INTERPLANT STANDARD - STEEL INDUSTRY		
IPSS	**SPECIFICATION FOR MECHANICALLY OPERATED LIMIT SWITCHES FOR CONTROL CIRCUIT FOR VOLTAGES UPTO AND INCLUDING 1000 V ac AND 1500 V dc** (*FIRST REVISION*)	**IPSS:1-04-003-03**
	Corresponding IS does not exit	Formerly: IPSS:1-04-003-93

0. FOREWORD

0.1 This Interplant Standard has been prepared by the Standard Committee on Switchgear and Controlgear, IPSS 1:4 with the active participation of the representatives of the steel plants, concerned organizations and established manufacturers of Mechanically Operated Limit Switches; and was adopted in June 2003.

0.2 Interplant Standards for steel industry primarily aim at achieving rationalization and unification of parts and assemblies used in steel plant equipment and accessories, and provide guidance in indenting stores or equipment (or while placing orders for additional requirements) by individual steel plants. For exercising effective control on inventories, it is advisable to select a fewer number of sizes (or types) from among those mentioned in this standard, for the purpose of company standards of individual steel plants. It is not desirable to make deviations in technical requirements.

0.3 This revision has been carried out to cover the requirements of the pull cord and the belt sway switches.

0.4 In the absence of any Indian Standard on Limit Switches, assistance has been derived from IS 13947 (Part5/sec 1):1993 `Specification for low voltage switchgear and controlgear – Part 5: Control circuit devices and switching elements – sec.1: Electromechanical control circuit devices (superseding IS 6875).

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1. SCOPE

1.1 This Interplant Standard covers the requirements of the following types of mechanically operated control switches for voltages up to and including 1000 V ac and 1500 V dc used in steel industry and intended to be used in control circuits or

auxiliary circuits of switchgear and controlgear for the purpose of controlling, signalling and interlocking:

a) Pushrod limit switches *(see Fig 1)*,

b) Typical Lever type limit switches (with roller) *(see Fig 2)*,

c) Belt sway switches of self-resetting type,

d) Spindle limit switches with travelling nut see Fig 3),

NOTE: This is operable in both the directions of rotation of the driven shaft. The travelling nut moves in longitudinal direction on the spindle until they are engaged by a cam of the engaging pulley. This way the trip case is actuated and contacts operated.

e) Spindle limit switches with rotating cams (Typical) *(see Fig 4)*, and

f) Differential limit switches (see Fig 5).

1.2 This Interplant Standard does not cover the limit switches meant for direct interruption of main power circuits and microswitches.

Further, mounting and overall dimensions are also not covered in this standard for the present in view of the diversity of usage.

1.3 The service conditions applicable for the limit switches conforming to this standard are given in *Appendix-A*.

2. TERMINOLOGY

2.1 For the purpose of this standard the definitions given in IS 1885 (Part-17):1979 `Electrotechnical Vocabulary: Part 17 Switchgear and Controlgear'(*first revision*)', and IS 13947 (Part 5 / Sec 1):1993 shall apply. Some important definitions have, however, been reproduced in *Appendix B* for ready reference.

3. DESIGNATION - A control limit switch shall be designated by the following:

a) Type, depending on the operating mechanism;

b) Rated operational voltage;

c) Rated operational current; and

d) Number of this standard.

Example: A lever limit switch for operation at 240 V ac and rated for 10 A thermal current and 6 A operational current conforming to this standard shall be designated as follows :

Lever Limit Switch 240 V ac 10 A Op - IPSS:1-04-003-03

4. REQUIREMENTS

4.1 Preferred Rated Operational Voltages

a) ac - 240 and 415 V; and

b) dc - 110, 220 V

4.2 Preferred Rated Currents

a) *Operational* - 10 A for ac, and
1 A for dc.

4.3 Rated Frequency - For ac, it shall be 50 Hz.

4.4 Rated Duty - The rated duty for limit switches shall be 300 operations per hour carrying operational current and at operational voltage under conditions given in Table 1.

4.5 Utilization Category

a) *For ac* - contacts shall be suitable for utilization category of AC-15 [see IS 13947(Part 5/Sec 1:1993], and

b) *For dc* – DC-13/14 contacts shall be suitable for utilization category of DC-14 (see IS 13947 (Part 5/Sec 1):1993].

4.5.1 Load operation and rated making and breaking capacities of the switches for utilization categories specified in clause 4.5 (a) and (b) shall be in accordance with Table 1.

4.6 Electrical Endurance – This shall be as per IS 13947 (Part 5 / Sec 1) : 1993 (APPENDIX C) .

4.7 Mechanical Endurance - This shall also be as per IS 13947 (Part 5 / Sec 1) : 1993 (APPENDIX C).

4.8 Contacts

a) Limit switch shall have electrically separated contact elements;

b) All contacts shall be snap acting and double break type unless otherwise specified;

c) All limit switches shall have minimum of 2 numbers of contacts, 1 NO and 1 NC, excepting rotating cam type limit switches; and

d) Rotating cam limit switches shall have 4, 8 and 12 cams and the cam details shall be mutually agreed upon between the purchaser and the manufacturer.

4.9 Materials

a) The enclosure shall be made of cast iron or cast aluminium.

b) Lever roller shall be made of rust protective steel or polyamide 6 & 6.6 or equivalent material.

4.10 Enclosure - The type of enclosure shall be minimum IP 65 as prescribed in IS 13947 Part I:1993 'Degrees of protection provided by enclosures for low voltage switchgear and controlgear'.

4.11 Earthing - Earthing arrangements shall be as prescribed in IS 13947 (Part 5/sec.1) and IS 13947 (Part 1) which is reproduced at Appendix C for ready reference.

4.12 Terminals - Terminals shall be suitable for connecting cable of 2.5 mm^2 stranded conductor.

4.13 Fixing Screws - All fixing screws shall preferably have hexagonal head with slot and shall be cadmium or zinc plated 15 microns.

4.14 Limits of Temperature Rise - The temperature-rise of various parts of limit switches during a test carried out in accordance with IS 13947 Part 5 ,1993 shall not exceed limiting values given in Table 2. This temperature-rise is applicable for the service conditions given in ***Appendix-A*** over a reference ambient temperature of 40^oC.

4.15 In belt sway switches, the roller (on the lever) which shall bear with the belt conveyor when it sways, shall be on antifriction bearings and shall be easily replacable in this field. It shall be completely sealed and there shall be a greasing point on the top.

5. TESTS

The following tests shall be carried out in accordance with IS 13947 (Part 5/sec.1): 1993.

5.1 Type Tests

a) General inspection,

b) Temperature-rise test,

c) Test for making and breaking capacities, and

d) High voltage test.

5.2 Routine Tests

a) General inspection, and

b) High voltage test.

5.3 Special Tests

a) Load operation test and
b) Verification of mechanical duty class.

6. MARKING

6.1 Each limit switch shall be provided with a name-plate carrying the following information marked in durable manner and so placed that marking is legible when the limit switch is in installed position:

a) Manufacturer's name or trade-mark,

b) Serial number, and

c) Designation

6.1.1 Number of positions and contacts with diagram showing the arrangements shall be marked on the inside face of the cover.

6.2 The information contained in clause 6.1 may be given in separate leaflet which shall include the following additional details as well:

a) Rated actuating force in case of lever limit switch and number of revolutions and reduction ratio for spindle and rotary limit switches, respectively;

b) Mounting and overall dimensions;

c) Pre-travel, over-travel and differential travel of contact element;

d) Any other relevant information as required by the purchaser.

TABLE 1 A

Verification of making and breaking capacities of switching elements under normal conditions corresponding to the utilization categories [1]

Utilization category	Normal condition of use								
	Make [2]			Break [2]			Number and rate of making and breaking operations		
	I/I_e	U/U_e	cos φ	I/I_e	U/U_e	cos φ	Number of operating cycles [3]	Operating cycles per minute	On-time [5] (s)
AC-12	1	1	0.9	1	1	0.9	6 050	6	0.05
AC-13 [6]	2	1	0.65	1	1	0.65	6 050	6	0.05
AC-14 [6]	6	1	0.3	1	1	0.3	6 050	6	0.05
AC-15 [6]	10	1	0.3	1	1	0.3	6 050	6	0.05
DC			$T_{0.95}$			$T_{0.95}$			
DC-12	1	1	1 ms	1	1	1 ms	6 050	6	0.05 [5]
DC-13	1	1	6 P [4]	1	1	6 P [4]	6 050	6	0.05 [5]
DC-14 [6]	10	1	15 ms	1	1	15 ms	6 050	6	0.05 [6]

I_e Rated operational current
U_e Rated operational voltage
$T_{0.95}$ Time to reach 95% of the steady-state current, in milliseconds
$P = U_e I_e$ Steady-state power consumption, in watts
I Current to be made or broken
U Voltage before make

[1] See Sub-clause 8.3.3.5.2.
[2] For tolerances on test quantities, see Sub-clause 8.3.2.2.
[3] The first 50 operating cycles shall be run at $U/U_e = 1.1$ with the loads set at U_e.
[4] The value "6 × P" results from an empirical relationship which is found to represent most d.c. magnetic loads to an upper limit of $P = 50$ W, viz. $6 \times P = 300$ ms. Loads having power-consumption greater than 50 W are assumed to consist of smaller loads in parallel. Therefore, 300 ms is to be an upper limit, irrespective of the power-consumption value.
[5] The on-time shall be at least equal to $T_{0.95}$.
[6] Where the break current value differs from the make current value, the on-time refers to the make current value after which the current is reduced to the break current value for a suitable period, e.g. 0.05 s.

TABLE **1 B**

Verification of making and breaking capacities of switching elements under abnormal conditions corresponding to the utilization categories [1)]

Utilization category	Emergency (abnormal conditions of use) [2)]								
	Make [3)]			Break [3)]			Number and rate of making and breaking operations		
	I/I_e	U/U_e	cos φ	I/I_e	U/U_e	cos φ	Number of operating cycles	Operating cycles per minute	On-time (s)
AC-12									
AC-13 [6)]	10	1.1	0.65	1.1	1.1	0.65	10	6	0.05 [7)]
AC-14	6	1.1	0.7	6	1.1	0.7	10	6	0.05 [7)]
AC-15	10	1.1	0.3	10	1.1	0.3	10	6	0.05 [7)]
DC			$T_{0.95}$			$T_{0.95}$			
DC-12									
DC-13 [6)]	1.1	1.1	6 P [5)]	1.1	1.1	6 P [5)]	10	6	0.05 [4)]
DC-14	10	1.1	15 ms	10	1.1	15 ms	10	6	0.05 [4)]

I_e Rated operational current
U_e Rated operational voltage
$T_{0.95}$ Time to reach 95% of the steady-state current, in milliseconds
$P = U_e I_e$ Steady-state power consumption, in watts
I Current to be made or broken
U Voltage before make

[1)] See Sub-clause 8.3.3.5.3.
[2)] The abnormal condition is to simulate a blocked open electromagnet.
[3)] For tolerances on test quantities, see Sub-clause 8.3.2.2.
[4)] The on-time shall be at least equal to $T_{0.95}$.
[5)] The value "6 × P" results from an empirical relationship which is found to represent most d.c. magnetic loads to an upper limit of $P = 50$ W, viz. $6 \times P = 300$ ms. Loads having power-consumption greater than 50 W are assumed to consist of smaller loads in parallel. Therefore, 300 ms is to be an upper limit, irrespective of the power-consumption value. For contactless switching devices the maximum time constant shall be 60 ms.
[6)] For contactless switching devices an overload protective device specified by the manufacturer should be used to verify the abnormal conditions.
[7)] See Note 6 of Table IV.

TABLE 2
(*Clause 4.14 and B-6*)

LIMITS OF TEMPERATURE-RISE OF VARIOUS PARTS OF MECHANICALLY OPERATED LIMIT SWITCHES

Sl No.	**Types of Material and Description of Part**	**Temperature-Rise** (Reference.ambient.Temp: 40°C)
1	**Contact Parts**:	
	a) Silver or Silver faced	Limited solely by the necessity of not causing any damage to adjacent parts. In the case of silver faced contact the quantity of silver facing shall be such that after carrying out one-tenth of total number of operations specified for the mechanical endurance test, there is still a continuous layer of silver on the contacts. If it is not so, the contact shall be regarded as copper contact.
	b) All other materials and sintered metals	To be specified according to the properties of the metals used and limited by the necessity of not causing any damage to adjacent parts.
2	Terminals for external insulated connections.	30°C
3	Metallic parts acting as springs	The temperature should not reach a value at which the elasticity of the material is impaired. For pure copper this implies a total temperature not exceeding 75°C.
4	Metal parts in contact with insulating materials	Limited solely by the necessity of not causing any damage to the insulating materials.

APPENDIX - A

(Clauses 1.3 and 4.14)

SERVICE CONDITIONS OF MECHANICALLY OPERATED LIMIT SWITCHES

A-1 The reference ambient temperature shall be 40°C.

A-2 Maximum humidity is 100 percent occurring simultaneously with maximum ambient temperature.

A-3 Altitude shall not exceed 1000 m.

A-4 For application where corrosion and inflammable gases are prevalent the limit switches shall be specially designed as per the needs.

A-5 Limit switches shall be suitable for withstanding vibration level of 2g vertically & horizontally and a shock of 20g.

APPENDIX B
(Clause 2)

TERMINOLOGY

B-1 **Actuating Force** - The force (or moment) applied to an actuator necessary to complete the intended operation.

B-2 **Double Break Contact Element** - A contact element which opens the conducting path of its circuit in two locations in series (See clause 2.3.3.2 of IS 13947 Part 5/ Sec.1):1993.

B-3 **Changeover Contact Elements** - A contact element combination which includes one make-contact element and one break-contact element [see clause 2.3.3.5 of IS 13947 Part 5 /Sec 1)

B-4 **Electrically Separated Contact Elements** - Contact elements belonging to the same control limit switch, but adequately insulated from each other so that they can be connected into electrically separated circuits.

B-5 **Snap Action Contact Element** - A contact element in which the velocity of contact motion is substantially independent of the velocity of actuating system [see clause 2.3.3.8 of IS 13947 Part 5 / Sec.1).

B-6 **Rated Thermal Current** - The value I of current assigned by the manufacturer and limited by the temperature rise as specified in Table 2

NOTE: It is the maximum value of current which a control switch installed under standard conditions of service can carry continuously without damage.

B-7 **Rated Operational Current** - A value of I_e of current which determines the application of the contact element. It is stated by the manufacturer and takes into account the rated operational voltage, the rated supply frequency, the utilization category and wherever applicable, the electrical endurance.

B-8 **Rated Operational Voltage** - A value U_e of voltage assigned by the manufacturer which, in combination with a rated operational current, determines the application of the contact element and to which the utilization categories are referred.

NOTE: A contact element may be assigned a number of combinations of rated operational voltage and rated operational current [see clause 4.3.1.1 of IS 13947 (Part 1).

B-9 Pre-travel of the Actuator - The maximum travel of the actuator which causes no relative motion of the contact element.

B-10 Over-travel of the Actuator - The travel of the actuator after all the contacts have reached their closed (open) position.

B-11 Pre-travel of the Contact Element - The maximum travel of the contact element which causes no relative motion of the contacts.

B-12. Over travel of the Contact Element - The travel of the contact element after the contacts have reached their closed (open) position.

B-13 Differential Travel - It is the distance travelled in reverse direction in millimeters or degrees at the time of resetting beyond the point where the switch operated at the time of forward travel.

APPENDIX C
(Clause 4.11)

C-1. As per IS 13947 (Part 5/sec.1):1993 & Clause 7.1.9 of IS 13947 Part I is reproduced below:

4.4 Earthing

4.4.1 The enclosures of control switch, if of metal, shall be provided with one earthing terminal for rated voltages not exceeding 250 V, and two separate earthing terminals for rated voltages more than 250 V. These terminals shall be provided over and above all other means provided for securing metallic enclosures (armour or other metallic covering) of current carrying cables.

4.4.2 The earthing terminals shall be readily accessible and so placed that the earth connection of the control station is maintained when the cover or any other movable part is removed.

4.4.3 The earthing terminals shall be of adequate size, be protected against corrosion and shall be metallically clean. Under no circumstances shall a movable metal part of the enclosure be insulated from the part carrying the earthing terminal when the movable part is in place.

4.4.4 The earthing terminal shall be identified by means of the symbol -- marked in a legible and indelible manner on or adjacent to the terminal.

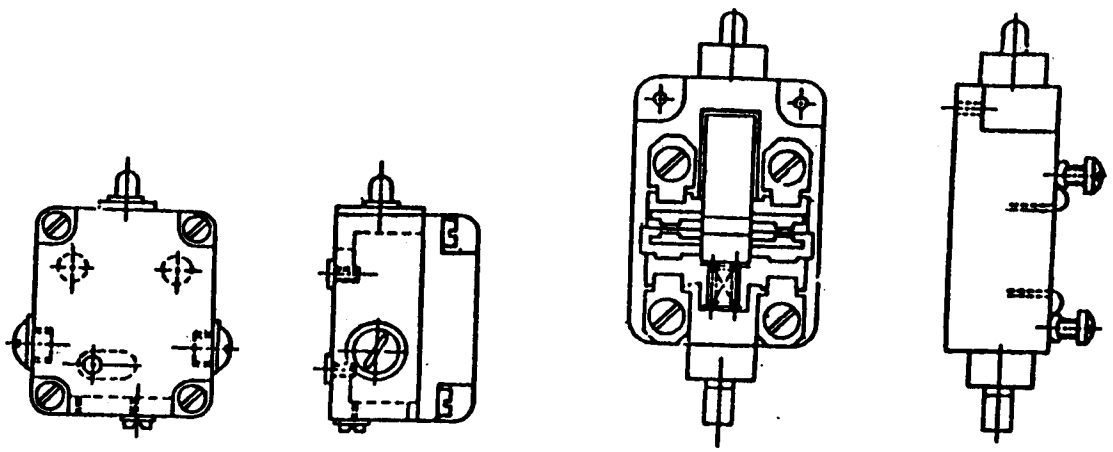
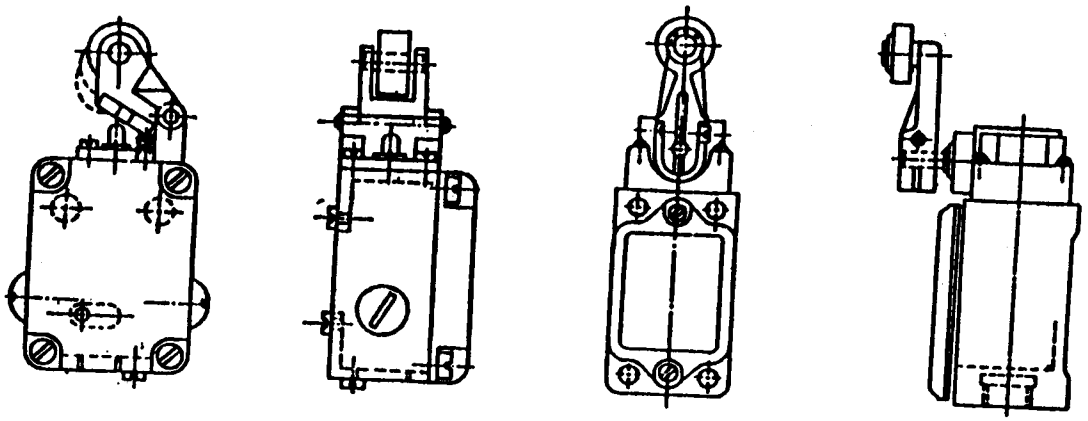


FIG.1 PUSHROD LIMIT SWITCHES



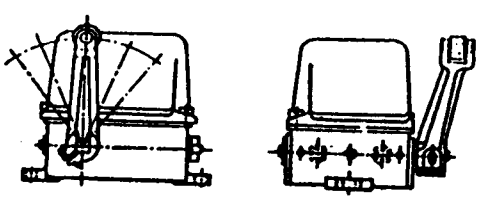
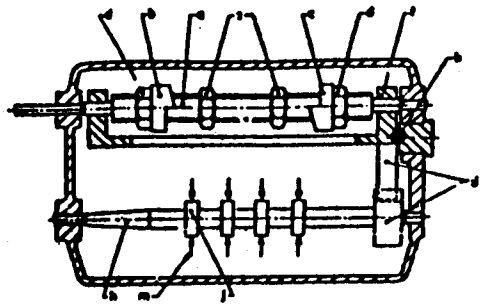


FIG.2 TYPICAL LEVER TYPE LIMIT SWITCHES (WITH ROLLER)



a — Driving spindle
b, c — Adjustable stop nut
d — Lock nut
e — Travelling nut (cam)
f — Trip case
g — Instantaneous switching
h — Switch shaft
j — Switch segment
k — Catch
m — Fixed contacts

FIG.3 SPINDLE LIMIT SWITCH WITH TRAVELLING NUT

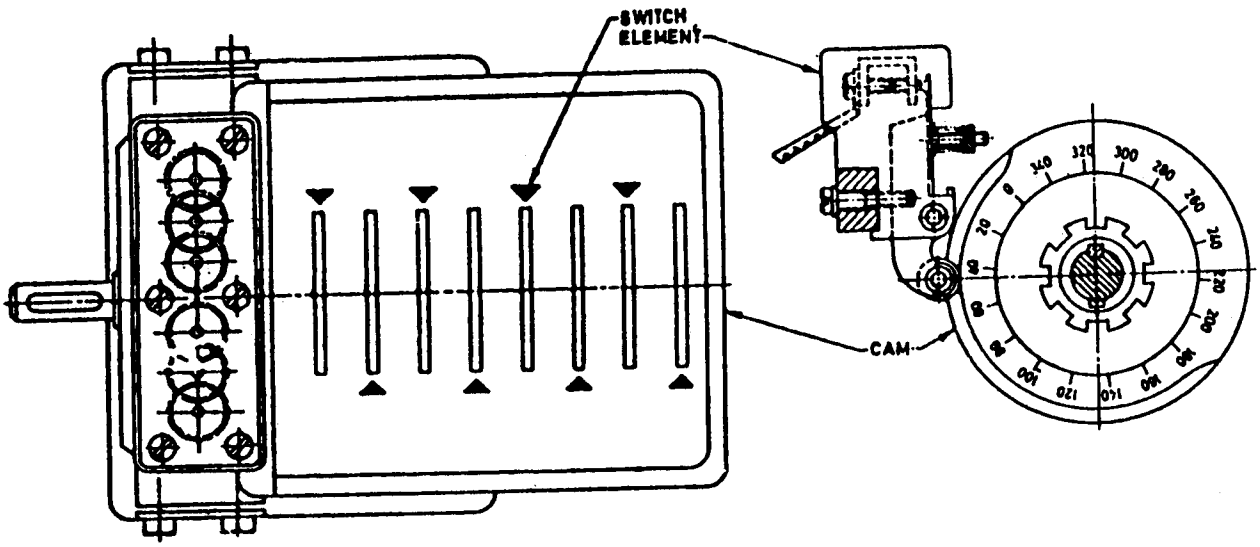


FIG.4 SPINDLE LIMIT SWITCH WITH ROTATING CAM (TYPICAL)

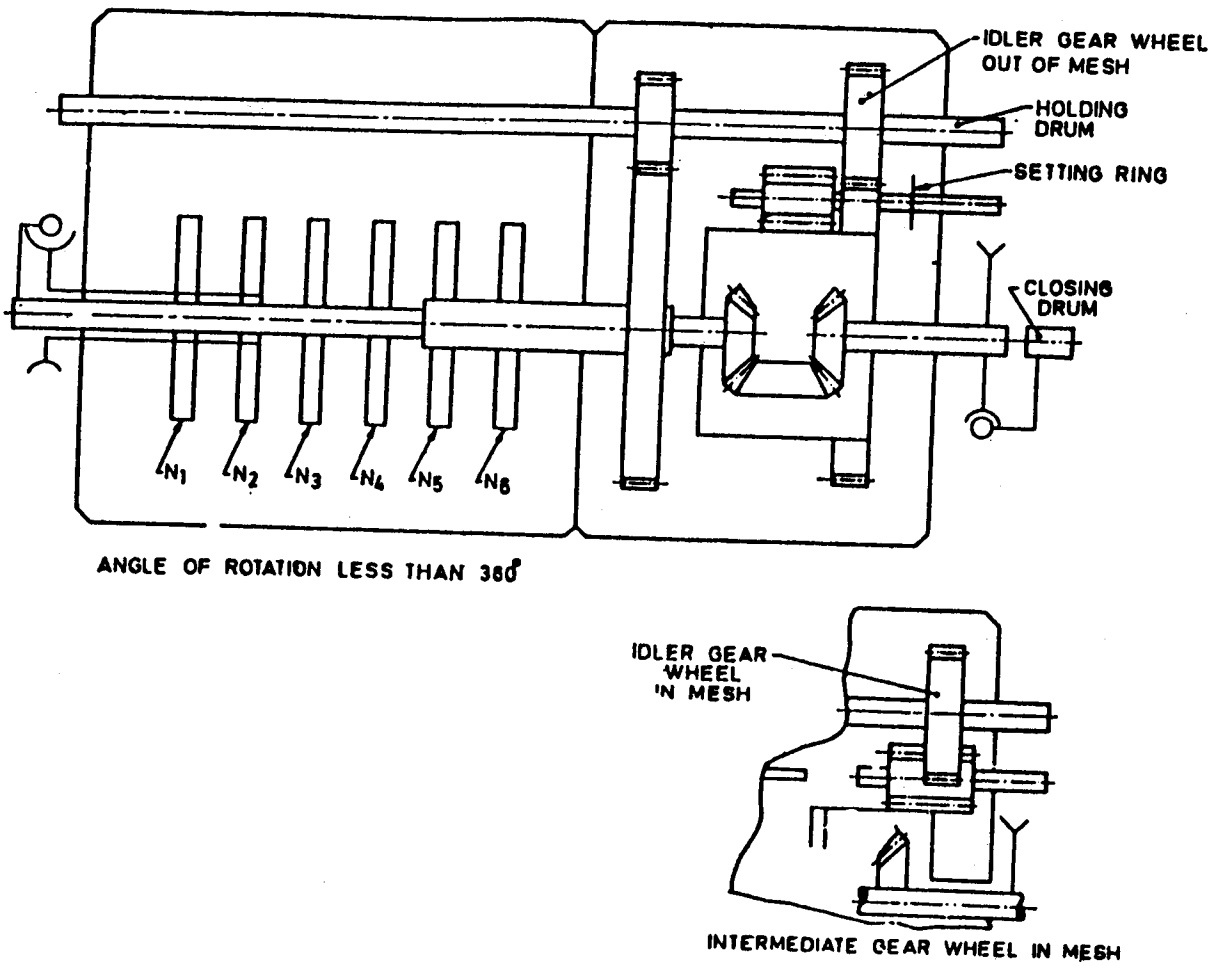


FIG.5 DIFFERENTIAL LIMIT SWITCHES