Description :–

General :–

The single lever control serves to largely simplify the control of the clutch less two–drum winch, so that the control of the two motors (holding and closing motors) does not depend on the crane operators skill as in the case of two separate master controllers. This systems permits fullest use to be made of the motor capability and the handling capacity of the crane. The ropes and motors are loaded almost uniformly Overloading of motors is prevented.

Important features :–

1 Simple operation with only one lever. The lever is guided in a gate. This prevents maloperation and also permits employment of inexperienced crane operators.

2 Automatic limit switching performed by the grab differential limit switch in all position. i.e. limitation of the closing and opening motion of the grab at any height, limitation at the highest and lowest grab position independently of the closing position.

3 Automatic transition from grabbing to raising without slack rope and loss of time. Automatic distribution of the load over the two ropes.

4 Utilization of the maximum handling capacity of the crane by semi–automatic contactor control of the motors, i.e. maximum possible acceleration of the raising an lowering motions.

5 No overloading of the motors due uneven load on the two ropes and excessive current peaks due to moving the control switch too rapidly from one extreme to the other. The motor capacity is fully utilized, but the motors are not stressed unduly.

6 Only two control position each for raising and lowering viz. one position for slow motion and one for full speed. Approximately equal speed of the motors at all raising and lowering position without a mechanical coupling. This prevents accidental opening of closing or the grab

7 It is possible for the control system to be used to link both motors for hook service, the grab being removed for the purpose. Special circuit connection and additional devices are then required

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Application of the control :–

The control system is designed for simpler handling equipment used for materials of the same grain size (powder like, fine grain materials) with infrequent exchange of the grab. Experience has shown that this control is well suited for this application. If materials are very different grain size are handled the grab differential limit switch may have to be readjusted which should be done only by specialized personnel. The control lends itself to grab cranes having a hoisting speed of 75m/minute(246 ft/min). The ratio of the empty to the full grab should be about 1:2 and should not exceed 1:2.5

(If the laden weight of the grab and the grain size differ considerably, so that exchange of the grab is required frequently, the use of a planetary gear for driving the winches is recommended)

The following detail information is required to ensure satisfactory design :–

* Protected (P 21) or totally enclosed motors (P33), Speed and output of motors based on 40 or 60% duty factor
* Weight of laden grab in kg.
* Weight of unladen grab in kg.
* Hoisting speed in m/min(ft/m)
* Mechanical efficiency in %

Electrical equipment :–

* 2 hoisting motors with slipring rotors, each rated for 55 to 60%of the full hoisting power required.
* 2 brake releases devices (motor thrustor or solenoid type)
* 1 grab differential limit switch OM 393
* 2 sets of contactor for the two motors, preferably installed in sheet steel cabinets
* 2 resistors
* 1 starting resistor each for closing and holding motors
* 2 master controllers, ironclad with universal operating mechanism, ball handle and gate.
* 1 multi motor protection circuit breaker (main crane breaker)
* 1 control transformer (if required)

Additional equipment for hook service (if required) consisting of pacco type rotary switch, 3 pushbutton and 3 control contactors.

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Mode of operation of the control gear :–

In order to handle a maximum of material and to avoid loss of time, the the control lever is moved direct from the Absolute "neutral" through "Closing" to the "Raising 2" position when the open grab lies on the material to be gathered. This switches the closing motor on and simultaneously releases both brakes. The grab closes. The hoisting motor is also on during closing, but with the main and extra resistor in the rotor circuit, thus developing sufficient torque to keep the holding rope taut, but not enough to prevent the grab from digging into the material to be grabbed. Shortly before closing is finished, the differential limit switch bridges the extra resistor of the holding motor, and the latter is run upto full speed automatically by the time relay (If the crane operator has set the control lever to "Raising I" the full grab is raised at about 20 to 30% of the raising speed). To stop the raising motion, the control lever is set to the "Closing" position (zero hoisting). It may remain in this position or be returned to the absolute neutral.

Lowering closed grab:–

The control is moved to the left hand (closing) side of the gate to the "Lowering I" or "Loering II" position. The "Lowering I" position operates by plugging control, both motors being switched on for raising with the full resistor in the rotor circuit. The laden grab moves down against the motor torque, the lowering speed being about 20 to 35% (depending on setting of resistor)

Note:–

In the "Lowering I" position the unladen grab cannot be lowered but remain stationary if in an exceptional case the empty grab has to be lowered when unladen (e.g.through a loading hatch) This can be acieved by jogging control on "Lowering II"

When the control handle is in the "Lowering II" position both motors are switched on for the lowering motion and are brought to the full speed by cutting out resistors by means of a time relay. The load is lowered in the hypersnchronous range (about 110% rated speed with full load)

Opening the grab :–

For opening the grab move the control lever to the right into the "opening" position. The closing motor is switched on as for lowering. When the grab is fully open, the grab differential switch automatically stops closing motor.

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Raising or lowering of the open grab :–

For raising or lowering the open grab, the control lever is moved in the appropriate sense in the right hand slot of the gate. There is no need to wait for the grab to open fully, raising or lowering may begin with the grab partly open. The raising or lowering is initiated immediately the control lever is set to "Raising" or "Lowering". If the control lever is then returned to "Opening" the holding winch is stopped and the opening process is continued, provided the control lever is not returned to the absolute neutral position.

Raising of open grab :–

In the "Raising I" position both motors are started for hoisting. Some resistance is introduced in the rotor circuit of the holding motor, while the full resistance plus the extra resistors are connected into the rotor circuit of the closing motor. The open grab is raised by the holding motor at about 20–30% of the raising speed.
In the "Raising II" position the rotor resistors of both motors are cut out in steps by the time relay and both motor hoist the grab at full speed.

Lowering of open grab :–

In the "Lowering I" position, the holding motor is started for hoisting with the full resistor in circuits, while the closing motor is cut off with the brake released. The empty grab pulls the holding motor in the opposite sense of rotation against the motor torque at approx. 20–30% of the rated speed. The closing rope, which is being pulled downwards by the grab may exert an upwards pull (e.g.in case of considerable frictional resistance) so that the grab begin to close gradually, In this case the differential limit switch is operated, the closing motor receives an impulse for lowering (full rotor resistance and extra resistor) so that the grab re opens. When lowering a greater distance in the "Lowering I" position this may be repeated several times.

In the "Lowering II" position, both motor are started for lowering, the time relay cut outs the rotor resistors step by step, both motor lower the open grab at super synchronous speed of approx. 105% rated speed.

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GRAB DIFFERENTIAL LIMIT SWITCH

* Grab differential limit switch OM 393 has the following functions :-

1. Disconnecting closing motor after closing or opening is completed, independent of height of grab;after closing, cutting-in holding motor for transition of raising.
2. Stopping raising or closing motor after highest or lowest grab position has been reached.
3. If both driving winch are connected to the same side of the differential limit switch and if both have the same direction of rotation, the idler gear wheel must be brought into mesh by the supplier of grab equipment before the commissioning.

* DESIGN AND OPERATION :-

The grab differential limit switch is an iro-clad auxiliary limit switch operated by the holding and closing winch. Its basic design is shown in fig.6. The cam N1 and N6 operate 6 cam switches having the following functions:-

b11 (31-031) cam N1 = limit switch: "Grab closed".

b20 (32-032) cam N2 = leading contact to initiate hoisting after the master controller. has been put right through the "Raising" position and to slow down the closing motor shortly before closing is completed

b 21 (34-034) cam N4 = limit switch: "Grab open".

b 22 (33-033) cam N3 = cam switch to prevent slack rope under the various operating conditions.

b 1 (36-036) cam N6 = limit switch : "Highest grab position."

b 2 (35-035) cam N5 = limit switch : "Lowest grab position."

As shown in fig.6, shaft 1 is driven by the closing winch, and shaft 2 by the holding winch. The gear ratio should be selected that the rated speed of the two shafts are equal. The direction of rotation is optional since by engaging the idler 7, the direction of rotation of the differential housing coupled to the gearwheel 6 can be reversed. Arrange rhe switch for the correct direction of rotation. For detail see Fig.6

If the shafts 1 & 2 are driven simulultaneously at the same speed shaft 4 remains stationary.

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The cams N1 to N4 for actuating the switches b11, b20, b22, b21, are mounted on shaft 4; the hollow shaft 11 carries the cams N5 and N6 operating the switches b2 and b1. As soon as these shaft being to rotate the associated cams are moved also, actuating the associated switch according in their shape.

Adjustable coupling which allow adjustment of the cams N1 to N4 without having to open the switch by removing the cover are fitted on the shafts 1 and 4. Adjustment of the cams and thus alteration of the switch position may become necessary in order to compensate for varying rope lengths or when fitting some other grab having a different closing travel The adjustable coupling are provided with scales, so that the individual positions can be observed and noted down. By means of the adjusting screw on shaft 1, the cams N1 to N4 are adjusted at the same time while the cam N1 and N2 can be adjusted separately with the aid of the adjusting screw on shaft 4. This is of particular advantage when a new grab is fitted and the closing travel has altered. As the switches b11 (31–031) and b20 (32–032) operated by the cams N1 and N2 limit the closing travel, the grab differential limit switch–after changing the grab–can be adjusted to the particular closing travel without opening the cover.

* Closing and opening of grab :–

While the grab closes and opens the shaft 2 remains stationary, since the holding motor has been stopped The closing winch drives shaft 1 and the later, via bevel gear 3, drives shaft 4 with the cams N1 to N4 at a ratio of 1:1.

* Raising and lowering :–

Both motors are in operation during raising and lowering shafts 1 & 2 are then driven at the same speed, shaft 4 is stationary, shaft 2 drives the hollow shaft 11 via the gearwheels 9 and 10. The cams N5 and N6 are fitted on this hollow shaft for actuation of the limit switches b2 and b1 controlling the highest and lowest positions of the grab.

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* INSTALLATION OF GRAB DIFFERENTIAL LIMIT SWITCH :

It is advisable to locate the switch on one side of the winch compartment between the winches, so that it is easily accessible. It may be in a horizontal or vertical position. The horizontal is preferable since it affords better access to the switch elements and the gearing when the cover is removed.

The switch is best driven by auxiliary shafts driven from the winch shafts of the grab hoisting gear. The closing winch is linked to the shaft 1 at the differential gear end. Shaft 2 is connected to the holding winch at the same end or at the other end.

The auxiliary shafts can be driven through spur, bevel or worm gearing. Chain transmission may also be used in which case shafts 1 & 2 should be connected at the differential gear end.

Couplings between auxiliary shafts and switch shafts should be in the form of universal joints, In the case of chain drives, adhere to the maximum shaft centre distances. Given in fig.9

* SELECTION OF GEAR RATIOS :–

As stated under "Design and Operation"(page 5),shaft 1 and 2 of the grab differential limit switch have to run at equal speed during hoisting. shaft4 with the cams N1 to N4 standing still and the hollow shaft 11 with the cams N5 to N6 turning at a quarter of the speed i.e. for every four revolution of the shaft 2 the hollow shaft 11 makes one revolutions. 3 out of these 4 revolutions can be utilized for the total lift of the grab On this basis, the ratio of the reduction gear for the drive of shafts 1 & 2 has to be chosen. It is also necessary to take into account that shaft 1, which is driven by the closing winch, makes an additional 3/4 revolution (about 270°) for the closing travel of the grab, independently of the magnitude of the hoisting travel. The following favourable conditions will result :

3 revolutions of the shafts 1 and 2 for the total hoisting travel (from the highest to the lowest grab position)

0.75 revolutions equaling 270 °for the closing travel of the grab (from grab closed to grab opened)

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* EXAMPLES :–

* Data given :–

L 1 = Rope length for total hoisting travel (m)

L 2 = Rope length for closing travel (m)

L 3 = Rope length for 1 revolution of winch drum (m rev)

The following ratios result :

* 1. For the total hoisting travel :

$$a \quad \frac{\frac{L1}{L3}}{3}$$ where 3 = Number of revolutions utilized

* 2. For closing travel :

$$b \quad \frac{\frac{L2}{L3}}{0.75}$$ where 0.75 = Number of revolutions utilized

The larger ratio will be used for determining the ratios between both the two winch shafts and the two auxiliary shafts.

* Examples of how to find the most favourable ratio are given below :–

* EXAMPLE 1.

L 1 = 40m: L 2 = 10m: L 3 = 1 m/rev.

$$a = \frac{\frac{40}{1}}{3} = 40 : 3 \qquad b = \frac{\frac{10}{1}}{0.75} = 10 : 0.75$$

It is evident that a=b=10:0.75, which is chosen as the ratio.
The shafts 1 and 2 make 3 revolution for the total raising motion. For the closing motion, shaft 1 is turned by 270° = 0.75 revolutions
This ensure the best utilization of the switch.

* EXAMPLE 2.

L 1 = 20m: L 2 = 10m: L 3 = 1 m/rev.

$$a = \frac{\frac{20}{1}}{3} = 20 : 3 \qquad b = \frac{\frac{10}{1}}{0.75} = 10 : 0.75$$

The larger ratio b = 10:0.75 must be chosen

EXAMPLE 2 IS CONTD...
ON NEXT SHEET

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The number of revolutions available for the closing shaft 1 is then $360^\circ \times 0.75 = 270^\circ$ Thus the new ratio for total hoisting travel is:

a' $\begin{matrix} \frac{L1}{L3} \\ X \end{matrix}$ where X = Unknown number of revolutions of shaft 1 & 2

It is stipulated that the ratios must be equal Hence a' b and therefore

$$\begin{matrix} L1 \\ L3 \end{matrix} \qquad \begin{matrix} L2 \\ L3 \end{matrix}$$

$$X \qquad 0.75$$

$$X \cdot \frac{\frac{L1}{L3}}{\frac{L2}{L3}} \cdot 0.75 = \frac{L1}{L2} \cdot 0.75$$

$$\boxed{X = \frac{20}{10} \cdot 0.75 = 1.5}$$

(Only 1.5 of the three revolution available on shafts 1 & 2 for the total hoisting travel are utilized)

---

* EXAMPLE 3.

L 1 = 45m: L 2 = 10m: L 3 = 1.25 m/rev.

$$a = \frac{\frac{45}{1.25}}{3} = 36 : 3 \qquad b = \frac{\frac{10}{1.25}}{0.75} = 8 : 0.75$$

a = The ratio to be selected is 36:3

The number of revolution available for the total hoisting travel hoisting travel of the shafts 1 and 2 will then be 3 revolutions. The new ratio for the closing travel of shaft 1 is :

X $\begin{matrix} L1 \\ L3 \\ X \end{matrix}$ where X = Unknown number of revolutions of closing shaft

since the ratios must be equal b' = a Hence

$$\begin{matrix} L1 \\ L3 \\ X \end{matrix} = \begin{matrix} L2 \\ L3 \\ 3 \end{matrix} \qquad X = \frac{L2}{L3}\ 3$$

$$\therefore X = \frac{10}{45} \times 3 = \frac{2}{3}$$

$$\therefore \frac{2}{3}\ 360^\circ = 240^\circ$$

(Only 240° of the available 270° of shaft 1 for the closing motion are utilized)

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* COMMISSIONING:–

* General :–

These instruction require a knowledge of the description of the single lever grab control, with the associated circuit diagram and the description of the grab differential limit switch OM 393. The under mentioned designation agree with the basic circuit diagram 3 TS 27 S 3293 and 3 TS 27 S 5293.31

* Checking the wiring arrangement :

Work to be carried out during the commissioning
2 men at least are required to carry out this work.
All switching element of the grab differential limit switch except the leading contact b 20 (32–032) are closed by appropriate adjustment of the cams N1, N3, N4, N5, and N6. The switch OM 393, is still disconnected from the gearing.
For testing the contactor control, the links in the multi–motor protection breaker are removed to disconnect the power circuit of contactor before the contactors operate.All contactors and relays should be clearly designated. Then the multi–motor protection breaker (automatic crane breaker) is reclosed.

* CLOSING :–

The control lever of the master controller is set to the "closing" position The contactors 2c1, 2c7, and 2c43 must closed immediately, where as the rotor contactors 2c42 and 2c41 close after a time lag introduced by the time relays d42 and d41. The time relays should be set at about 1 second After separate opening by hand of the switches b 11 (31–031) and b1 (36–036) in the grab differential limit switch, the contactors 2c1 and 2c7 must open.
The control lever of the double master controller is now set to "Opening".
The contactors 2c2,2c7,2c43,and 2c42 must close immediately, where as the rotor contactor 2c41 closes with a time lag introduced by the time relay d41. After separate opening by hand of the switches b21 (34–034) and b2 (35–035) in the grab differential limit switch the contactors 2c2 and 2c7 must open.
The control lever is moved to the "Raising II" position through the "Closing" position. the contactors mentioned under "Closing", as well as the contactor 1c7, 1c1, 1d1, 2d12 must be energized.

contd.....

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The leading contact b20 (32–032) in the grab differential limit switch is bypassed with a makeshift bridge and the armature of the time relay d43 is held. For this purpose the time relay casing is opened. Then the rotor contactor 2c44 must close whereas contactors 1c43, 2c42 and the time relay d42, d41 are opened The rotor contactors 2c43 and 2c41 remain energized, but 2c41 only if its NO contact 13–14 is connected If the armature of the time relay d43 is now released, the latter starts energizing the auxiliary contactors cd11, 2d10 and thus 1c44 and 1c43 after the predetermined time lag of 0.25 secs. The time relay d42 starts and energizes the contactors 1c41, 2c41, after a tome lag (if it had been deenergized), the tome relay d40 starts down and energizes the contactors 1c40,2c40 after a time lag.
Further switching operation may be checked according to schematic wiring diagram with the purpose of making sure that the actual wiring agrees with the schematics diagram.

* Checking of brakes :–
After the leads to the stator of the motors and the brake release devices have been connected up, the brakes are checked. They must be checked as follows :
Brake springs, which should be as strong as possible and equal on both brakes, so that the brake release devices are utilized upto 90% of their thrust. This ensure the shortest breaking time and shortest stopping distance. When the brakes are released , the gap should be as small as possible and equal at both shoes.

* Fitting and adjusting the rope :
the rope for the holding and closing winch are fitted to the drums and received on the grab by makeshift controlling of the contactors.
The grab is closed and brought to the highest position. The master controller can be used already now, the leading contact b20 (32–032) in the differential limit switch may be opened.

* Grab is closed and in highest position :
The cam N1 is so adjusted that the switch b11(31–031) open when the grab is fully closed. close the leading contact b20(32–032) by adjustment of the camN2. Precision adjustment of the leading contact b20 only after adjustment of the resistors. The cam N6 is so adjusted that the switch of b1 (36–036) opens when the grab is in the highest position.

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The grab differential limit switch is connected to the two winch drums. Make sure of the proper direction of rotation. see Fig.6

* Lowering grab :–
The control lever is set to the closing side and "Lowering II"

* Opening grab :–
Control lever at "Opening". Cam N4 is so adjusted that switch b21(34–034) opens with the grab fully open. Switch b22 (33–033) is so adjusted by means of cam N3 that it opens shortly after b21(about 5mm on the cam) Slackening of closing rope should be avoided.

* Lowering grab of lowest position :–
The control lever is set to "Lowering II". The cam N5 is so set that switch b2 (35–035) opens as the lowest position is reached.

* Adjustment of resistors :–
Slow raising of the open grab.

* Raising of open grab :–
The control lever is set to "Opening" and the grab is opened. After opening the control lever is set to the right–hand side (opening side of the gate, position "Raising I"). The contactors 2c1,2c7,1d1,1c1,1c7,1c43 and 1c44 are energized. The holding motor should run at about 20 to 25% rated speed in the raising direction. If the speed deviates considerably from this value, change the tapping of the rotor contactors 1c43 on the resistor. (if the speed is too high the resistance must be increased and vice versa.) The tapping on the resistors of the rotor contactors 2c43 of the closing motor must correspond exactly to those of the contactors 1c43. the closing motor too must run in the raising direction at about 20 to 25% rated speed when the control lever is in the "Raising I" position. This is achieved by appropriate adjustment of the extra resistor.

* Raising closed grab :–
Slow raising of the closed grab.With the same resistor tapping as previously the full grab too will be raised at 20 to 25% raising speed when the control lever is moved through "Closing" to the "Raising" position. The contactors 2c1,1d1,2c7,1c1,1c7,1c44,2c44,1c43,2c43,2d12,2d11 and 2d10 pick up. The partially filled or empty, closed grab will be raised correspondingly faster.

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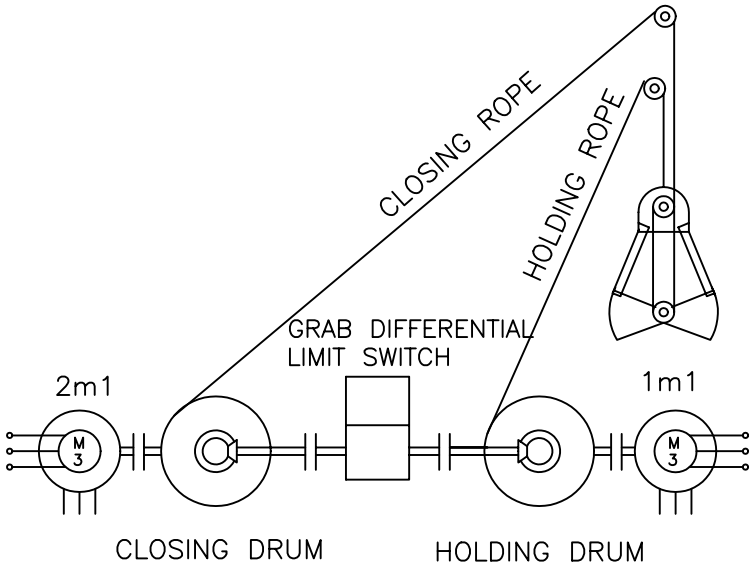

FIG.2 PRINCIPLE OF A CLUTCHLESS TWO DRUM WINCH WITH DIFFERENTIAL LIMIT SWITCH

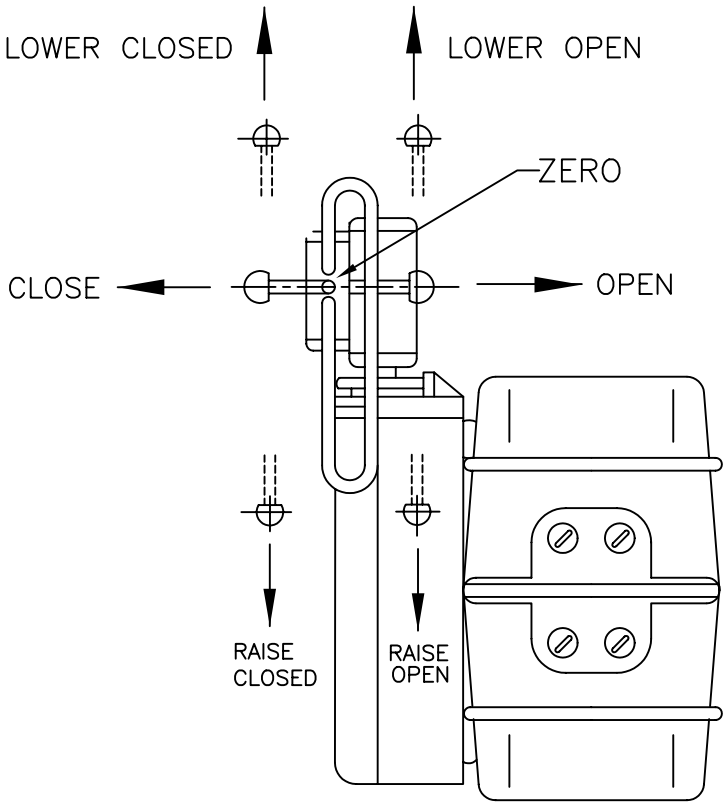

FIG.3 DOUBLE MASTER CONTROLLER WITH GATE

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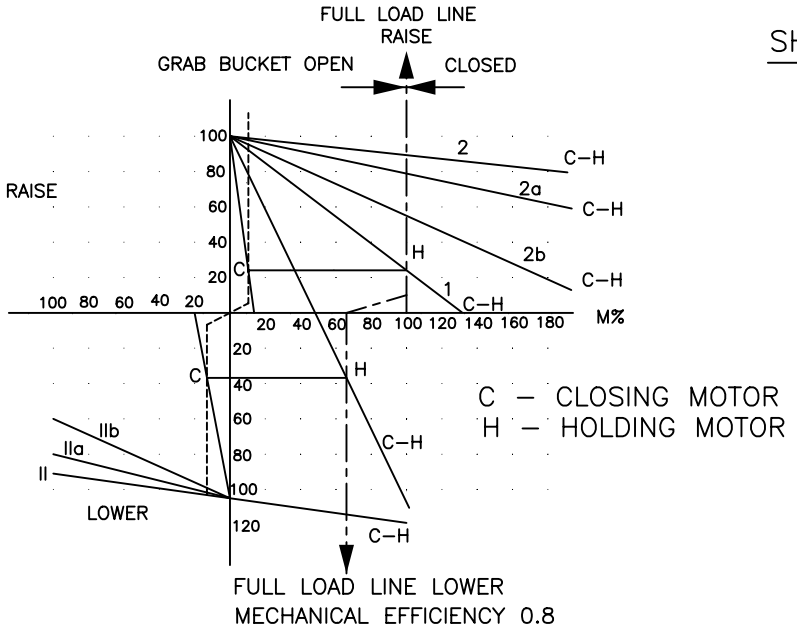
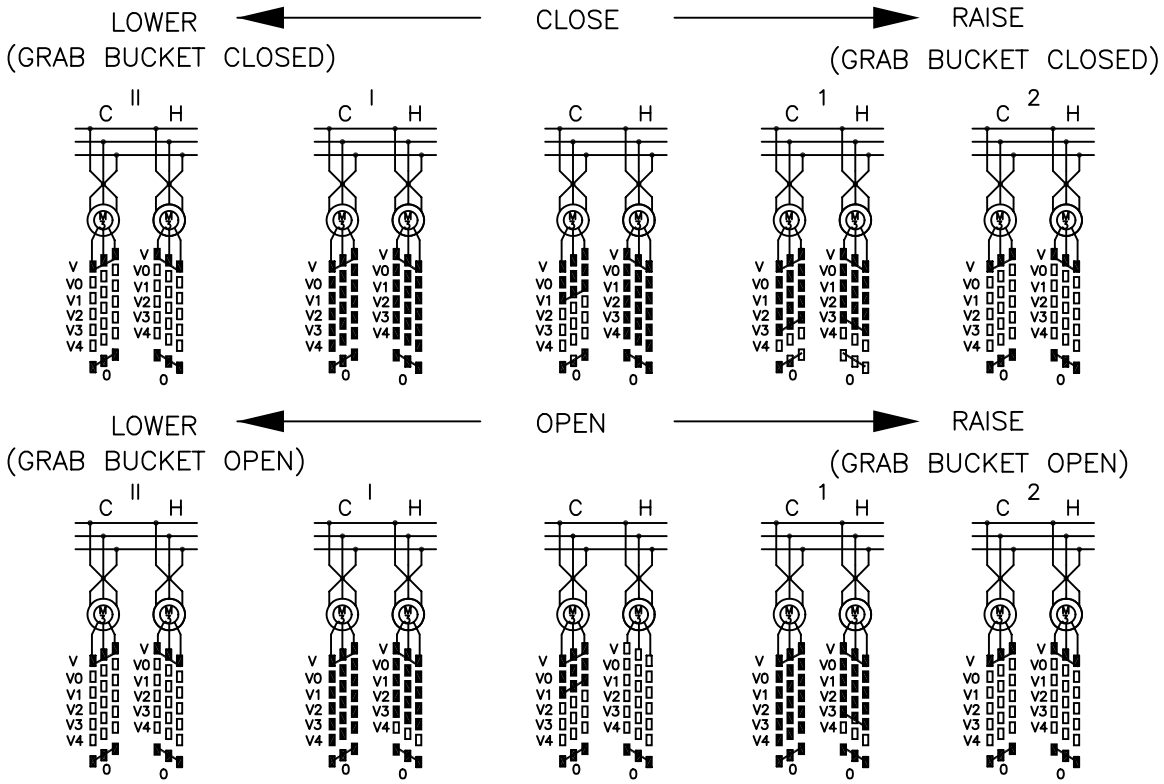


FIG.4 SINGLE LEVER CONTROL CHARACTERISTIC



SWITCHED ON ONLY DURING CLOSING WHEN CHANGING TO "RAISING" THROUGH THE "CLOSE" POSITION.

FIG.4 BASIC CIRCUIT DIAGRAM OF SINGLE LEVER CONTROL

		WRITE–UP FOR DIFFERENTIAL LIMIT SWITCH			Speed-O-Controls Pvt. Ltd. MUMBAI–400 072.	
REVISION	DATE	DRAWN	MPC	MATERIAL		AUTOCAD FILE NAME:– D:\PF..\SOC.\LI.SW.\LS TEXT
		TRACED		TOTAL WT.		
		CHECKED		SCALE	NTS	DRG.No.:–
		APPROVED	K.R.D.	DATE	15.02.2000	

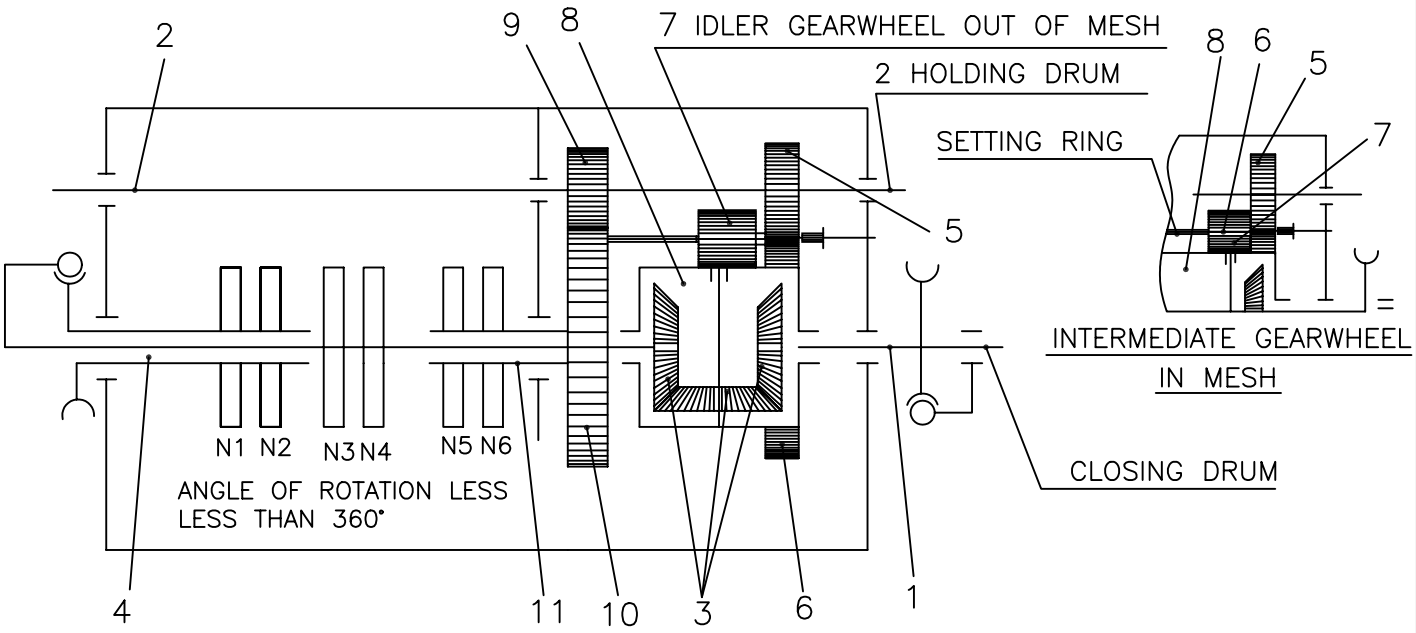
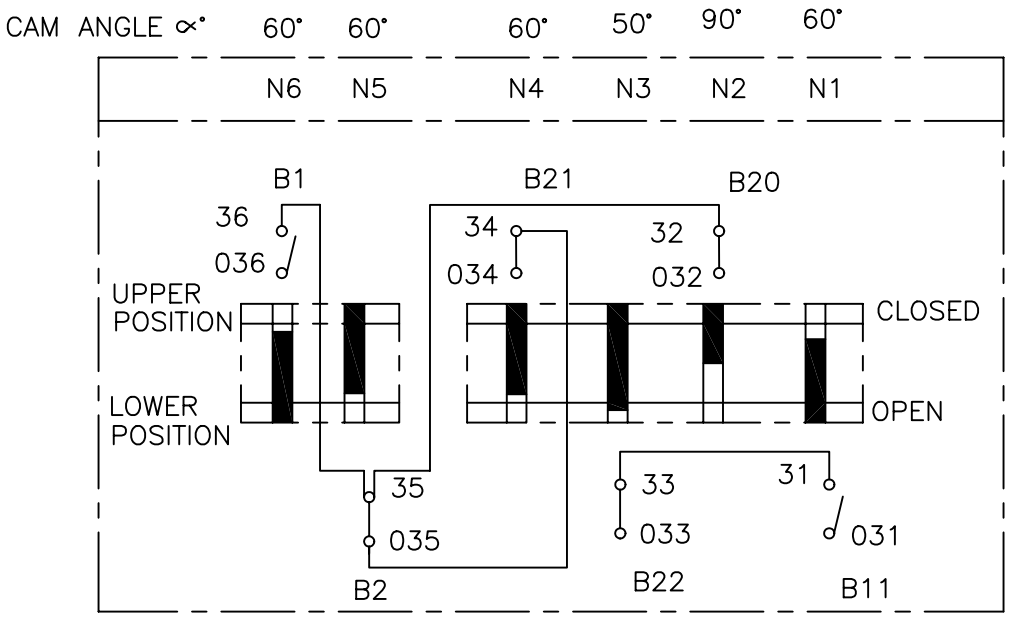


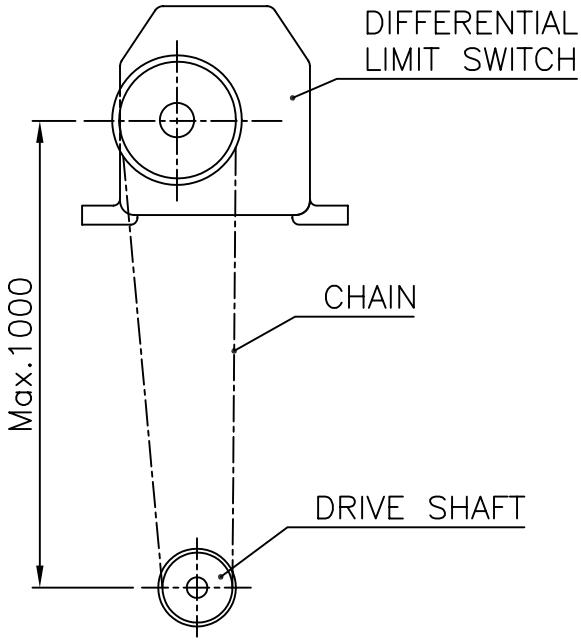
FIG.6 DIFFERENTIAL LIMIT SWITCH

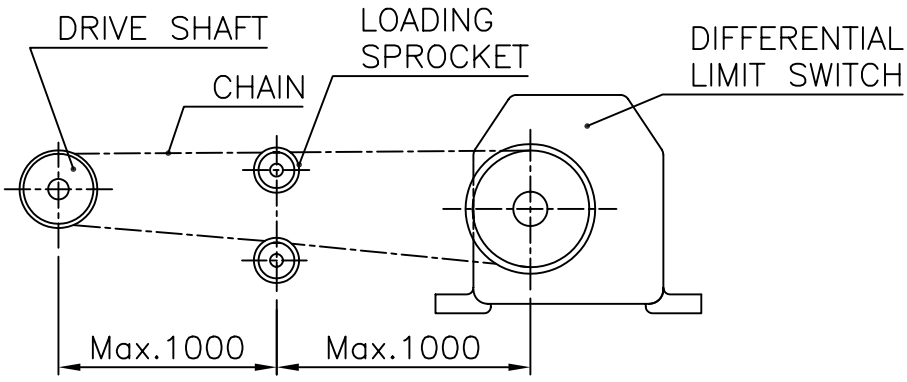


DIFFERENTIAL LIMIT SWITCH WITH GRAB BUCKET CLOSED AND IN UPPER POSITION.

FIG.7 INTERNAL WIRING AND ASSEMBLY DIAGRAM OF DIFFERENTIAL LIMIT SWITCH

		WRITE–UP FOR DIFFERENTIAL LIMIT SWITCH			Speed-O-Controls Pvt. Ltd. MUMBAI–400 072.		
REVISION	DATE	DRAWN	MPC	MATERIAL		AUTOCAD FILE NAME:– D:\PF..\SOC.\LI.SW.\LS TEXT	
		TRACED		TOTAL WT.			
		CHECKED		SCALE	NTS	DRG.No.:–	
		APPROVED	K.R.D.	DATE	15.02.2000		





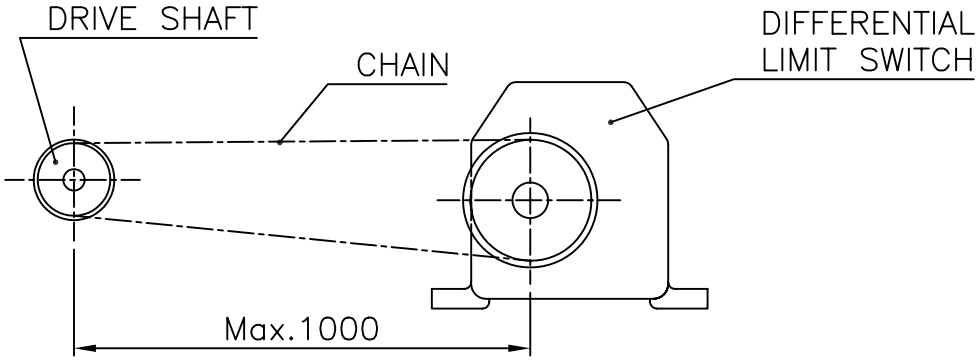


FIG.9

		WRITE–UP FOR DIFFERENTIAL LIMIT SWITCH			Speed-O-Controls Pvt. Ltd. MUMBAI–400 072.	
REVISION	DATE	DRAWN	MPC	MATERIAL		AUTOCAD FILE NAME:– D:\PF..\SOC.\LI.SW.\LS TEXT
		TRACED		TOTAL WT.		
		CHECKED		SCALE	NTS	DRG.No.:–
		APPROVED	K.R.D.	DATE	15.02.2000	