

Brake Control System

5 The invention relates to a brake control system for a multiple unit vehicle, especially a railway train, comprising a mixture of motor and trailer units and which has a mixed braking system of dynamic and friction brakes.

10 Dynamic braking systems have been known for some time and offer the advantages of saving wear of friction brake components and also, if the dynamic brake is of the regenerative type, of recovering some of the kinetic energy of the vehicle. However, the efficiency of a dynamic brake is directly related to the velocity of the vehicle and as the speed of the
15 vehicle decreases the dynamic brake has to be supplemented by a friction brake.

Thus virtually any vehicle provided with a dynamic brake must have a mixed braking system
20 including friction brakes and is is therefore well known in the art to employ systems of co-ordinating or blending the operation of the dynamic and friction brakes with the object of maintaining a selected level of retardation throughout a decreasing speed range.
25 In order to make the best use of the dynamic brake such prior art mixed braking systems usually preferentially select the dynamic brake and use a feed-back connection from the dynamic brake indicating the level of braking effort achieved and this is used
30 to "back-off" the friction brake at speed. In such an arrangement as the dynamic braking effort falls with reducing speed the friction brake is brought into operation gradually in order to maintain the selected retardation rate.

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A problem can arise with existing mixed braking systems when a high rate of retardation is selected

because this may be greater than that which can be supported by the adhesion of the dynamically braked wheels. For example, in a multiple unit railway vehicle which comprises motor and trailer cars the dynamic brakes
5 are provided only on the motor cars. Since the wheel to rail adhesion is determined by the load carried by the car but the load is shared between all cars (possibly unevenly) then the load on the dynamically braked wheels may be insufficient to provide adhesion capable of
10 sustaining the required retardation rate. A second problem can arise, especially in the case of railway vehicles, because a railway train of such mixed multiple units is designed to be made up in a fixed order and the equipment of the braking system may not be identical
15 on all motored cars. For example the dynamic brake controller, which preferentially selects the dynamic brake, may be located on only one motor car. In this case if either of the motor cars is faulty it is has to be replaced by another motor car of identical type.

20 The invention has for its object to provide a brake control system capable of predicting the maximum adhesion level of a dynamically braked unit and ensuring that the dynamic effort does not exceed the sustainable level,
25 and in one form of the invention, to provide a brake control system for a multiple unit train in which those parts on motor cars are identical.

According to the invention there is provided a brake
30 control system for a multiple unit train which has a mixed braking system of dynamic and friction brakes, which is made up of dynamically and friction braked motor and friction braked only trailer units, and in which the dynamic brakes are applied preferentially;
35 the brake control system comprising:
i) means for generating a brake demand signal calling for a rate of retardation of the train; load

- responsive means on each said unit operative to provide for each respective unit a load weighed brake signal corresponding to the brake demand signal and in accordance with the load of the unit;
- 5 ii) summing means connected on the input side to receive the load weighed brake signals from all said units and connected on the output side to dynamic brake control means to control actuation of the dynamic brake system, this connection being via dynamic
- 10 brake control signal limiting means also connected at the input side to receive said load weighed signal of each dynamically braked unit so as to be operative effectively to limit dynamic braking to a maximum adhesion limit calculated thereby; and
- 15 iii) friction brake controlling means on each unit connected to the friction brakes of the unit to control the level of friction braking of the respective unit,
- each said friction brake controlling means including
- 20 signal subtracting means connected to receive the load weighed brake signal for the unit, this signal subtracting means on a dynamically braked unit being connected also to receive a signal from the dynamic brake control means representing the dynamic braking effort achieved and
- 25 the signal subtracting means on a unit that is only friction braked being connected also to receive a signal that is a summation of said signal from the dynamic brake control means and said load weighed signal of each dynamically braked unit and hence representing
- 30 the excess of dynamic brake effort achieved over that required by the load weighed signal of each dynamically braked unit.

The invention and how it may be carried into practice

35 will now be described with reference to the accompanying drawings, in which:

Fig 1 shows a schematic block diagram of a mixed brake system of a multiple unit railway train,

Fig 2 shows a modified form of the brake system of Fig 1 in which those parts of the control system on motor cars are identical,

Figs 3(a), (b) and (c) show histograms for comparison of the performance of a prior art control system, the system of Fig 1 and the system of Fig 2 respectively,

Fig 4 shows a block diagram of the electronic brake control system of a three car train, comprising

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two motor cars and one trailer car,

Fig 5 shows a block diagram of the electronics for each of the motor cars of the system of Fig 4,

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Fig 6 shows a block diagram of the electronics of the trailer car of the system of Fig 4, and

Figs 7, 8, 9 and 10 show detailed circuit diagrams for the electronics of the blocks of Figs 5 and 6.

Referring now to Fig 1 there is shown a schematic representation of a three unit train comprising motor cars A and B and a trailer car C. Each of the car units has a friction brake system controlled by electro-pneumatic units 1, 2 and 3 respectively, and car units A and B are also provided with dynamic brakes both of which are controlled by a dynamic brake controller 4.

The brake control system for the whole train is operated by means of a signal carried by a brake demand signal line 5 running the whole length of the train, which is generated by a handle operated unit (not shown) located in the driver's cab. A level of retardation and the corresponding brake demand signal is generated in accordance with the position of the driver's brake control handle. The brake demand signal is decoded on each of the cars A, B and C by decoder units 6, 7 and 8 respectively and the outputs from these decoders control operation of both the friction and dynamic brakes.

Each car unit A, B and C is also provided with a load sensor 9, 10 and 11 respectively the output of which is connected to the decoders 6, 7 and 8 to

modify the brake demand signal to produce in respect of each of the car units a brake control signal on line 12, 13 and 14 which is directly representative of the amount of braking effort required for that car unit.

The preferential application of the dynamic brake is controlled by an adder-scaler unit 15 which receives each of the signals 12, 13 and 14 from the individual car unit's decoders 6, 7 and 8 and generates a signal on line 16 which is supplied to the dynamic brake controller 4 to provide as much dynamic braking as possible. The output of the adder-scaler 15 is connected to the dynamic brake controller 4 through a limiting unit 17 which is operative to limit the dynamic braking effort to a maximum adhesion level sustainable by the motor car units A and B. The output of the load sensors 9 and 10 on units A and B is also connected to the limiting unit 17 enabling it to calculate said maximum adhesion level.

For integral control of the friction brakes on the three car units A, B and C there is provided a feed-back connection 18 from the dynamic brake which indicates the average braking effort of the dynamic brakes on cars A and B, this signal is connected to a blending unit 19 on car A and to a further blending unit 20 on car B. The blending unit 19 is operative to subtract the average dynamic brake signal 18 from the load weighed brake demand signal 12 for car unit A thus producing an output 21 which is supplied to actuate the electro-pneumatic friction brake unit 1 on car A. Similarly the dynamic brake signal 18 is subtracted from the load weighed brake demand signal 13 for car B by blending unit 20 which produces a signal 22 connected to control actuation of the electro-pneumatic friction brake unit 2 on unit B.

5 This latter blending unit 20 also receives the load weighed brake demand signal 12 for car A and provides a further output 23 representative of the excess of dynamic brake effort over that required by the brake demand signals for both cars A and B, which is connected to a further blending unit 24 on car unit C. This blending unit 24 also subtracts the "spare" dynamic brake signal from the brake demand signal 14 for car C to produce an output 25 which is connected to control actuation of the electro-pneumatic unit 3 controlling the friction brake on car unit C.

15 The total dynamic braking effort required is calculated according to the load of all car units, A, B and C, and in some instances, for example, when units A and B are relatively lightly loaded, this can cause wheel slip or skidding because the wheel to rail adhesion limit required to support the dynamic brake effort demanded is insufficient. The limiting unit 17 is operative to calculate the maximum adhesion limit, according to the load weighed signals from sensors 9 and 10, in accordance only with the sensed loads of units A and B. In this described embodiment the brake control equipment fitted to cars A and B is therefore not identical so that if one or other of the car units A and B is temporarily withdrawn from service it has to be replaced by an identical car unit.

30 In another embodiment of the invention, illustrated in Fig 2, in which like parts have like references, the brake control equipment on both motor car units A and B is identical so that either can be replaced by a similarly equipped unit as required. In this arrangement the load weighed brake demand output signal 14 from decoder 8 on unit C is supplied to each of the motor units A and B. In unit A the signal 14 is added to the corresponding load weighed

brake demand signal 12 from decoder 6 by means of an electronic adder 30, the signal from car C is appropriately scaled, i.e. divided by two so as to share the braking effort required between the dynamically braked cars A and B, and the output of the adder 30 is supplied to a limit unit 32 which also receives from load sensor 9 a further signal 33 representing the load of unit A. The limit unit 32 calculates a maximum adhesion level from signal 33 and, if necessary, limits signal 31 and provides a dynamic brake demand signal 34 which is supplied to the dynamic brake controller 35 for actuation of the dynamic brake.

Similarly, on motor car unit B the signal 14, again scaled by a factor of two, is added to the load weighed brake demand signal 13 for unit B by an adder 36, the output 37 of which is also compared with a calculated adhesion limit based on the load signal 38 from sensor 10 by a limit circuit 39 which generates an output 40 connected to the dynamic brake controller 41 of unit B.

The dynamic brakes of cars A and B provide individual feed-back signals, in car A this signal 42 is connected to the blending unit 19 to call upon an appropriate level of friction braking on car A, as before. In car B the feed-back signal 43 is connected to a blending unit 44, which is identical to unit 19 on car A and this calls upon an appropriate level of friction braking on car B.

In order to enclose operation of the friction brake of trailer car C within the system the dynamic brake feed-back signals 42 and 43 are connected to further electric control circuits as follows: in car A, signal 42 is supplied to the input of a subtraction

unit 45 together with the load weighed brake demand signal 12 and the output is connected through a series fixed resistor to a common wire 47. In unit B the signals 43 and 13 are similarly connected to a
5 further subtraction unit 48 the output of which is also connected through a fixed series resistor 49 to the common wire 47. This common wire 47 is connected to a blending unit 50 on trailer car C which includes a common current source connected to the wire 47.
10 Thus, wire 47 carries a total current proportional to the total "spare" dynamic brake effort available on car units A and B, and each of the subtraction units 48 and 49. In the blending unit 50 in car C the total current drain on wire 47 is detected by means of a
15 differential amplifier connected across a fixed resistor and the result is effectively used to "back-off" the friction brake required by the load weighed brake demand signal 14 from decoder 8.

20 The practical result of the above arrangements are contrasted in Fig 3 with the results achieved by a prior art system. The results of this known system are illustrated in Fig 3(a) which shows the weights of the two motor and trailer cars, the retarding force
25 actually produced by the dynamic brakes of the motor cars and the retardation rate required. It should be noted that the preferential selection of dynamic brake with no adhesion limiting has resulted in no braking effort being required of the trailer car.

30 Fig 3(b) represents operation of a system such as that illustrated in Fig 1, which includes calculation of an adhesion limit for each of the dynamically braked cars but assumes equal performance for the
35 dynamic brakes on both cars, and it will be seen as a result that some friction braking effort is required of a trailer car.

Finally in Fig 3(c), in which the individual cars have the same weights as in Figs 3(a) and (b) and where the dynamically braked cars A and B have separate dynamic brake feed-back connections, it is to be noted that compared with Fig 3(b) the performance of motor car A is the same but that the remaining braking effort is shared differently between cars B and C with car B taking a greater share of the retarding force up to its adhesion limit, while the contribution of trailer car C is reduced.

Fig 3(a) clearly shows the over braking on the two motor cars A and B that occurs in prior art systems even before the friction brake on the trailer car is brought into operation. The result of the system of Fig 1 is prevention of the over braking of the motor cars A and B but at the cost of under utilization of the dynamic brake due to the friction brake on the trailer car C being brought into operation earlier. The system of Fig 2 is preferred because, as the results in Fig 3(c) show, the dynamic brake on motor cars A and B is used to optimum and to identical extent.

In alternative arrangements of the system illustrated in Fig 2 current detection in the blending unit 50 on trailer car C may be achieved by alternative arrangements such as a magnetic amplifier, a coil and Hall-effect device, or an optical coupler. The primary requirement for these arrangements is to provide voltage isolation between the current source and the blending circuit which in the system illustrated in Fig 2 is achieved by use of a floating power supply for the differential amplifier.

A practical embodiment of the invention will now be described with reference to the remaining

accompanying drawings. Whilst in these diagrams the electronic circuits are shown complete, many of the components shown serve to bias the active circuits and components, to couple signals between circuits, and others to control the gain of amplifying circuits. The purpose of these components will be immediately apparent, to a skilled electronic engineer, once the functions of the circuits is made clear; thus, the following description will concentrate upon describing the functions of the circuits so as to providing a concise, but meaningful, description.

Fig 4 shows a block diagram of the electronic brake control system of a three car train comprising two motor cars which have an electric traction motor and a dynamic brake in addition to friction brakes, and one trailer-car which has friction brakes only. The drawing shows the inputs and outputs of each part of the electronic system, the original brake demand signal, calling for a level of retardation, is generated in the block labelled encoder (51) within the trailer-car block, in response to operation by the driver of his brake control means.

The block of electronics on each motor car M1 and M2 receives inputs of: the driver's brake demand signal, a suspension load signal, and a brake demand signal for the trailer car. In addition, each of the blocks receives a feedback signal indicating the amount of dynamic braking achieved and a digital signal, indicating dynamic brake fade. Each block produces a dynamic brake demand output signal and a pulse width modulated signal, connected to the trailer car electronics and which indicates the amount of unused of dynamic braking capacity available. The trailer car's electronics receives inputs of the driver's brake demand, a suspension load signal and,

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from each motor car, the amount of spare dynamic brake capacity available. The dynamic brake demand for each motor car is limit in accordance with a maximum adhesion limit calculated in accordance with the weight of the motor car.

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The electronics for each of the motor cars M1 and M2 is shown in the more detailed block diagram of Fig 5 and in the circuit diagrams of Fig 7, 8 and 9, in which like parts have like references. The
10 electronics for the trailer car are shown in the more detailed block diagram of Fig 6 and in the circuit diagrams of Figs 7, 8 and 10, where like parts have like references.

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Fig 7 shows a transducer circuit which is provided on all cars, the transducer 60 comprises an electrical resistance bridge circuit responsive to the load acting on a suspension unit. In an air suspension system this transducer may be responsive to
20 system air pressure. A transducer 16 is energised by the output of a power supply 61 and provides a load influenced voltage connected to the input of an amplifier circuit 62, and through a further inverter amplifier 63 to produce a load signal or suspension
25 pressure signal at terminal 64. This part of the system is not shown in Figs 5 and 6, however, the terminal 64 of a transducer circuit is connected to the signal input suspension pressure 66 in Figs 5 and 6.

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The circuit shown in Fig 8 is also used on both motor cars and trailer cars, the suspension pressure signal is connected to terminals 66. A pulse width modulated signal representing the driver's brake
35 demand from the encoder 51 (see Fig 4) is supplied to input terminals 68 through a decoder circuit generally

indicated at 70, which effectively subtracts a fixed percentage (7%) of the pulse width to ensure that a brake application cannot be triggered by a mere transient pulse, also this allows the electronics to provide a good rising edge in accordance with the requirements of subsequent circuits for reliable operation. The brake demand pulse width modulated signal is connected to one input 72 of an electronic multiplier circuit 74, the second input 76 of which is connected to terminal 66 to receive the suspension load signals. The output of multiplier 74 is the so-called load weighed demand signal 78, which is connected to a blending circuit 80, together with further signals 83, a dynamic brake back-off signal, and 84 a dynamic brake fade input. This dynamic brake fade input signal is a digital signal which is normally 0 when the dynamic brake is working effectively but which changes to 1 when the dynamic brake fades as vehicle speed slows.

The blending circuit 80 also receives a step input from inshot circuit 86, in effect a pedestal level generator actuated in response to any level of driver's brake demand signal and which is effective to actuate the brakes sufficiently to take up any slack in the mechanical system, and to bring the friction braking surfaces into rubbing contact. The output of the blending circuit 80 controls, in the example being described, an electro-pneumatic converter, the output terminal 88 is connected to one end of an electro-pneumatic valve energising coil to control current flow from 110 volt supply through the coil; the level of current being proportional to the brake demand and providing downstream of the valve air pressure to actuate the brakes.

Referring now to the remainder of Fig 5 and Fig 9

the load weighed driver's brake demand signal 78 is also supplied to a first comparator 90 together with the dynamic brake achieved or feedback signal from input 82 which is also used to produce the dynamic
5 brake back-off signal 83 referred to in connection with Fig. 8. The comparator 90 derives the difference between the demand signal and the achieved signal and supplies the results to the input of a pulse width modulation generator 92, the output 94 of which
10 represents the spare dynamic brake capacity available and is connected, as shown in Fig 4, to the trailer car.

The load weighed signal 78 is also connected to
15 one input of a second comparator 96, the second input of which is connected to input 98 and receives the trailer dynamic brake demand signal. This comparator 96 effectively sums these signals to produce a demand signal input 100 to an adhesion limit circuit 102. A
20 further input to this circuit is provided by the suspension load signal for the respective car.

As previously described, the adhesion limit is set according to the calculated maximum brake force that can be sustained for the given load of the
25 vehicle. Therefore there is a minimum retarding force determined in accordance with the tare weight of the vehicle and a progressively increasing retarding force dependent upon the load carried by the vehicle, which relationship has a calculable slope. In the circuit
30 102 there is provided an amplifier 106 having a first input connected to a first potentiometer chain 108, operative to provide an offset voltage in accordance with a minimum dynamic brake retarding force, and the load signal is connected through a second
35 potentiometer chain 110 which determines the slope of

a linear relationship between vehicle weight, as represented by the load signal input and braking force, as represented by the brake demand output.

5 The result of the adhesion limit calculation at the output 112 of the amplifier 106 is compared by a comparator 114 with the resultant total brake demand on line 100, and the result, up to the maximum level permitted, is supplied at terminals 116 to the dynamic brake control
10 circuit as a dynamic brake demand. In the present example this signal is a voltage level within the range 0 to 10 volts.

Referring now to the trailer car electronics illustrated
15 by Figs. 6, 7, 8 and 10; the suspension transducer is as previously described with reference to Fig 7. The load multiplier circuit 76 is connected to the suspension load input 66 and the driver's brake demand input 68, the inshot circuit 86, blending circuit 80 and
20 electro-pneumatic converter output 88 are also as previously described in Fig 8.

Referring to Fig 10. the circuit, which is provided only on a trailer car, has a first input 118 connected
25 to receive the spare dynamic brake available signal at terminal 94 of the electronics of the motor car M1, and the similar second input 120 connected to the spare dynamic brake available signal at terminal 94 of the electronics on motor car M2. These two inputs are passed
30 through averaging circuits 122, 124 respectively before being summed in an adder 126, the output of which provides the dynamic brake back-off signal, which is connected to the input 83, Fig 8 into the blending unit 80 to back-off the electro-pneumatic brake actuating signal
35 according to the amount of braking effort supplied by the dynamic brake. The electronics of the trailer car in Fig. 10

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also includes a circuit to generate the trailer's dynamic brake demand as an output 130 supplied to terminal 98 (Fig 9) of both motor cars M1 and M2. This signal is produced using the load weighed demand signal 78 for the trailer, connected from terminal 79, Fig 8 to terminal 132, Fig 10. As previously mentioned this a pulse width modulated signal and is produced by a continuously running sawtooth ramp generator 134 feeding a constant offset amplifier circuit 136, and in series therewith a variable level offset amplifier 138 controlled by the modulating signal and the output of which is connected through a high voltage output stage to terminal 132.

In the described embodiment the circuit shown in each of the drawings of Figs 7, 8, 9 and 10 is contained on a single printed circuit card, therefore each of the vehicle electronic blocks comprises three such cards, and each is provided with an individual power supply unit as shown in the drawings. All the signals which are communicated between vehicle units are encoded as pulse-width modulated signals on the "sender" card and decoded on the "receiver" card and returned to analogue signal format.

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CLAIMS

1. A brake control system for a multiple unit train which has a mixed braking system of dynamic and friction brakes, which is made up of dynamically and friction braked motor and friction braked only trailer units, and in which the dynamic brakes are applied preferentially;

the brake control system comprising:

i) means for generating a brake demand signal calling for a rate of retardation of the train; load responsive means on each said unit operative to provide for each respective unit a load weighed brake signal corresponding to the brake demand signal and in accordance with the load of the unit;

ii) summing means connected on the input side to receive the load weighed brake signals from all said units and connected on the output side to dynamic brake control means to control actuation of the dynamic brake system, this connection being via dynamic brake control signal limiting means also connected at the input side to receive said load weighed signal of each dynamically braked unit so as to be operative effectively to limit dynamic braking to a maximum adhesion limit calculated thereby; and

iii) friction brake controlling means on each unit connected to the friction brakes of the unit to control the level of friction braking of the respective unit, each said friction brake controlling means including signal subtracting means connected to receive the load weighed brake signal for the unit, this signal subtracting means on a dynamically braked unit being connected also to receive a signal from the dynamic brake control means representing the dynamic braking



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effort achieved and the signal subtracting means on a unit that is only friction braked being connected also to receive a signal that is a summation of said signal from the dynamic brake control means and said load weighed signal of each dynamically braked unit and hence representing the excess of dynamic brake effort achieved over that required by the load weighed signal of each dynamically braked unit.

10 2. A brake control system as claimed in Claim 1, wherein said summing means is a single adder provided on one only of two motor units, said limiting means is a single limiting unit provided on only this one motor unit, and said dynamic brake control means comprises a
15 single controller provided on this one motor unit only so that the single subtracting means on each of these two motor units is connected to receive said signal from this single controller.

20 3. A brake control system as claimed in Claim 1, wherein said summing means comprises an adder on each motor unit, wherein said limiting means comprises a limiting unit provided on each motor unit, and wherein said dynamic brake control means comprises a
25 controller provided on each motor unit; the adder on each motor unit being connected to the controller on that motor unit via the limiting unit on that motor unit.

30 4. A brake control system as claimed in Claim 1, 2 or 3, wherein the limiting means calculates the maximum adhesion limit according to the load of the motor unit.

35 5. A brake control system as claimed in Claim 4, wherein the limiting means limits the dynamic braking in accordance with the lowest calculated adhesion



limit of a motor unit.

5 6. A brake control system as claimed in Claim 4, wherein the limiting means limits the dynamic braking of a motor unit to a level in accordance with the calculated adhesion limit for that motor unit.

10 7. A brake control system as claimed in Claim 2 or any one of Claims 4 to 6 as appendant to Claim 2, wherein the signal subtracting means on said one motor unit is also connected to receive the load weighed brake signal of the other motor unit to generate, from the load weighed brake signals of both motor units, said signal representing excess of dynamic brake effort.

15 8. A brake control system as claimed in Claim 3 or any one of Claims 4 to 6 as appendant to Claim 3, wherein each motor unit is provided with a subtraction unit connected to receive the load weighed brake signal and said signal from the dynamic brake controller of the respective motor unit, these subtraction units being connected to supply their combined outputs as said signal representing the excess of dynamic brake effort to the signal subtracting means of the trailer unit that is only friction braked.

25 9. A brake control system as claimed in Claim 3 or any one of Claims 4 to 6 as appendant to Claim 3, or Claim 8, wherein said dynamic brake control signal limiting means include an amplifier having its input side connected to receive:

- 30 a) a signal representing vehicle load,
35 b) a predetermined offset voltage produced by first circuit means and representing a minimum dynamic brake effort, and



c) a signal produced by second circuit means that is dependent upon a linear relationship between the load signal input and a brake demand output having a predetermined slope.

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10. A brake control system as claimed in Claim 3, or any one of Claims 4 to 6 as appendant to Claim 3, or Claim 8 or 9, wherein each motor unit is provided with:

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A) first comparator means having the input side connected to receive a first signal that is the load weighed brake demand signal for that unit and a second signal representing the dynamic brake effort achieved, this first comparator means being operative to provide a third signal from said first and second signals;

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B) second comparator means having the input side connected to receive said first load weighed signal and a fourth signal that is a solely friction braked unit dynamic brake demand signal, this second comparator means being operative to provide a fifth signal from said first and fourth signals; and

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C) third comparator means having the input side connected to receive said first load weighed signal and said fifth signal, this third comparator means being operative to produce from said first and fifth signals a sixth signal that represents a dynamic brake demand which is connected through a circuit means responsive to a signal from the load responsive means to limit said sixth signal to a maximum level;

and wherein the trailer unit is provided with:

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D) adder means connected for summing said third signals from each motor unit to produce a seventh signal, and

E) blending means connected to receive said seventh

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signal and an eighth signal that is the load weighed brake demand signal for this unit to produce therefrom a ninth signal to actuate the friction brakes of this unit.

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11. A brake control system as claimed in Claim 10, wherein the first blending means is connected to receive a digital signal arranged to change state and thereby actuate the friction brakes when the dynamic
10 brake effort achieved falls below a predetermined level.

12. A brake control system as claimed in Claim 10 or 11, wherein there is provided an inshot circuit in
15 parallel with the blending means and connected to provide sufficient output to the friction brakes to produce rubbing contact.

13. A brake control system as claimed in any one of
20 the preceding claims, wherein means for communicating signals between a motor unit and a trailer unit includes on the one a pulse width modulation signal encoder and on the other a pulse width modulation decoder.

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14. A brake control system substantially as herebefore described with reference to Fig 1, Fig 2, or Fig 4 to 10 inclusive of the accompanying drawings.

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