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CONTROL MECHANISM FOR HOISTS, LIFTS, AND THE LIKE

Filed March 31, 1926

3 Sheets-Sheet 1

Fig. 1.

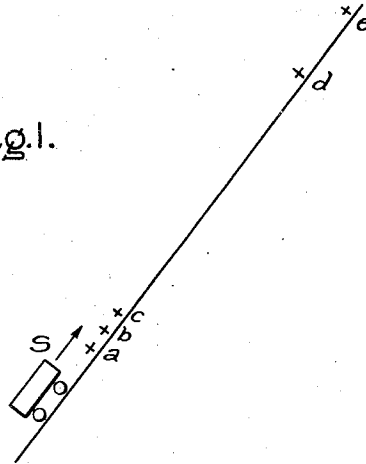
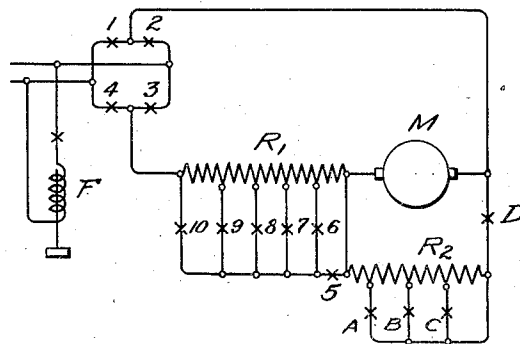


Fig. 2.



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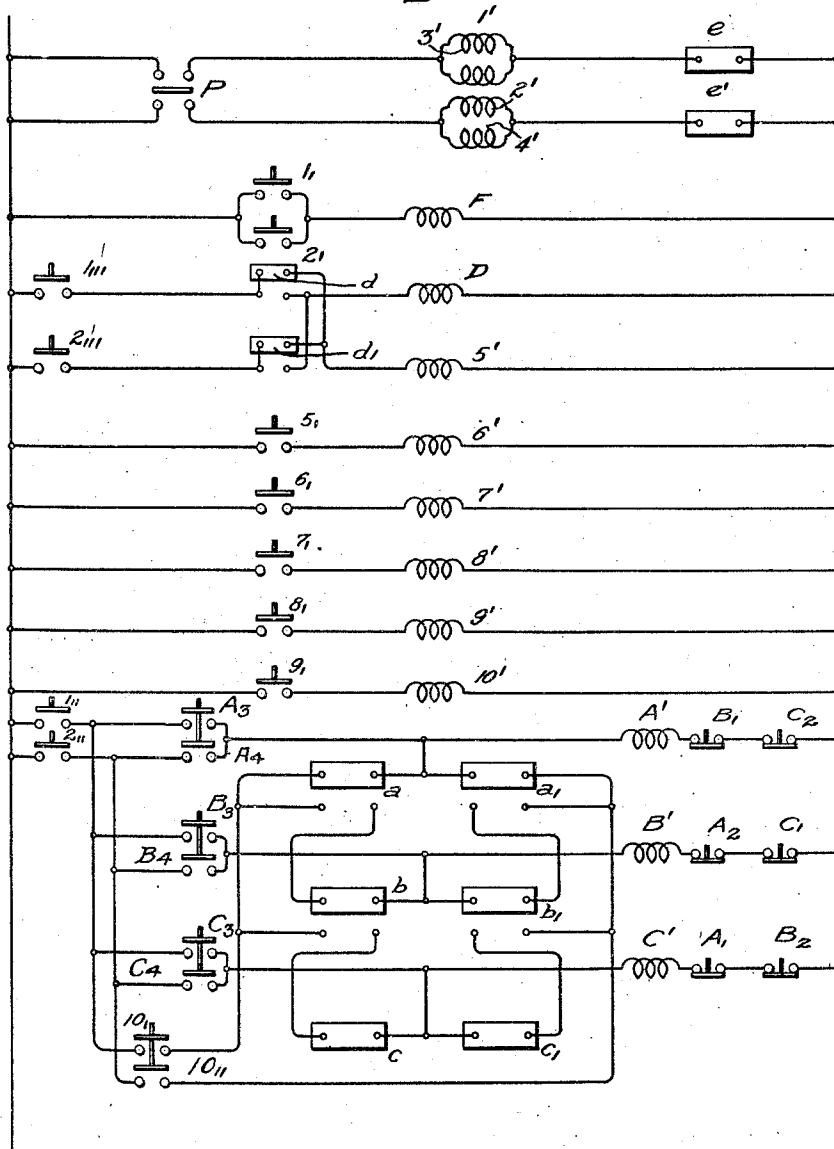
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3 Sheets-Sheet 2

Fig. 3.



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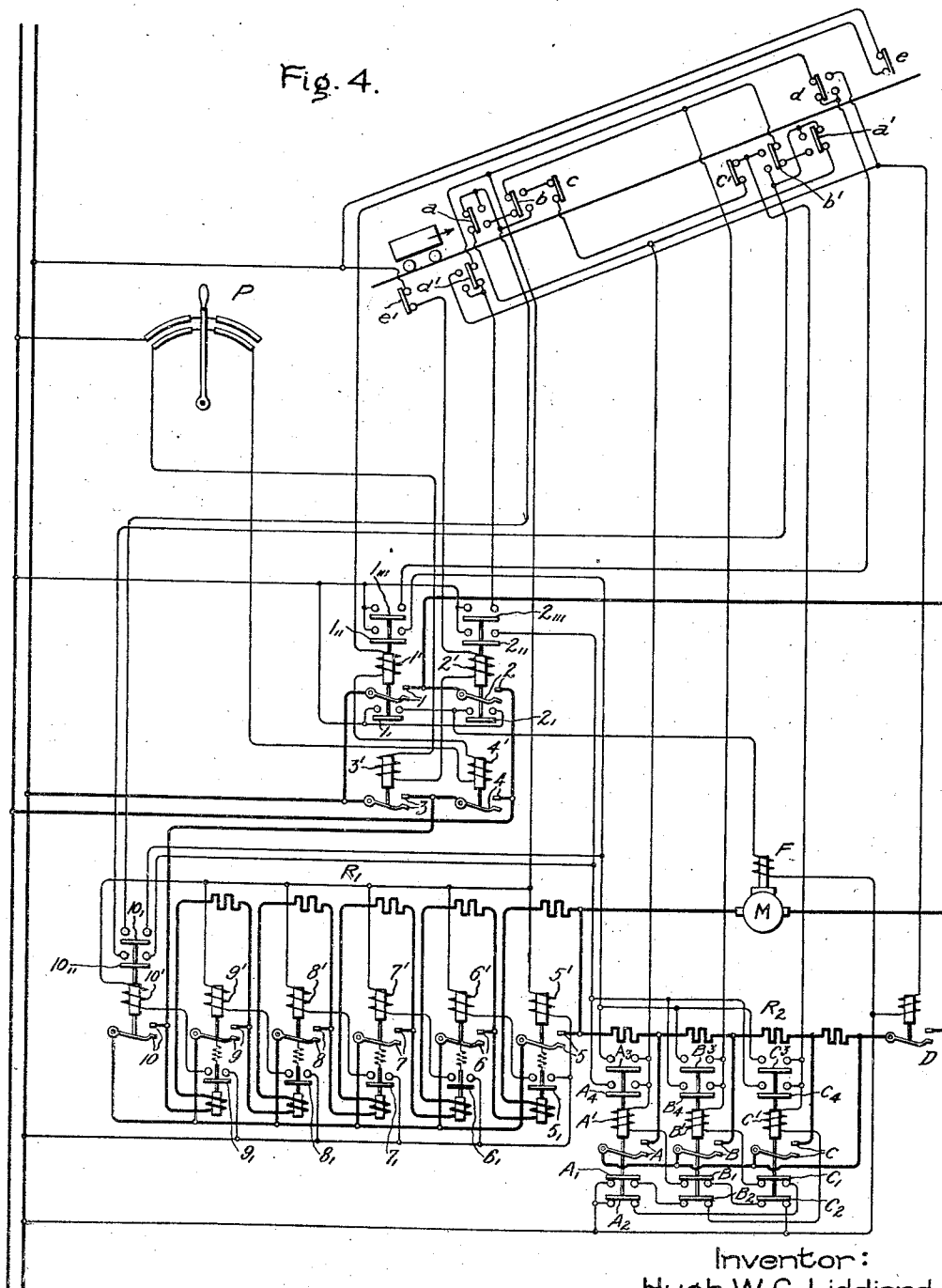
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3 Sheets-Sheet 3

Fig. 4.



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UNITED STATES PATENT OFFICE.

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CONTROL MECHANISM FOR HOISTS, LIFTS, AND THE LIKE.

Application filed March 31, 1926, Serial No. 98,875, and in Great Britain April 6, 1925.

In an electrically-operated hoist, or lift, difficulty is often experienced when using automatic control in ensuring that the skip, or cage, is brought to the correct level under all conditions of load. It is usual to bring in some form of slowing mechanism at a point some distance from the end of the travel, and to stop the skip or cage by a final limit switch. The ordinary form of hoist is one in which the skip or cage is counter-weighted so that the stopping distance depends on the unbalanced load, the inertia, and the speed of travel, and unless special arrangements are provided it is found difficult to ensure that the skip or cage is reduced to a sufficiently low speed with light loads, ascending, and, at the same time avoid stalling with heavy loads, ascending, before reaching the final stop switch, and it is necessary to utilize some form of discriminating device to bring in various degrees of braking on the operation of the slow limit switch, in order to ensure that on the one hand the skip shall be sufficiently reduced in speed, and on the other that it shall not stop. In descending, the condition is the opposite, since with a light load in the skip the unbalanced load is moving upward, and with a heavy load in the skip the unbalanced load is moving downward.

The present invention applies particularly to electrically-driven hoists or lifts, in which the acceleration of the hoist or lift is carried out automatically by means of contactor gear or the like, under current limit control. The time taken to accelerate up to full speed and likewise the distance travelled during the acceleration is dependent on the same factors as govern the amount of braking required to bring the lift or hoist to the required reduced speed prior to being finally stopped. I propose to use the distance covered during this accelerating period for the purposes of selecting the amount of braking required towards the end of the trip, since this distance traveled takes into account the variable factors of the value and the direction of movement of the unbalanced load.

In the accompanying drawings, Figure 1 represents diagrammatically an inclined hoist in which the skip S is hoisted up an incline; at the top of the incline is a stop limit switch e which is tripped by the skip at the position corresponding to the required stopping position. d represents the slow limit switch mentioned above, introducing a varied amount of

braking, according to the requirements as determined by the position of the skip, relative to the selector switches a, b, c at the end of the accelerating period. Similar arrangements can of course, be made to govern the required slowing effect on the reverse travel when the skip is descending, and a separate set of switches will have to be suitably arranged in the reverse order down the track to cover the stopping in this direction, as indicated in Fig. 4, the corresponding "down" switches being designated as a', b', c', d' and e' .

Figure 2 shows the diagram of the main connections for the hoist, in which M represents the armature of the driving motor. 1, 2, 3 and 4 represent the reversing contactors, contactors 1 and 3 being closed for one direction, and 2 and 4 for the reverse direction. Contactors 5, 6, 7, 8, 9 and 10 are the ordinary accelerating contactors for bringing the motor up to speed, these being under current limit control, and cutting out the starting resistance of R_1 in the ordinary manner.

R_2 is a diverter resistance which is introduced during the slowing period for reducing the speed as mentioned above, this diverter resistance being introduced by contactor D, and the amount of which is varied according to the closing of contactors A, B and C, thus varying the amount of braking effect according to the requirements. F represents the brake magnet contactor.

Figure 3 shows a suitable arrangement of the control circuits for the above, in which contactor coils are numbered and lettered so as to correspond to the numbers and letters on Figure 2, and Fig. 4 represents the control system which incorporates the system of Fig. 2 and the system of Fig. 3, the numbering and the lettering of the various parts corresponding to those used on Figs. 2 and 3. In Figs. 3 and 4, P represents the starting switch for closing the contactors in the required sequence, either in the forward or reverse direction. On closing this in, for example, the "up" direction, the mechanical holding brake is first lifted, and the skip is brought up to speed through the agency of the accelerating contactors in the known manner. When all the contactors 5, 6, 7, 8, 9 and 10 are closed, the motor is up to approximately full or normal speed, and on 10 closing, an interlock completes the circuit to the diverter selecting contactors A, B and C, this circuit

being completed through one of the switches a , b and c if reversing contactors 1 and 3 are closed, and through switches a_1 , b_1 , c_1 if reversing contactors 2 and 4 are closed, selection between these two circuits being accomplished by suitable interlocks on the reversing contactors.

Should the skip not have reached switch a (or the corresponding switch a_1 if going in a downward direction), when the last accelerating contactor is closed then the diverter selecting contactor A will close and be retained through its own interlocks. Should the skip have passed the switch a (or the corresponding switch in the downward direction a_1), but not have reached switch b (or the corresponding switch b_1), then diverter selecting contactor B will be closed and retained through its own interlocks. Similarly, if the skip has passed switch b and not reached c , then diverter contactor C will be closed, and finally, if it passes all three switches none of the diverter contactors will close.

On the skip reaching the slow limit switch d (or corresponding switch d_1), this slow switch opens the accelerating contactors 5 to 10, which puts full starting resistances in series with the motor and closes diverter contactor D, which puts an appropriate amount of the diverter resistance R_2 across the motor armature according to the diverter selecting contactor closed. The forward and reverse stop limit switches are indicated at e and e' .

As before stated, the system of Fig. 4 incorporates the system of Fig. 2 and the system of Fig. 3, in accordance with the invention. In this figure, the various parts of the system are lettered and numbered the same as the corresponding parts of Figs. 2 and 3 and the operation of this system is the same as that which has been given in connection with Fig. 3. The field winding of the motor has been omitted as in Fig. 2, since this winding is presumed. Thus, with the skip at the place on the incline as indicated at the top of Fig. 4, assuming that it is desired that the skip proceed up the incline, the master switch P will be thrown to the right, thereby completing a circuit for the operating windings $4'$ and $1'$ of contactors 4 and 1, respectively, through a circuit which includes the right-hand segments of the master switch, the coils $4'$ and $1'$, limit switch e , to the other supply conductor. This will effect the closing of the contactors 1 and 4 and a circuit for the armature M of the motor will be completed through the contactor 4, resistor R_1 , armature of the motor, contacts of contactor 1 to the other supply conductor.

Upon the closing of contactor 1, the lower interlock or auxiliary switch 1_1 thereof establishes an energizing circuit for the winding of the electromagnetic brake F, this circuit being readily traced. The contactor 1 in

closing likewise establishes an energizing circuit for contactor 5 through the auxiliary switch 1_{11} , the travel limit switch d and the coil $5'$ of resistor contactor 5. This contactor is thus energized and closed, but the closing thereof produces at this time no direct effect on the acceleration of the motor. However, the current limit auxiliary switch 5_1 is placed under a bias to the closed position. It will be remembered that I have stated that my invention is particularly adapted to a system in which the motor is accelerated under current limit control. I have selected a conventional system for illustrating this current limit control and I would have it understood that the particular method of current limit control which I have selected for purposes of illustrating the principles of the invention is not necessary to carrying the invention into effect, since other well known forms of current limit control may be utilized as desired.

The auxiliary switch 5_1 is magnetically held in the open position until the current taken by the motor has dropped to a predetermined value. When this happens the auxiliary switch will close its contacts, thereby completing an energizing circuit for the winding $6'$ of contactor 6. Contactor 6 is thus closed and the auxiliary switch 6_1 is likewise placed under a bias to the closed position. When the motor armature current again drops to the predetermined value, the auxiliary switch 6_1 will close its contacts and establish the energizing circuit for the winding $7'$ of contactor 7. The contactors 8, 9 and 10 are then automatically closed in succession under current limit control by the closing of the auxiliary switch 7_1 to energize the operating winding $8'$ of contactor 8, the closing of auxiliary switch 8_1 under current limit control to establish the energizing circuit for the winding $9'$ of contactor 9 and the closing of the auxiliary switch 9_1 under current limit control to establish the energizing circuit for the winding $10'$ of contactor 10. As explained in connection with Fig. 2, these contactors successively shunt sections of the resistor R_1 to effect the acceleration of the motor to the normal running speed.

It will be observed that the auxiliary switches associated with the contactor 10 establish control circuits whereby the contactors A, B and C may be subsequently selectively closed. Thus, in case the contactor 10 has closed before the skip reaches the selector switch a to operate the same, the windings A' and A' of A will be energized through a circuit which may be traced as follows: Through the auxiliary switch 1_{11} associated with contactor 1, auxiliary switch 10_{11} , selector switch a , coil A' of contactor A, through the auxiliary switch B_1 associated with contactor B and the auxiliary switch C_2 associated with contactor C to the other supply conductor. The closing of contactor A will shunt the

major portion of resistor R_2 so that later when the contactor D is closed, merely a small portion of resistor R_2 will be included about the armature M of the motor, and a comparatively great braking effect will be had.

The winding circuit for the coil of contactor A is carried through an auxiliary switch associated with contactor B and also an auxiliary switch associated with contactor C so as to prevent the closing of contactor A in case either the contactors B or C are closed. Likewise, the coil circuit for contactor B is carried through auxiliary switches C_1 and A_2 associated respectively with contactors C and A and the coil circuit for contactor C is carried through an auxiliary switch B_2 associated with contactor B and another auxiliary switch A_1 associated with contactor A, for a similar purpose. In other words, it is desired that merely one of these diverter resistor contactors be closed at a time so that a definite value of the armature shunting resistance is had in dependence upon the extent of the travel of the skip during the acceleration interval while the motor is being accelerated under current limit control.

If instead of the contactor 10 closing before the skip had reached the selector switch a , the contactor 10 had closed when the skip was between selector switches a and b , contactor A would not have closed because of the fact that the closing of this latter contactor is dependent upon the prior closing of contactor 10. Thus, in this case a circuit will be completed for the winding B' of contactor B through a circuit which may be traced as follows: From the left-hand conductor of the supply circuit through auxiliary switch 1_{11} of contactor 1, auxiliary switch 10_1 of contactor 10, selector switch a in the right-hand position thereof, selector switch b in the position indicated in the drawing, coil B' of contactor B, auxiliary switch C_1 of contactor C, auxiliary switch A_2 of contactor A to the right-hand contactor of the source of supply.

In case the skip or car had been loaded such that the car had proceeded past the selector switch b before the final resistor contactor 10 had closed, and before the car had reached the track selector switch c , the contactor C would be closed, the circuit for the winding C' of this contactor being as follows: Through the auxiliary switch 1_{11} of contactor 1, auxiliary switch 10_1 of contactor 10, track selector switch b in the right-hand position thereof, track selector switches c and c' , coil c' and auxiliary switches B_2 and A_1 associated with contactors B and A, respectively, to the other supply conductor. A braking effect corresponding to the unbalanced load would thus be secured at the limit of travel. In case the acceleration of the motor had been such that the car had proceeded past the selector switch c before the final resistor con-

tactor 10 had closed, neither of the diverter resistor contactors A, B or C would be closed. In any event, when the car reaches the selector switch d , the winding of contactor D is energized through a circuit which may be traced as follows: Through the auxiliary switch 1_{11} associated with contactor 1, selector switch d in the right-hand position thereof, coil of contactor D to the other supply conductor. The operation of the selector switch d from its left-hand or lower to its right-hand or upper position, effects the de-energization of the winding $5'$ of contactor 5 so that contactors 5, 6, 7, 8 and 9 will successively open, thereby reinserting the resistor R_1 in the motor armature circuit.

In case any of the diverter resistor contactors A, B and C had been previously closed as above explained, the contactor would have remained closed, since although the winding circuit for these contactors is through an auxiliary switch associated with contactor 10, each of these contactors in closing establishes a maintaining circuit for itself through an auxiliary switch associated with contactor 1. Thus, when contactor A closes it establishes a maintaining circuit for itself which may be traced as follows: Through the auxiliary switch 1_{11} , auxiliary switch A_2 of contactor A, auxiliary switch B_1 , auxiliary switch C_2 to the other supply conductor. Had the contactor B been closed, it would establish a maintaining circuit for the coil thereof through its auxiliary switch B_2 and had contactor C been closed, it would have established a maintaining circuit for its coil through its auxiliary switch C_3 . That means that the particular one of contactors A, B or C which had been closed would have remained closed until the line contactor 1 is opened. The line contactor 1 is deenergized and opened when the final limit switch e is opened. When this happens, the various contactors are caused to return to their positions indicated in the drawing.

From the explanation which has been given in connection with the operation of the equipment, while the skip is proceeding up the incline, it is believed that those skilled in the art will readily understand the operation of the equipment when the skip is proceeding down the incline. To initiate the downward movement, the master switch P is thrown to its left-hand position. The windings $2'$ and $3'$ of contactors 2 and 3 will in this case be closed so as to connect the motor armature to the source of supply for the reverse direction of operation. In this case the auxiliary switch 2_1 performs a similar function to the auxiliary switch 1_1 associated with contactor 1 in effecting the release of the electromagnetic brake F, the auxiliary switches 2_{11} and auxiliary switch 2_{111} associated with contactor 2 perform similar functions to those described in connection with auxiliary switches 1_{11} and

1,111, respectively, of contactor 1. In this case the auxiliary switch 10₁₁ performs a similar function to the described function of auxiliary switch 10₁ and the auxiliary switches A₄, B₄ and C₄ perform similar functions to those those described in connection with auxiliary switches A₃, B₃ and C₃, respectively. Likewise, in this case the selector switches a', b', c', d' and e' perform similar functions to those described in connection with track selector switches a, b, c, d and e, respectively. It is thought that a detailed description of the operation of the equipment when the skip is proceeding in the downward direction will be unnecessary, since those skilled in the art will readily understand the same from a consideration of the operation of the equipment when the skip is proceeding in the up direction.

Although a particular arrangement of control from a direct current supply using diverter control for braking is shown, the invention is not limited to this arrangement, but is equally applicable where an alternating current supply is utilized provided the required selective braking effect can be introduced according to the position of the skip at the end of the accelerating period. It is also to be noted that any number of diverter selecting switches and corresponding diverter selecting contactors can be used, according to the requirements, without departing from the spirit of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of controlling a motor driven device which consists in applying an acceleration effect to the device to effect acceleration thereof to substantially the normal running speed, continuing the running of the device at substantially said speed, and then before a limit of operation of the device is reached applying to the device a braking effect which is automatically varied in value

in dependence on the extent of travel of the device during the accelerating period.

2. In combination, a device, a motor for driving the same, acceleration controlling means for said motor set in operation before a limit of travel of the device is reached for applying a braking effect to the device, and means for automatically varying the braking effect applied by said first mentioned means in dependence on the extent of travel of said device during the period in which the device is accelerated to the normal running speed.

3. In a hoist or the like, a skip or cage, an electric motor for operating the same, acceleration controlling means for said motor, a resistor for effecting retardation of the motor speed, means set in operation before a limit of operation of said skip or cage is reached for connecting the said resistor with said motor, and means for automatically varying the retardation effect of said resistor in dependence on the extent of travel of said skip or cage during the acceleration thereof to substantially a normal running speed.

4. In a hoist or the like, a skip or cage, an electric motor for operating the same, means for effecting acceleration of said motor to a normal running speed, a diverter resistor for the armature of said motor for effecting retardation of the motor speed, a plurality of switches for shunting sections of said resistor, a limit switch for effecting the connection of said resistor to the armature of said motor before a limit of operation of said skip or cage is reached, and a plurality of selector switches for selectively controlling the closing of said shunting switches in dependence on the extent of travel of said skip or cage during the acceleration thereof to substantially normal running speed.

In witness whereof, I have hereunto set my hand this 16th day of March, 1926.

HUGH W. C. LIDDIARD.