the platform is accommodated to substantially cover the opening. Preferably, the support means is of elongate rectangular form having opposed ends and the platform extends therealong, but having opposite ends spaced from the respective opposed ends of the support means, parts of the said opening to each such support means end not covered by the platform being substantially closed by removable cover plates. Preferably the load cells are supported one pair to each end of the platform, the cover plates removably covering bays within the support means so that when the cover plates are removed and the platform is in raised condition, the load cells can be removed by withdrawal of the load cells sidewardly thereof from beneath the platform, followed by upward movement of the load cells through the said parts of said opening.

The said means for raising the platform may include two lifting devices one at each end of the platform. These may each include a threaded member passing through a cooperating threaded opening in an associated support portion of the platform, to a lower end thereof, which threaded member bears against an associated bearing portion on the support structure whereby

appropriately directed turning of the threaded member will advance the shaft through the threaded opening to cause said raising at the associated end of the platform.

Preferably, the weighing platform is constrained against excessive movement relative to the support means by links pivoted at one end to the platform and at the other end to the support means. There may, for example, be a plurality of links including links pivoted for movement in vertical planes both normal to and at right angles to the direction of extent of the platform and support means.

The weighing platform of the invention is usable in a road or other network of paths along which vehicles can travel, said network being provided with a plurality of testing sites for weighing axle loads or other loads of vehicles using the network, wherein each testing site includes a weighing platform and structure which can removably accept a plurality of electrical load cells to support the platform on the structure, the cells being responsive to load, such as from a vehicle axle, on the platform to cause an electrical characteristic of the cells to vary, a plurality of live load cells being provided, responsive as indicated, and a test vehicle being provided equipped with electrical apparatus connectable to the live load cells for detecting variations in the said electrical characteristic of the live cells to provide indication of a load on a said platform, when supported by the live load cells, whereby the sites may be left with the live load cells removed and the vehicle can transport the live load cells about the network to any desired said site to enable the live load cells to be positioned thereat for measurement of loads at that site. Preferably, a plurality of dummy load cells is also provided, which load cells can removably support a said platform in the same disposition as if the live load cells were present, but which are not responsive as indicated, whereby unattended sites are not responsive as indicated, whereby unattended sites can have the said platforms thereof supported by said dummy load cells, which dummy load cells of any site can be removed and replaced by the said live load cells when that site is to be used for measurement of loads.

The invention is further described with reference to the accompanying drawings in which:

Figure 1 is a plan view of a weighing platform structure constructed in accordance with the invention;

Figure 2 is an end view of the structure of Figure 1;

Figure 3 is a side view of the structure of Figure 1;

Figure 4 is an underside view of the structure of Figure 1;

Figure 5 is an enlarged plan view of one end of the structure of Figure 1;

Figure 6 is a cross-section on the line X—X in Figure 5;

Figure 7 is a cross-section on the line Z—Z in Figure 5; and

Figure 8 is a cross-section on the line Y—Y in Figure 5.

The weighing platform structure 10 shown includes a frame 12 of elongate rectangular configuration. This is formed from four pieces of steel angle section comprising two elongate side sections 14, 16 interconnected by shorter end sections 18, 20 respectively. The frame 12 is reinforced towards the opposite ends thereof by transverse members 22, 24 and, at locations along the length of the frame, by a plurality of upright angle sections 26. A steel weighing platform 28 is supported within frame 12 by four load cells 30, there being two of these towards each end of the platform 28. Platform 28 is dimensioned so as to fit within an upper opening 32 of frame 12, the opening being defined by inner edges of the sections 14, 16, 18, 20. In the direction of the longer dimension of frame 12, the platform is shorter than the corresponding dimension of opening 32 so as to leave open two end portions 32*a*, 32*b* of the opening and these portions are closable by removable covers 34, 36 respectively. The arrangement is such that platform 28, together with covers 34, 36 substantially close opening 32 except for edge spaces around the edges of platform 28, the platform and covers being substantially coplanar with outwardly directed horizontal flanges of the sections 14, 16, 18, 20. Covers 34, 36 rest on ridges 74 on the inner surfaces of sections 14, 16.

Platform 28 is provided with four load pads 38 there being two to either end of the platform. The load pads are located beneath the platform, being carried at the lower ends of threaded shafts 40 which shafts extend through bosses 42 carried on metal plates 44 positioned below and welded to platform 28, there being two such plates 44 one to each end of the platform and each supporting two of the load pads 38. Thus, from the pads 38, the shafts 40 pass upwardly through plates 44 and through threaded openings in the bosses 42 to project upwardly therefrom. The pads are locked at a desired vertical position by nuts 46 on the shafts 40. By loosening the nuts 46, the shafts 40 can be rotated to advance or retract them in the vertical direction to select a desired height for the pads.

The pair of load cells 30 at one end of the apparatus are supported on member 22 and the pair at the other end are supported on member 24. The load cells 30 are of cylindrical configuration, the pads 38 resting on the top of respective ones of the cells to support the platform 28.

By appropriate adjustment of the vertical positions of pads 38, the platform is leveled and positioned to bear evenly on the load cells.

Although the platform 28 is, in this manner, mounted so that loads on the platform are transmitted directly, in an unimpeded manner, from the platform to the load cells 30, the platform is nevertheless maintained constrained against excessive movement by mechanical

interconnection to the frame 12. This mechanical interconnection is effected by four links, two to either end of the frame. Only two of these links, numbered 48, 50 are visible in the drawings, these being the links to one end of the frame. Although the following description is confined to these two links, it is to be understood that the two links to the other end are substantially identical. Link 48 is pivoted about horizontal transverse axes for movement in a vertical plane which extends in the longer direction of frame 12. One end of link 48 is pivoted to the frame by means of a bolt 52, which acts as a pivot pin and which passes through an aperture in that end of the link and into a threaded opening in a projecting boss 54 on the inner surface of section 1. The other end of the link is pivotally mounted on platform 28 by a pivot pin 56 which passes through an aperture in the link and which is affixed to a lug 58 projecting from the end of platform 28. Link 50 is pivoted for movement in a vertical plane and about pivot axes which are parallel to the longer dimension of the frame 12. Thus, one end of link 50 is provided with an opening through an opening which a pivot pin 60 extends, the pin 60 passing through an opening in an angle section lug 62 affixed to the inside surface of section 14. Similarly, the opposite end of link 50 is pivotally secured to a boss 64 projecting from the end of platform 28 this securement being effected by means of a pivot pin 66 which pin passes through an opening in the link 50. The links 48, 50 and the equivalent links at the opposite end of the platform and frame have sufficient slack to permit unimpeded deflection of the platform 28 to the small extent necessary for the purposes of the invention whilst preventing gross movement of the platform 28 relative to the frame.

In order to permit removal and replacement of the load cells 30, means is provided for raising each end of the platform 28. The means at each end is identical and only that at the left hand end of the frame 12 as viewed in figure 1 is described. This includes a threaded bolt 68 arranged with its head uppermost and with the shank extending downwardly through a threaded boss 70 on plate 44, through the plate to a lower end which bears upon the upper face of an upstanding boss 72 projecting from member 22. Thus, by turning the bolt, the lower end of the bolt can be moved to increasingly project below plate 44 to force the platform end upwardly thereby moving the pads 38 away from contact with associated cells 30 to permit removal of these cells.

Access to the load cells and to the bolts 68 at either end of the frame 12 is provided by removing the covers 34, 36. Spaces at each end of the frame which are covered by these covers 34, 36 effectively form servicing bays of the structure 10. Thus, with a cover 34, 36 removed, it is possible for users of the structure to adjust the associated bolts 68, and the nuts 46 as required and to remove and replace the cells 30 by withdrawal, first inwardly, in sideways direction of the frame, and then lengthwise of the frame into the associated bay from which they can then be vertically withdrawn.

Although, in normal operation, the platform 28 is supported as mentioned on the load cells 30, the internal side surfaces of sections 14, 16 are provided with lengthwise extending internal support ridges (not shown) upon which sides of the platform can rest when the cells are removed and the bolts 68 at each end are sufficiently raised.

In use of the structure 10, this is positioned in a prepared hole in a road with ground surface of the road flush with the upper surface of the frame and platform. Frame 12 is then secured in position by, for example, concreting. The frame 12 is provided, in this instance, with a number on vertically arranged downwardly and sidewardly projecting fins 76 and with a number of outwardly extending side loops 78 of steel rod to effectively key the frame in the embedding concrete so as to minimize movement of the frame.

In the present instance, the load cells 30 are electrical resistance elements which vary their resistance in accordance with axial compression loads transmitted thereto. Although various forms of such load cell are available and may utilized in the invention, it is particularly preferred that the load cells be of a type manufactured by Interface Inc. 7401 East Butherus Scottsdale, Arizona, United States, under type identifecation number 1211. It would be appreciated, in this connection, that an as near linear relationship as possible is desired between the load on plate 28 and the resistance of the cells 30. For best accuracy, the cells 30 should be relatively insensitive to side loads and, mainly at least, sensitive only to axial loads as transmitted thereto via pads 38. The preferred cells have been found to be very satisfactory in this respect.

The cells 30 are provided with electrical connection means (not shown) to enable electrical connections to be made thereto by means of an electrical cable and cooperating connectors, the cable being taken out, when one of the covers 34, 36 is removed, via the service bay of the structure so uncovered. This cable provides connection, in a manner known *per se*, to electronic resistance measuring equipment which can determine variations in resistance in accordance with loads applied to the platform 28 and provide, from this, an output, for example a visual display, indicating the load on the platform. The use of the four cells as described enables these to be connected in the bridge circuit configuration commonly employed for this purpose. Thus, to weigh the axle load of a vehicle, the vehicle could be parked on the platform 28 with the wheels of the corresponding axle disposed thereon, although it has been found preferable that the vehicle should drive slowly across the platform in a direction at right angles to the longer dimension of the platform so as to produce corresponding pulse type variations in the resistances of the load cells as each vehicle passes across the platform, which variations are

converted to corresponding electrical pulses by the aforementioned electronic equipment, from which pulses it is possible to determine, in a manner known *per se*, the loading of each of the axles.

For vehicles fitted with load equalizing devices between two or more axles, statically determined axle loads may not be combinable by direct addition to give a total vehicle loading, where this is desired, and this preferred dynamic weighing method enables individual axle loads to be directly combined to give the total loading.

The described arrangement is particularly adaptable for use in a road network where a number of structures 10 would be positioned, for example in small diversions roads, at strategic locations about the network. In this arrangement, the load cells 30 in each structure 10 would normally be removed and replaced by correspondingly shaped dummy load cells. Then, one or more test vehicles is provided which can traverse the road network, each vehicle being provided with the electronic processing apparatus and with live load cells 30 so that an operator of a test vehicle can activate any structure 10 within the network as required, simply by removing cover 34, 36, raising the platform 28 as described, removing the dummy cells and replacing these by the active cells carried by the test vechicle. This permits structures 10 to be selectively activated quickly whilst the test vehicle or vehicles employed may also be quickly moved about the network, thus rendering it difficult for persons attempting to avoid compliance with axle loading requirements within the network to predict a safe route through the network. This arrangement is particularly satisfactory because the electronic equipment and load cells as carried by the test vehicle or vehicles are not very bulky and the vehicles may be relatively inconspicuous on roads in the network, thus making it difficult for users of the road network to follow their movements. The load cells, in this system are precalibrated. Since they are not normally directly associated with the structures 10, recalibration can easily be carried out on a regular basis.

As described previously, the platform structure 10 is designed for use in a road network where a number of platform structures 10 are positioned at locations on roads in the network and live cells 30 together with the electronic apparatus necessary to effect load measuring are transported about the network on a separate vehicle. The platforms 28 which are not, for the time being in use, are supported on dummy cells which are replaced by the live cells wherever a selected structure 10 is to be activated for use.

It will be appreciated that the described weighing platform structure 10 has the particular advantage that the load cells can be easily removed therefrom without the necessity of removing the platform itself so that it is practicable to use it is the above-described way. Particularly, interconnection of the platform 28 to the frame 12 provided by the links 48 and 50 at each end effectively secures the platform to the frame 12 in a manner which permits the operation of the raising of lifting means (i.e. bolts 68) to the extent necessary for changing of the cells. It should be noted too that the links at the same time secure the platform 28 to the frame 12 in a way which renders it difficult for unauthorised persons to tamper with the platform structure 10. Thus, the access covers 34, 36 can easily be provided with locking means so that access to the interior mechanism of the platform can only be achieved by authorised persons. It will be appreciated that it is particularly important that a weighing platform structure for use in the described mode be vandal-proof, since the structure will be left unattended possibly for long periods. The described structure arrangement provides this, whilst at the same time not being unduly inconvenient to activate when required.

Claims

1. Weighing platform structure comprising weighing platform support means positionable on or in a road surface, a weighing platform and a plurality of load cells between the weighing platform and support means, said load cells being responsive to load on the weighing platform to vary an electrical characteristic of the load cells whereby measurement of such electrical characteristic permits at least approximate measurement of the load over a range of such loads, characterised in that means is provided for raising the platform relative to the support means to enable removal of the load cells from the structure.

2. Weighing platform structure as claimed in claim 1 wherein the support means and platform provide opposed bearing surfaces between which the load cells are located.

3. Weighing platform structure as claimed in claim 2 wherein the support means is upwardly open and presents an upper opening within which the platform is accommodated to substantially cover the opening.

4. Weighing platform structure as claimed in claim 3, wherein the support means is of elongate rectangular form having opposed ends and the platform extends therealong, but having opposite ends spaced from the respective opposed ends of the support means, parts of the said opening to each support means end not covered by platform being substantially closed by removable cover plates.

5. Weighing platform structure as claimed in claim 4 wherein the load cells are supported one pair to each end of the platform, the cover plates removably covering bays within the support means so that when the cover plates are removed and the platform is in raised condition, the load cells can be removed by withdrawal of the load cells sidewardly thereof from beneath the platform, followed by upward movement of the load cells through the said parts of said opening.

6. Weighing platform structure as claimed in

claim 5 wherein said means for raising the platform includes two lifting devices one at each end of the platform, these each including a threaded member passing through a cooperating threaded opening in an associated support portion of the platform, to a lower end thereof, which threaded member bears against an associated bearing portion on the support means whereby appropriately directed turning of the threaded member will advance the shaft through the threaded opening to cause said raising at the associated end of the platform.

7. Weighing platform structure as claimed in claim 6 wherein said lifting devices are accessible from within said bays.

8. Weighing platform structure as claimed in any one of claims 1 to 6 wherein the weighing platform is constrained against excessive movement relative to the support means by links pivoted at one end to the platform and at the other end to the support means.

9. Weighing platform structure as claimed in claim 8 wherein there are a plurality of said links including links pivoted for movement in vertical planes both normal to and at right angles to the direction of extent of the platform and support means.

10. Weighing platform structure as claimed in claim 9 wherein said links permit sufficient movement of the platform relative to the support means to permit raising of the platform for cell changing without disconnection of the links.

11. Weighing platform structure as claimed in claim 5 wherein said cover plates are securable to the support means so that the bays are inaccessible so as to preclude withdrawal of the load cells.

12. A weighing platform structure substantially as herein described with reference to the accompanying drawings.

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