LIFT OVERLOAD CONTROL SYSTEMS
Strain Gauge Electronic Overload Protection

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ABSTRACT
Protecting a moving load from being overloaded in a lift installation, whether it is passenger or freight carrying, ensures that the electrical and mechanical components of the entire installation is working within their design parameters. Various other inherent advantages are discussed. The efficiency of the Overload Protection Device has to be of the highest order to detect the load changes evenly, and to be accurately set to trip at the desired load and then maintain these parameters throughout the life of the lift installation without any further intervention or maintenance of parts of the Device itself. The most successful of these Devices is the TINSLEY Strain Gauge Electronic System with a proven long history on most types of lift installations worldwide. Practical illustrations are given.

1 INTRODUCTION

The paper is divided into three main sections. The first is concerned with the main advantages of Overload Protection in general and a brief description of the Tinsley Strain Gauge Electronic Device. The second section of the paper deals with the types available, the installation and setting of the trip points. The final section discusses the application of the device on Compensated Chain Lifts, Hydraulic Lifts, Fork Lift types of car and the Solid State Logic Unit.

2 SECTION 1

2.1 Main Advantages of Overload Protection

We first look at the reasons for Overload Protection and the advantages to all personnel involved with Lifts.

2.1.1 The Lift Owner
With the correct Lift Overload Protection Device installed and set, the Lift cannot be overloaded. The electrical and mechanical components of the Lift are working within their design criteria. The brakes in particular are not having to do excessive work, hence the brake linings will last their intended design life and will not require frequent attention. Maintenance costs are therefore kept low. The Owner benefits from lower running costs.

2.1.2 The Lift User

With efficient overload protection, lift breakdowns resulting from continuous overloaded operation will be dramatically minimised. The Lift will remain in continual safe operation. The only downtime experienced will be subject to the usual routine maintenance barring of course any other external elements affecting its safe operation. Inherent sense of security in safety will be felt by the User if additionally an in-car indicator is used to reassure the User that NO OVERLOAD condition exists. The User benefits from a Lift which is always in operation.

2.1.3 The Lift Engineer and His Company

Urgent Call-outs to Lifts out of action due to misuse by overloading are avoided. It is far better for the Lift Servicing Engineer and his Company to concentrate on routine planned maintenance. His Company can aim towards a planned programme of parts replacement thus maintaining a better control on stock holding of the various parts. Almost certainly the Service Engineer himself will reap direct benefits as he seems to get the blame unfairly, whenever a Lift is out of action, he would not be constantly confronted by irate Users as less emergency breakdowns will occur. As these devices may be installed at any time during the life of the lift installation with minimum downtime, additional revenue can be aimed for by his Company in the sale and installation of the units, particularly of older types of installations.

2.1.4 The Lift Design Engineer

Designing-in the Overload Protection on new installations will enhance the reputability of the Lift Manufacturer. He will be offering his customer a better, safer and a more durable installation. He will also remain with Piece of Mind throughout the life of the Lift installation in that his design will not be overloaded.

2.2 Brief Description of the Tinsley Strain Gauge Electronic Overload Protection Device (See Figure 1)

This device is based on the measurement of strain in the Crosshead of the Lift-car. A very small special strain gauge BEAM SENSOR, bolted to the Crosshead, produces an electrical signal which varies with the amount of strain. This signal is fed to a high-gain high-sensitivity Amplifier within the Control unit. The amplified signal is then compared with a preset internal voltage in the Comparator circuit of the Control unit. This internally produced voltage is manually set at installation. When the two signals are equal the RELAY is tripped. This in turn operates the external circuit and a warning LED is illuminated on the CONTROL UNIT for local indication during installation.

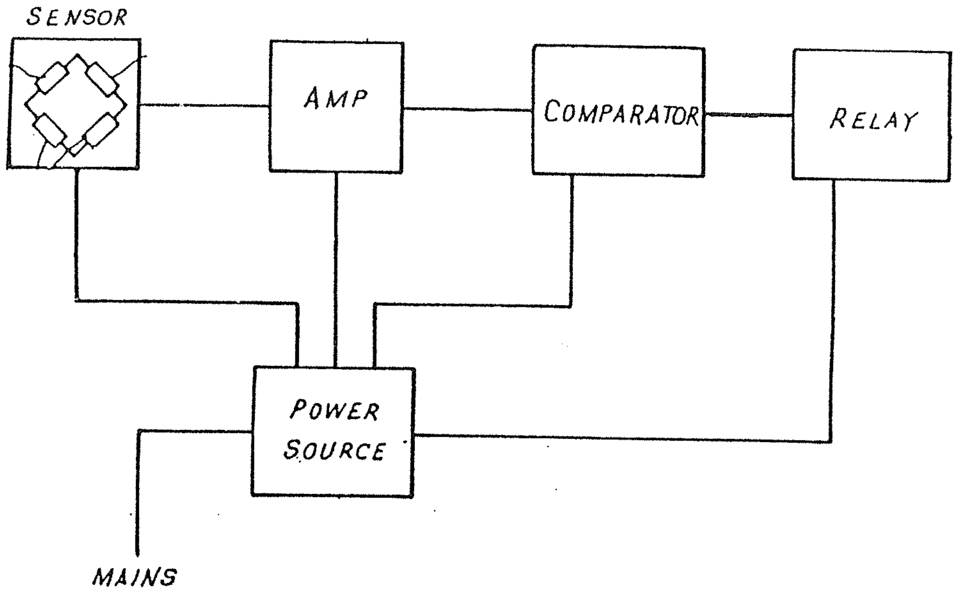

FIGURE 1 Block Diagram of Tinsley Overload Protection Device

2.2.2 The Strain Gauge Beam Sensor

The Load/Strain sensing device is an accurately machined beam which is of bright zinc plated mild steel material measuring approximately 9cms x 1.5cms. High precision strain gauges are accurately attached to both sides of the Beam to form a Strain Gauge Bridge Circuit. The Figure 2 shows the layout of the Strain Gauges and equivalent Bridge.

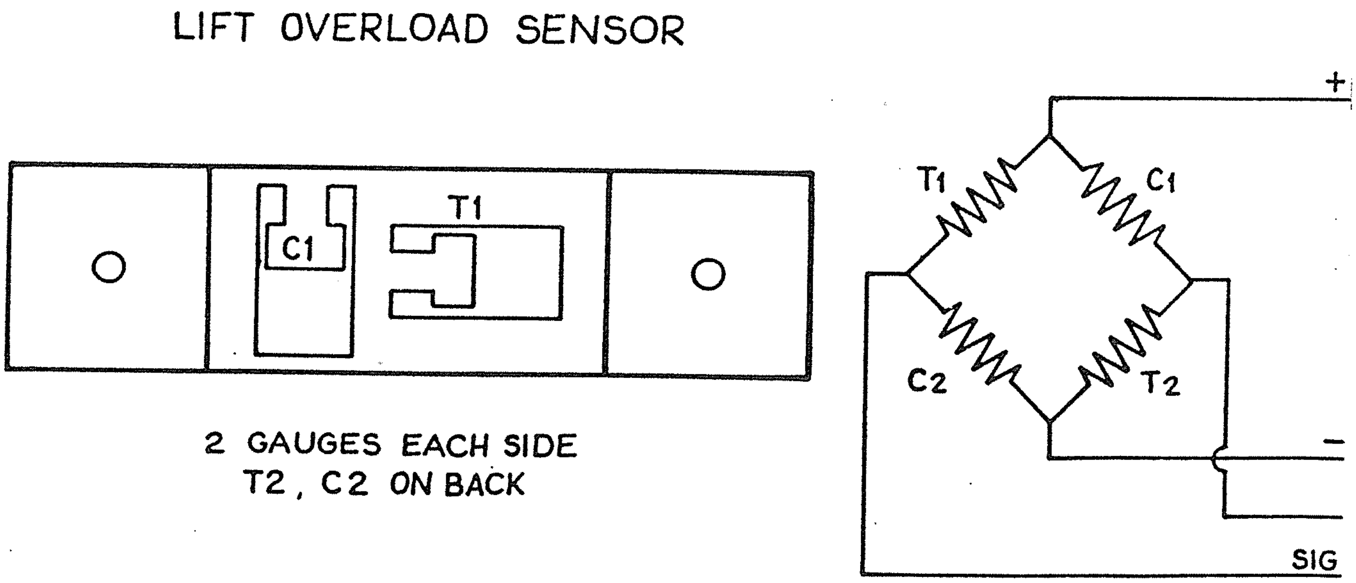

FIGURE 2 Strain Gauge Beam Sensor

From the diagram (Figure 2) it will be seen that if gauges T1 and T2 are elongated (stretched), the ohmic resistance of the gauges will increase and the Bridge circuit will become unbalanced. The electrical properties of a Wheatstone Bridge circuit is that when it becomes unbalanced it gives rise to a voltage signal. The output is then fed to the Amplifier and compared with the present Comparator threshold voltage. When the Bridge voltage signal exceeds the set threshold voltage, the output relay will changeover and LED indicates OVERLOAD condition.

3 SECTION 2

3.1 Types of Strain Gauge Overload Protection Units

The Strain Gauge Beam is the heart of the device and is standard. However, two half Bridge circuits can be used to form a double-sensor detection system for minimal strain response structures. Four Quarter Strain Bridges are utilised at different positions of the car-overload assembly. However, a Four-Sensor unit is rarely required.
The Electronics Control Unit is made in various configurations to suit the different applications. In its most common form, and the most widely used, is the single Set-Point unit. This provides a single Overload trip control and indication via one volt-free changeover relay.
Double Set-Point and upto Ten-Set Point Units (See photograph - Figure 3) provide By-Pass facility, and programming signals for more complex Lift Controllers. ALL Set-Points are fully adjustable from Zero-load upto Full-load and may easily be set at percentage steps to replace the older type of Stepped-Control by micro-switches set under a false floor in the Lift-car.

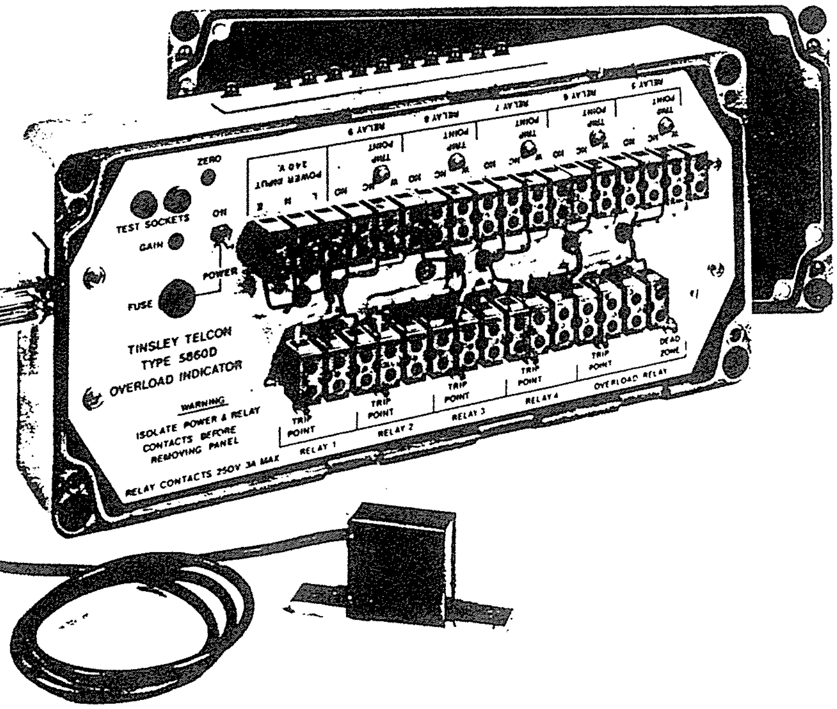

FIGURE 3 TINSLEY TEN-WAY Strain Gauge Overload Protection Unit

Each of the set-points in the multi-relay units can be independently set to trip the relay changeover contacts at any desired percent of full load capacity. The relays may be wired to an external circuit in different ways. In the simplest application the relay output may be used to interrupt the door closing circuit and also apply a circuit to a simple audible Warning and light Indicator Unit.

When the overload is removed the units automatically reset and the door closing circuit will be completed allowing the doors to close and thus the lift to run. Relay outputs may also be used to changeover Power Relays in the machine room to initiate safety circuits in an overload condition if required.

3.2 Installation and Setting-Up

3.2.1 Installation of Strain Gauge Beam Sensor

The installation is a very simple and straightforward procedure which renders the unit to be introduced on existing installations. The downtime experienced is around one hour or less depending on the type of lift structure.

The Beam Sensor is located to the top surface of the crosshead using two high tensile bolts. The location of the sensor along the crosshead is determined by the type of lift structure. The optimum position is that part of the crosshead which truly reflects the changing load inside the car. For example for lifts of single pulley at centre of crosshead the optimum location is one third of the distance along the crosshead from its centre, as shown in Figure 4 below.

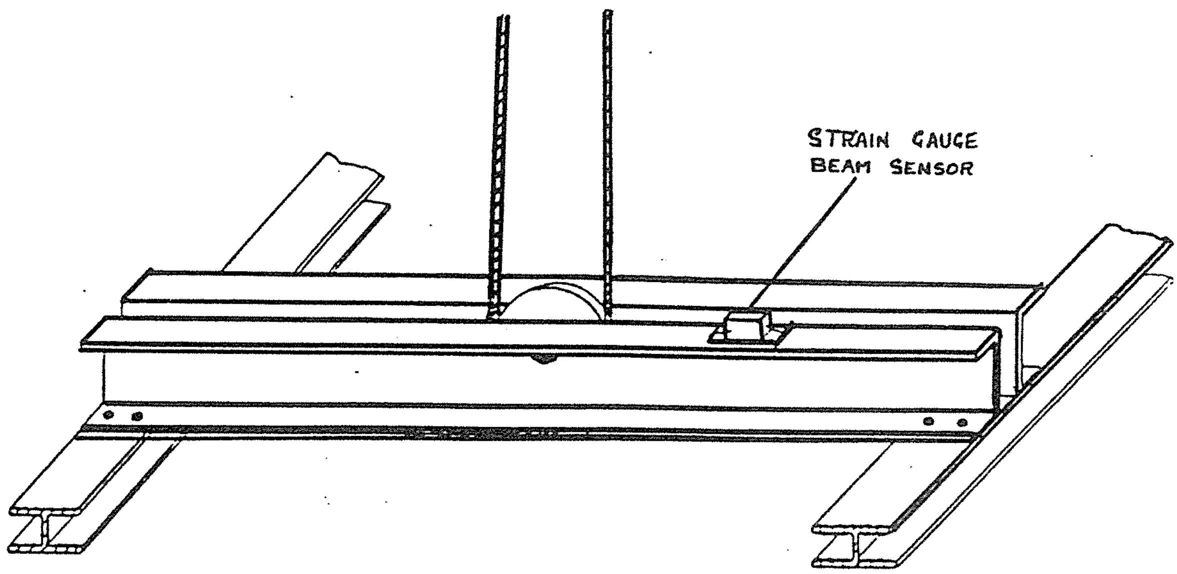

FIGURE 4 Single Pulley Structure Tinsley Strain Gauge Beam Fitting Location

For the Double Pulley mounting on crosshead, the sensor is fitted immediately left of Centre Line on the crosshead, see Figure 5 below.

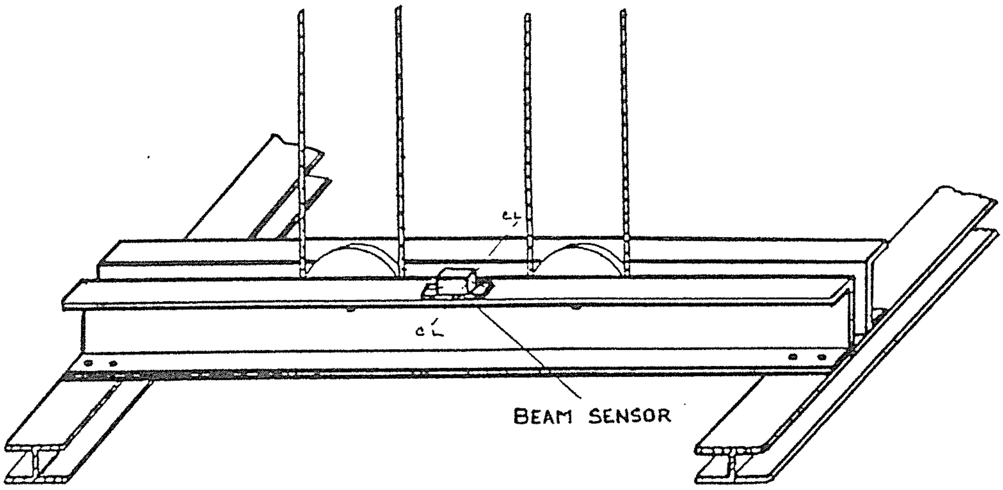

FIGURE 5 Double Pulley Structure Tinsley Strain Gauge Beam Fitting location

The two-pulley and centre strut calls for the sensor to be fitted on the centre strut, two-thirds distance from crosshead beam fixing. See Figure 6 below.

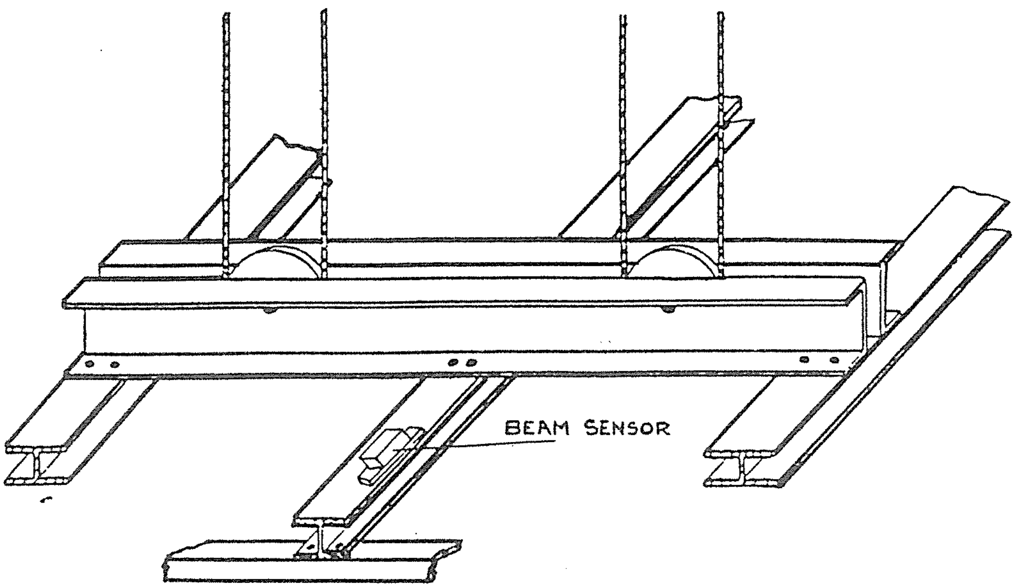

FIGURE 6 Double Pulley - Centre Strut

For lifts with equalizing unit on crosshead and where the equalizer uses more than one pirot point, a varied strain pattern through each section of the crosshead is produced. In this case four Strain Gauge Beam Sensors are fixed as shown in Figure 7 below.

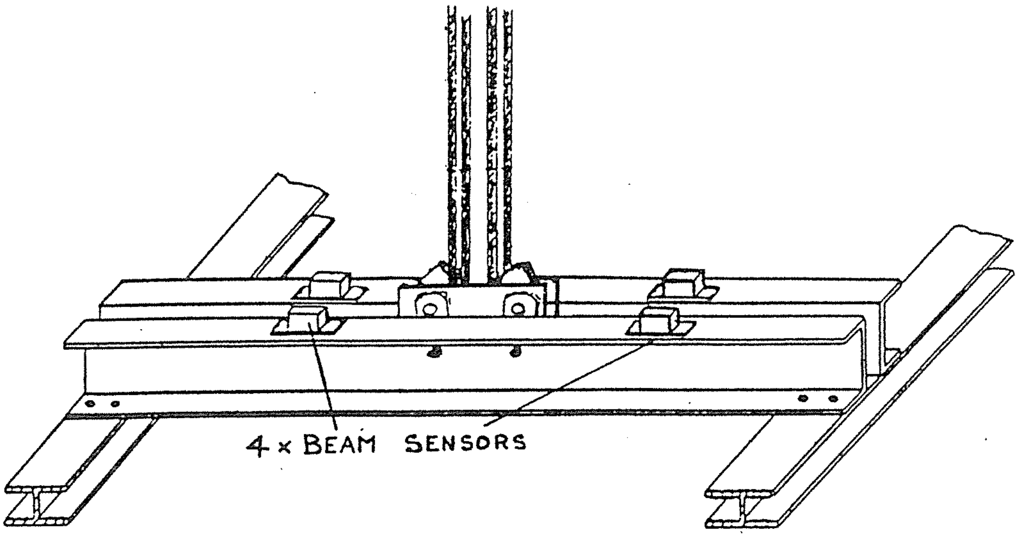

FIGURE 7 Cable Termination Equalizer

3.2.2 Installation of the Electronic Control Unit
The Strain Gauge Beam Sensor comes supplied with connecting lead which is simply plugged-in to the Control unit supplied. The Electronics Control Unit houses the various circuits to accept the electrical signal of measured strain and then gives the output via a relay of an overload condition to trip the external safety circuits. The Control Unit may be fitted anywhere on top or bottom of the lift-car. This unit can be supplied with a selection of voltage levels ranging from 24V DC to 240V AC.

3.3 Setting-Up

Following mechanical and electrical installation of the sensor and electronics unit, the ZERO-LOAD is first determined electrically with No-Load inside the car. A Zero adjuster is provided in the electronics unit and it is rotated until 0 volts are achieved. This balances the Wheatstone Bridge of the sensor.

Test Weights to the required Full-load permissable, are then introduced inside the car. The trip control on the electronics control unit is then rotated until the LED illuminates to indicate that the relay has tripped. The Trip-Control sets the voltage threshold on the Comparator circuit so that when the voltage output (equal to the strain measured against the load) equals this preset Comparator voltage, the output relay trips. As has already been discussed, the output from this relay may then be wired up to the external safety circuits and to a Warning Audible and Light Indicator, inside the car itself or to a remote location.

4 SECTION 3

Compensated Chain, Hydraulic and fork Lifts and the Solid State Control Unit

4.1 Compensated Chain Lifts:-

Any of the models supplied by Tinsley may be used on Compensated Chain Lifts. The Standard Single Beam Sensor already discussed maybe used in a similar manner on those compensated chain lifts where the winding gear is mounted on RSJ's or steel framework at the head of the shaft. The Beam Sensor is mounted on the steel framework or RSJ at the top of the shaft in such a way that it detects and responds to the total weight of the lift car counter balance weight and the ropes. Thus the only change in signal would be due to the changing load inside the car. See Figure 8 below.

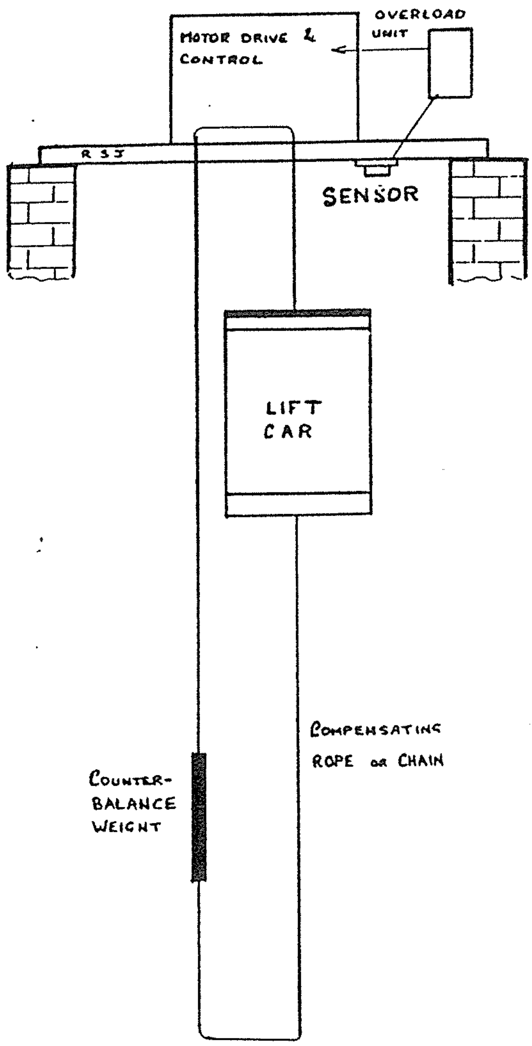

FIGURE 8 Tinsley Device on Compensated Lift (Winding Gear on Steel Framework)

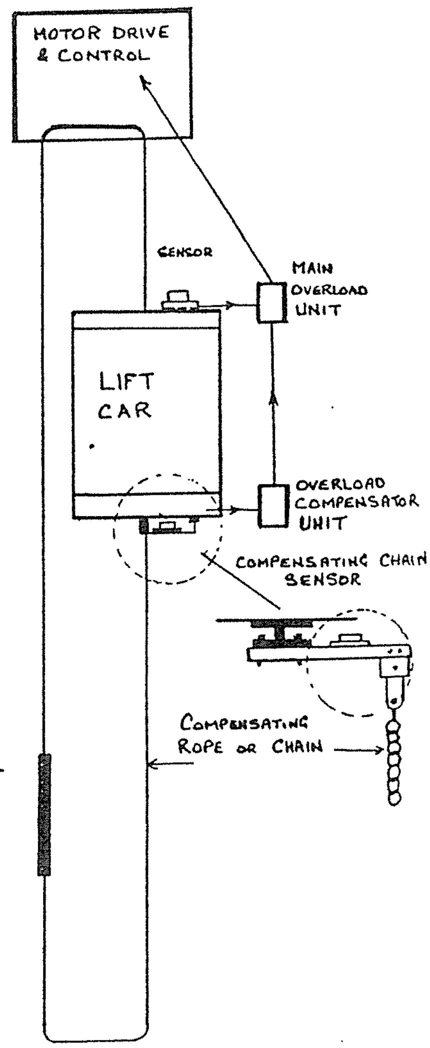

FIGURE 9 Compensated Lift with Tinsley Electronic Compensating Unit

In this system the additional sensor is fitted below the lift-car to compensate for the varying weight of the rope or chain that hangs below the car. The electrical signal derived from this second sensor is then subtracted from the main Strain Gauge Beam Sensor, on top of the car, to electrically remove the varying weight changes of the compensating weight below the car. In many cases, the compensating Strain Gauge Beam Sensor is best fitted onto an extension U-Channel which reacts to strain in response to the weight of the compensating chain as shown in Figure 9.

4.2 Hydraulic Lifts

The Strain Gauge Beam Sensor is also extremely effective on Hydraulic Lift Systems. Figure 10 below shows the location of the Beam Sensor on a standard double hydraulic system. In this case a double half Bridge Sensor is recommended.

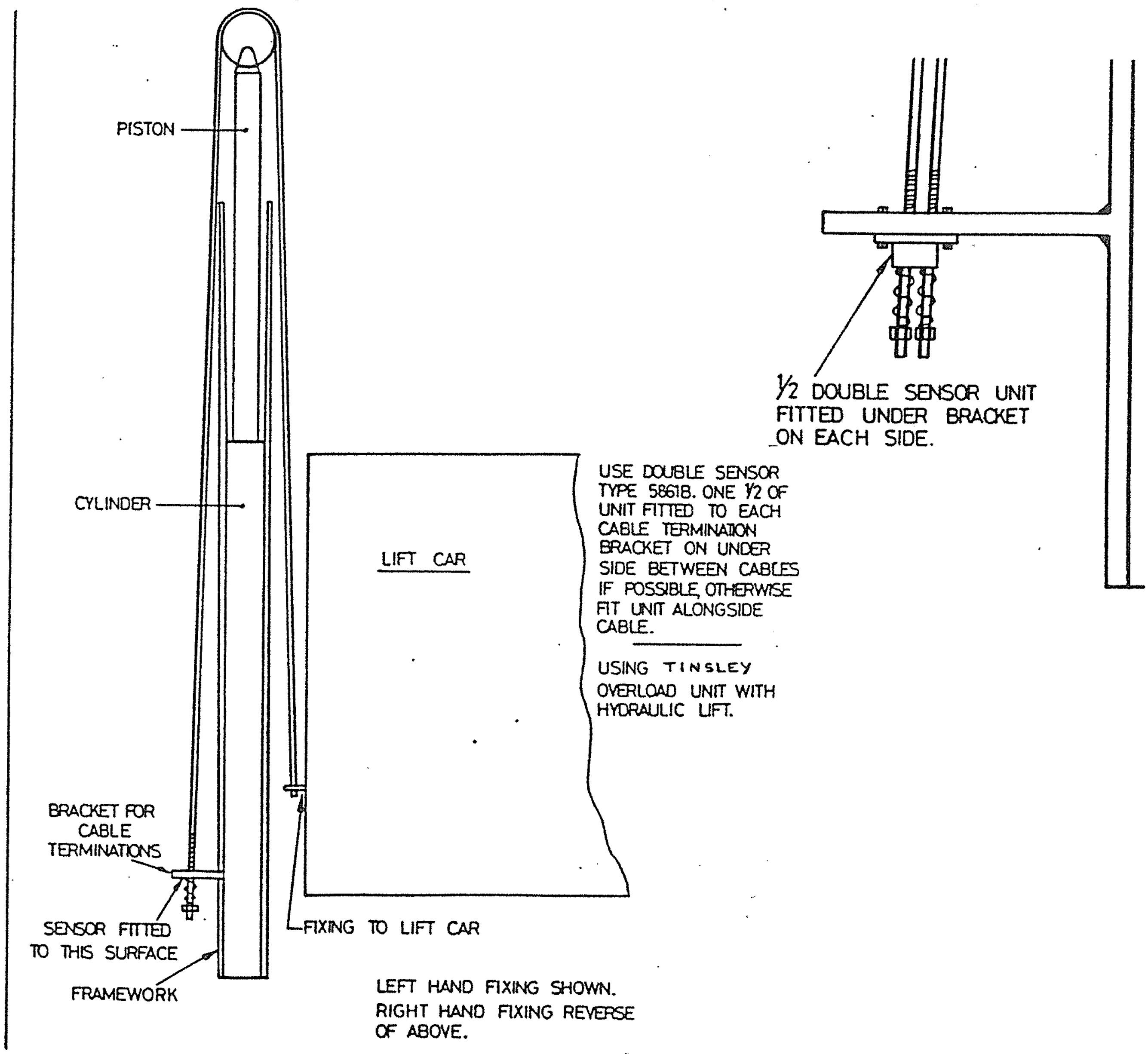

FIGURE 10 Tinsley Strain Gauge Beam Overload Unit applied to a Hydraulic System

4.3 Fork Lift Types

Nowadays, we come across many new designs of suspension systems for lifts. Among these the Fork Lift type of car is becoming increasingly popular. The Tinsley Overload Protection Device is utilised just as effectively on this type of construction. Every load carrying structure has to have a point of maximum strain. The rule of thumb is to look for this point around the structure and if suitable locate the sensor on it or very close to it.

4.4 Solid State Logic Units

In place of the relays of the standard electronic units, the Solid State Logic Unit will provide ten Logic outputs on a set of terminals for external solid state controllers. This would save the need for an Analogue to Digital Convertor Unit.

4.5 Security Device

The Tinsley Strain Gauge Overload Unit is also utilised as a security device, for example in Bank premises. As a Security Device, the unit can be set to prevent STOPS at specified floor levels unless the car is empty. It is also a useful method to prevent the doors closing if a small child is unaccompanied in the lift. In these applications, the ZERO control is adjusted to read a small negative voltage (-0.5V) on a Digital Voltmeter. The trip control may then be adjusted as normal to the required overload trip point.

The Authors would be pleased to advise on suitability to other designs of Lift Geometry on receipt of a sketch of the cable layout or hydraulic suspension.
