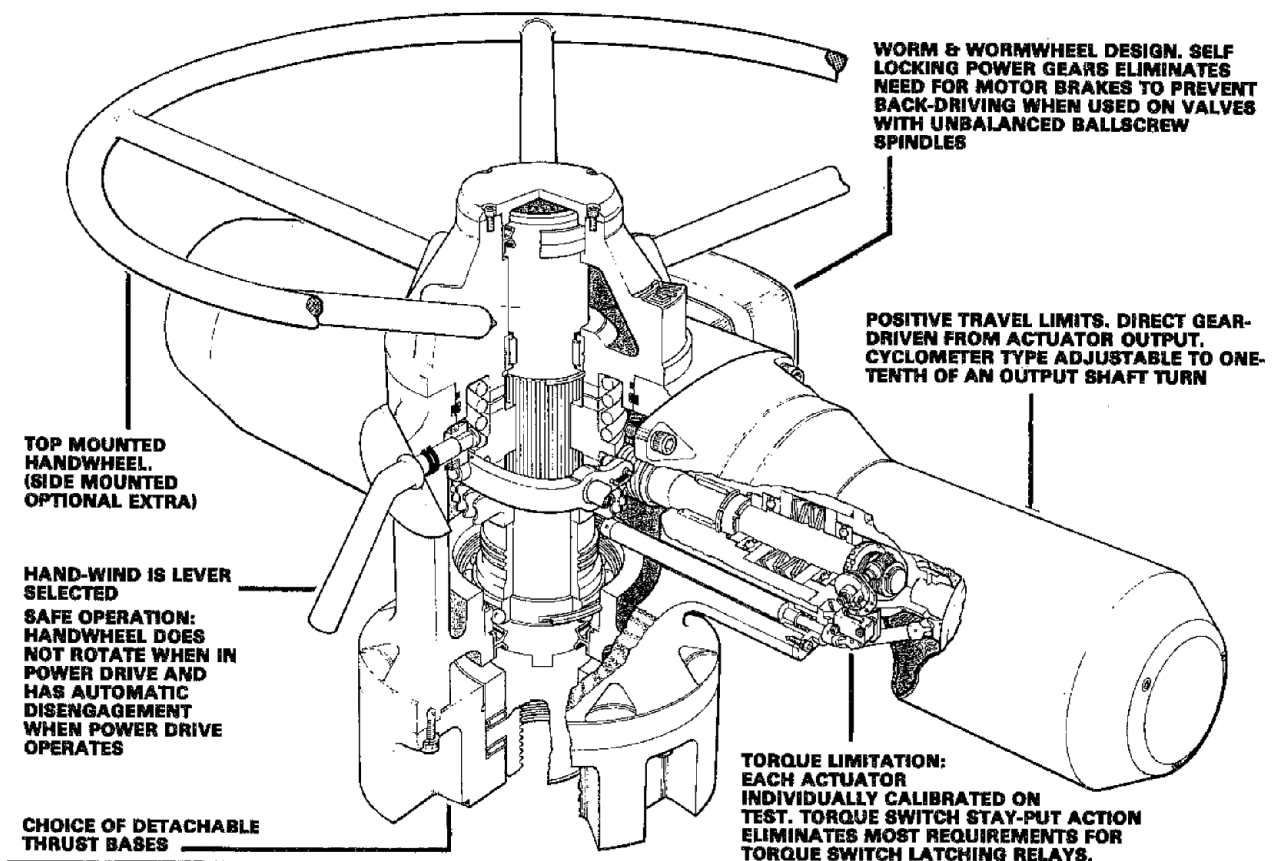


**Standard Operating & Maintenance Instructions**

# AutoTork Fig AA300 & AA165 Issue 1994 ELECTRIC ACTUATOR



**CUT AWAY OF FIG. AA300 & AA165 ELECTRIC ACTUATOR**

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# AutoTork Fig AA300 & AA165 ELECTRIC ACTUATOR

## Section 1

### 1.1 GENERAL

The actuator consists of a rotor stator unit driving an output shaft through a single stage worm reduction, which incorporates an automatic mechanical device for changing the drive from manual to power. The actuator includes a travel limit switch unit and a torque switch unit and is of totally enclosed construction, to IP 65 with switchgear, or IP 67 without switchgear, for mounting at any angle (see Fig. 1).

### 1.2 MOTOR AND GEAR TRAIN

A.C.3 phase motors are of squirrel cage rotor stator design. Class 'F' insulation is provided. The windings are terminated on stud type terminals in the actuator terminal box. Motor winding thermostats are provided to protect the motor against burn out.

The stator is mounted in a housing forming an integral part of the actuator housing and the rotor is mounted directly onto the wormshaft which is mounted on oil and grease lubricated needle roller bearings. The output shaft ball and needle roller bearings are located in the main housing and handwheel and are oil lubricated.

The output shaft assembly incorporates a lost motion, or hammer blow device which allows the motor to run up to speed before transmitting full torque to the output shaft (see Fig. 2b).

### 1.3 THRUST BASE

The thrust base is detachable and bolted to the underside of the actuator by high tensile screws. In most cases, the actuator can be removed from the thrust base while leaving the base in situ on the valve. This allows for manual operation of the valve, using a special key, which fits on the drive sleeve.

The drive sleeve is located radially by the output shaft and driven by two dogs that fit into slots in the drive sleeve. The thrust is taken by two needle roller thrust bearings which are grease lubricated (see Fig.2a).

### 1.4 MANUAL OPERATION

The actuator is equipped with a direct mounted handwheel as standard or side mounted, depending on the order requirements, to operate in the event of a power failure.

The handwheel is easily engaged with the output shaft by moving the hand/power lever from left to right and at the same time slowly turning the handwheel.

An automatic device is incorporated which transfers the drive from manual to power immediately the motor starts to rotate. As the sliding clutch is withdrawn completely from manual before engaging power drive the operator is ensured complete safety should the actuator be started during hand operation.

The actuator can be equipped with a side mounted handwheel as an optional extra, this substantially reduces the required rim effort on the handwheel. The handwheel conveys the rim effort to the driving dogs through a single stage worm reduction which is totally enclosed in a gear housing. The wormshaft is supported by ball and needle roller bearings and the wormwheel by plain journals, which are "packed for long life" grease lubricated,

The sliding clutch is mounted on the serrated output shaft and a compression spring ensures that the dog teeth on the underside are fully in mesh with the dog teeth on the top side of the wormwheel, thus transmitting the drive from wormshaft to the wormwheel, from the wormwheel to the sliding clutch via the dog teeth lost motion device and from the sliding clutch to the output shaft. The hand/power lever operates a cam which acts on the cam roller attached to the clutch fork. The clutch rollers fitted to the clutch fork lift the sliding clutch out of engagement with the wormwheel and into engagement with the dog teeth on the handwheel (see Fig. 2a). The clutch is maintained in the hand position by two spring loaded latches. The hand/power lever now returns to the power position. To return to power operation the motor is energised and as the wormshaft rotates the two latches resting on top of the wormwheel move radially and allow the sliding clutch to return to the power position.

## **1.5 TORQUE LIMITING DEVICE**

The wormshaft of the actuator is capable of axial movement against a disc spring pack.

The design of the spring pack is such that a limited deflection is permitted allowing axial movement of the wormshaft in either direction corresponding to 40% to 120% output torque of the actuator in the opening or closing direction (see Fig. 3).

## **1.6 LIMIT SWITCH ASSEMBLY**

The limit switch and indicator units are mounted on plates which embody an indicator take-off spindle from the limit switch drive gear.

The complete assembly is fitted to the end of the actuator, opposite the motor. The limit switch is driven from the output shaft, through crossed helical gears and a limit switch take-off spindle, to a universal joint drive and cross pin arrangement to a slot in the limit switch drive spindle (see Fig. 4). The standard limit switch assembly comprises 4 'open' position and 4 'close' position micro switches of which only 3 "open" position and 2 "close" position micro switches are wired to the actuator terminal board. The additional switches may be wired to the actuator terminal board depending upon customers requirements. Each bank of lever-roller actuated switches is operated by a cam positively driven by the hunting tooth gear train. Switches 1,2

and 3 are designed to operate simultaneously with switch 4 operating last by means of a small step on the cam. As such, switch 4 should always be used as the actuator travel limit switch.

Intermediate position switches or additional open and close switches may be fitted when required by the addition of another limit switch assembly (see Fig.4).

The hunting tooth gear trains are so arranged that each bank is independently adjustable to provide any limit switch setting from zero to 100 turns in steps of 0.1 of a turn. Special assemblies can be provided to count from zero to 1000 actuator turns in adjustable steps of 1 turn.

The limit switch gear train consists of a drive spindle driven by internal actuator gears, to a spur gear pinned to the drive shaft, which drives the first stage spur wheel and hunting tooth wheel. The latter being located and driven by the spur wheel with a double pentagon recess in the hunting tooth wheel which can be located in any of ten positions on the pentagon spigot of the spur wheel. These positions correspond to the numerals on the hunting tooth flange. The drive is transferred to the hunting tooth pinions through three stages of hunting tooth wheels and then back to the final hunting tooth pinion which has an integrally moulded spur gear which drives the cam. A spring on the hunting tooth spindle keeps the spur wheel and the hunting tooth gear locked together in the normal driving or set position but permits them to be separated for initial setting (see Fig. 4).

## **1.7 CONTINUOUS MECHANICAL INDICATOR UNIT (WHEN FITTED)**

The indicator unit consists of two plates separated by pillars, input and output spindles, change gears, spur gears, index plates, pointer and pointer spindle. An indicator unit supplied with an actuator includes change gears of the correct ratio for the number of output turns of the actuator. No adjustment is required to the indicator other than setting the pointer to the 'shut' index of the scale with the valve in the full shut position after setting the limit switch and adjusting the index plates if necessary (see Fig.4).

### **1.7.1 VALVE POSITION TRANSMITTER (WHEN FITTED)**

The addition of a transmitter, used for the purpose or remote indication, is the only difference between a continuous mechanical indicator unit and the valve position transmitter.

To prevent damage to the transmitter fitted to an actuator which has not been direct mounted to a valve and commissioned by Autotork the final drive gear attached to the transmitter shaft should be left out of mesh with the other indicator gears. The final drive gear should be left to the commissioning engineer to couple up and adjust after setting the limit switches (see Fig. 4).

## Section 2

### 2.1 ALTERNATING CURRENT

For A.C. 2 and 3 phase.

**It is very important to ascertain that the direction of travel of the valve corresponds to the 'open' and the 'close' button of the controller.**

Carefully check the direction of travel of the valve with the movement of the controller by having the **valve in mid-position**. Then press the 'open' or 'close' operating button and immediately after that stop the actuator and then ascertain whether the valve has moved to correspond to the button which was operated. If the valve has travelled in the opposite direction, reverse any two of the supply leads on the contactor, then restore electrical supplies and repeat the procedure.

### 2.2 LIMIT SWITCH SETTING UP PROCEDURE

The limit switch assembly of an actuator fitted direct on to a valve at Autotork Works is set for the correct number of turns before despatch and should not be disturbed.

Pedestal type actuators or actuators for fitting on to valves at site or other makes of valve are despatched with each switch bank set at 50 turns so that any mal-operation of the handwheel before the actuator is coupled or fitted to the valve should not disturb the correct relationship of cams and rollers.

After coupling or fitting the actuator to the valve remove the limit switch cover, taking care not to damage or misplace the 'O' ring seal. Hand operate the valve to within 1% of the full shut position and observe that the limit switch cams are in the correct position i.e. switch rollers at the top of the cam with the black setting line on the cam visible and under the rollers. Set the close bank hunting tooth wheels to 00.0 and then operate the actuator handwheel 1/4 of a turn more and observe that the limit switch cam moves away from the micro switch rollers and allows the micro switches to operate. Check that switches have operated using a suitable measuring instrument.

On a parallel slide valve, check that 1/16" (1 mm) to 1/8" (3 mm) clearance exists between the bottom of the valve stop and the shoulder of the valve pillars. If this clearance is not observed - re-adjust limit switch setting as above. Then operate the valve to within 1% of the full open position and set the open bank hunting tooth wheel to 00.0 and repeat the setting procedure. **CAUTION:** Always rotate the hunting tooth wheels in a descending order i.e. 3, 2, 1, 0.

If for any reason the cam is not in the correct position it can be easily adjusted by separating and rotating the hunting tooth wheel, which registers 10s turns indicated by the continuous white line on the barrel. One complete revolution will cause the spur wheel which is moulded to the pinion to rotate, and this can be assisted by hand, rotating the spur wheel causes the operating cam to move 144°. Continue until such time as the black line on the cam is positioned under the micro switch rollers.

**CAUTION:** Always rotate this hunting tooth wheel in an ascending order i.e. 1, 2, 3 etc. There is **only one correct position** of the black line allowing correct re-engagement of the hunting tooth wheel with its mating spur wheel.

In certain inaccessible site locations it may be difficult to observe that the black line on the operating cam is in the correct position. This can be checked using a multimeter or bell and battery across the terminals corresponding to the open and close travel limits. (Normally, the open limit is numbered 3 and 5 and the close limit 4 and 6). Ascertain that connections have been made correctly to the limit switch. With the valve in mid travel position a circuit should exist between terminals 3 and 5 and 4 and 6. If this is not the case the cam is in the wrong position.

Set the intermediate 'open' and 'close' bank limit switches (when fitted) to the correct number of turns from the respective zero at which these switches are required to operate.

Operate the actuator and check operation of all switches, indicators etc., replace the limit switch cover and 'O' ring seal with care.

### 2.2.1. REPLACING MICRO SWITCHES

It is recommended that adjustments or repairs that are carried out on site are restricted to the replacement of micro switches only. To do this the following procedure **must** be followed to ensure correct future operation.

(i) Isolate the actuator from the electrical supplies, remove faulty limit switch assembly to workshop.

(ii) Set the limit switch assembly to mid-travel, i.e. cams depressing switch plungers.

(iii) Remove the micro switch securing nuts and rods, replace faulty switches and re-tighten the rods ensuring that all the switches are pulled away as far as possible from the operating cam. A minimum clearance of 0.010" (0.25 mm) should exist between the cam and the switch rollers when the black line on the cam is under the rollers and the rollers are hard up to the switch moulding. Check operation of assembly to ensure that the drive spindle can be turned by hand and that the switches can be operated freely.

(iv) Replace limit switch in actuator, re-connect and follow setting up procedure.

### 2.3 TORQUE SWITCH ASSEMBLY

The actuator is fitted with a torque switch assembly which incorporates 'open' and 'close' torque switches which are infinitely adjustable and easily set to limit the actuator torque within the indicated range. The torque switch assembly is spigot mounted on the actuator housing and the open and close pinions are engaged with the drive sleeve fitted on the end of the wormshaft. Torque indication in terms of axial displacement of the wormshaft is transmitted via the pinions to the 'open' and 'close' torque switch operating spindles. To adjust the torque

switch setting release the capscrew on the end of the pinion spindle and turn the index plate so that the desired figure is opposite the pointer, and retighten the capscrew,

The index plate is infinitely adjustable between 0.4 and 1.2 setting (40% - 120% of rated output torque). The switch is normally in the free state with the circuit closed. The switch is tripped and the circuit opened at the set torque figure by the action of the index plate attached to the pinion spindle (see Fig.3).

The actuator torque switches are normally set at our works to suit the particular application. Therefore no adjustment should be necessary.

N.B. If the predetermined torque switch settings or the actuator application is not known, the torque switches will be set at a minimum and left to the commissioning engineer to set.

The torque switches operate independently and do not reset until actuator is reversed.

## **2.4 FITTING DIRECT MOUNTED ACTUATORS**

Valves which are to be fitted with direct mounted actuators at site are fitted with an adaptor plate secured to the valve by the pillar nuts or the pillar capscrews.

If a standard hand operated valve is to be motorised by means of a direct mounted actuator, remove the existing handwheel, gearing (when fitted) sleeve and bridge, leaving the valve pillars and spindle only for application of the actuator. Remove the adaptor plate from the base of the actuator and fit this item on the valve pillar ends and secure by means of the existing pillar nuts or pillar capscrews. Do not remove any covers at this stage but engage manual operation in preparation for fitting to the valve.

Sling the actuator by means of overhead tackle and carefully lining up the actuator with the valve spindle axially and radially, lower the actuator on to the valve until the drive sleeve begins to engage the valve spindle. Rotate the handwheel in the opening direction, and, at the same time, gradually lower the actuator until the base face or distance pieces is/are flush with the top face of the adaptor flange. Fit the nuts to the mounting studs or the capscrews and secure. A grease gun nipple is provided for lubricating the sleeve and valve stem this should be charged with grease when commissioning with the valve in the full open position to the specification, referred to in paragraph 2.6.

Set limits and torque switch as described previously.

## **2.5 FITTING PEDESTAL MOUNTED ACTUATORS**

First ascertain that the valve is in the full shut position i.e. on a parallel slide valve that the stop is 1/16" (1 mm) to 1 /8" (3 mm) clear of the lower shoulder of the valve pillars. Connect the valve and unit mechanically by the extension spindle supplied taking care not to move the valve from the full shut position and also ensure that the universal joints on the intermediate shafts are in line and not at 90° to each other.

## 2.6 LUBRICATION

The actuators are despatched with the gearbox filled with an ISO 460 grade oil, suitable for an ambient temperature range of -10° to 70°C, unless specially ordered for extreme climatic conditions.

Actuators for mounting direct on to a valve are fitted with a grease gun nipple for a valve stem lubrication. When an actuator is fitted to a valve at site, the latter nipple should be fully charged when commissioning, with the valve in the full open position and not excessively lubricated during service with the valve full shut. The normal operating conditions of an actuator are such that minimum maintenance is required. The grease gun nipples and the non drive end motor bearing should be lubricated occasionally during the life of the actuator. It is also necessary to lubricate sparingly the limit switch drive shaft.

It is however, advisable to set up a routine maintenance schedule, particularly in cases where the actuators are operated infrequently.

### RECOMMENDED LUBRICANTS:

SHELL ALBIDA R2 GREASE - Indicator gears, grease gun nipples, non drive end motor bearing, side mounting handwheel bearings, limit switch drive spindle.

BATOYLE REMUS 460 OIL - Gearbox including torque switch assembly.

OIL CAPACITY - 3 litres approx.

ROCOL TUFGEAR 85 - Side mounted handwheel worm and wormwheel only.

## 2.7 SPARES

If at any time spares or additional optional extras are required it would assist us to identify your requirements if the following information was given, which can be found on the identification plate attached to the actuator gearbox.

- a) Actuator Figure Number
- b) Actuator Serial Number ADT .....
- c) Name of part required

### Standard Specification

Performance - On/Off or Regulating Duty:

| OUTPUT SPEED | 50Hz rev/min |           | 60Hz rev/min |     | 72  |     | 96  |     |
|--------------|--------------|-----------|--------------|-----|-----|-----|-----|-----|
|              | 300 MODEL    | 165 MODEL | 24           | 36  | 48  | 58  | 86  | 115 |
| RATED TORQUE | Nm           | 300       | 255          | 240 | 240 | 175 | 175 | 140 |
|              | lbf ft       | 220       | 190          | 175 | 140 | 140 | 120 | 95  |
|              | Nm           | 165       | 135          | 120 | 120 | 90  | 90  | 70  |
|              | lbf ft       | 120       | 100          | 90  | 90  | 90  | 90  | 70  |

Maximum output shaft turns:

100 Std (1000 Special).

Drive and spindle acceptance:

Choice of detachable thrust bases (see overleaf).

Design & construction: In accordance with CEGB standard GDCC 136

Housing and covers of high grade cast iron and aluminium alloy. Gasket or 'O'-ring seals on removable covers.

Totally enclosed weatherproof to CSA enclosure IV, and IP67 on actuator without switchgear, IP65 on actuator with switchgear.

Hand-wind ratio: Std - top mounted 1:1  
Rim load at rated output:  
1375N (310 lbf) on 300 model  
915N (205 lbf) on 165 model

Optional - sidemounted 10.3:1  
Rim load at rated output:  
295N (66 lbf) on 300 model  
160N (36 lbf) on 165 model

Ambient temperature: 70°C (158°F) max

Lubrication: Oil (gearbox)  
Grease (thrust base)

Power supply: 3 phase 50/60 Hz

Motor: Short time duty  
Duty type S2 10 min

Travel limit switches: 3 at Open position  
2 at Close position

Torque limit switches: 1 in Opening direction  
1 in Closing direction

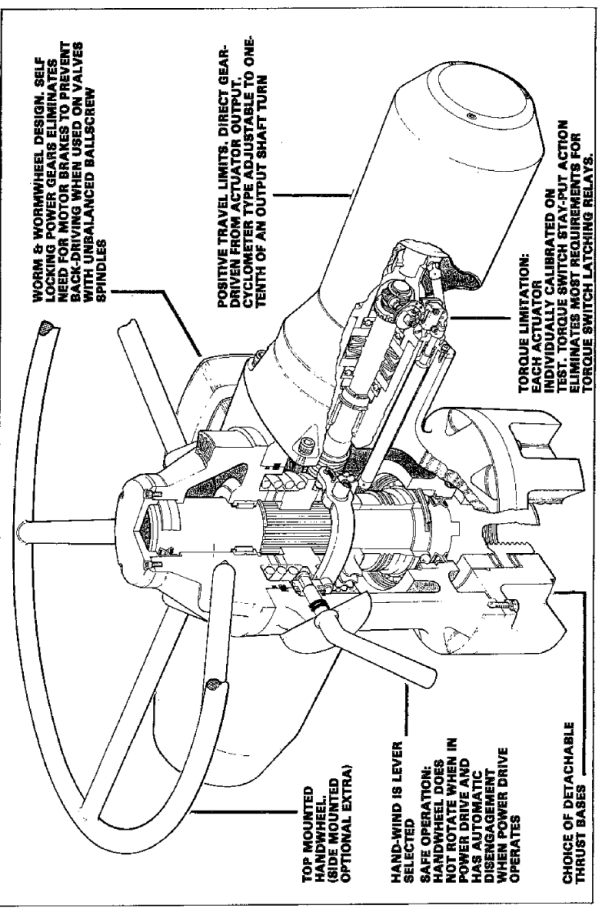
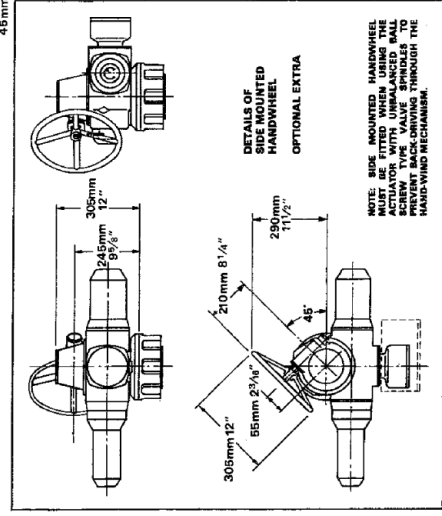
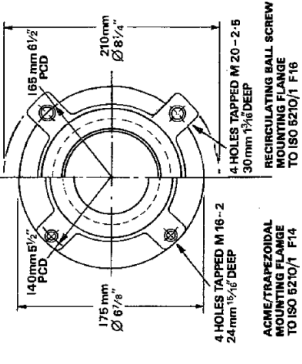
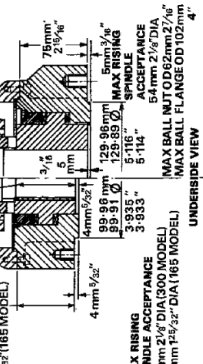
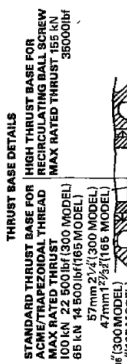
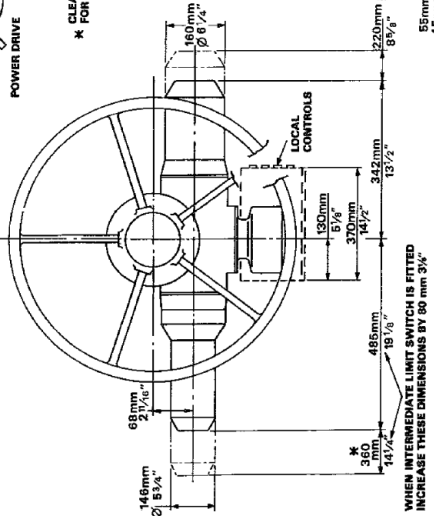
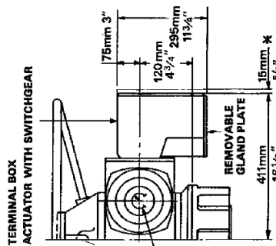
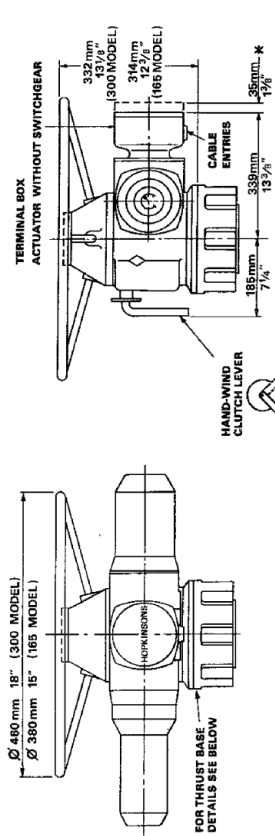
Reset on reversal of drive  
Stay-put action

Switch ratings: See appropriate 'DATA SHEET'

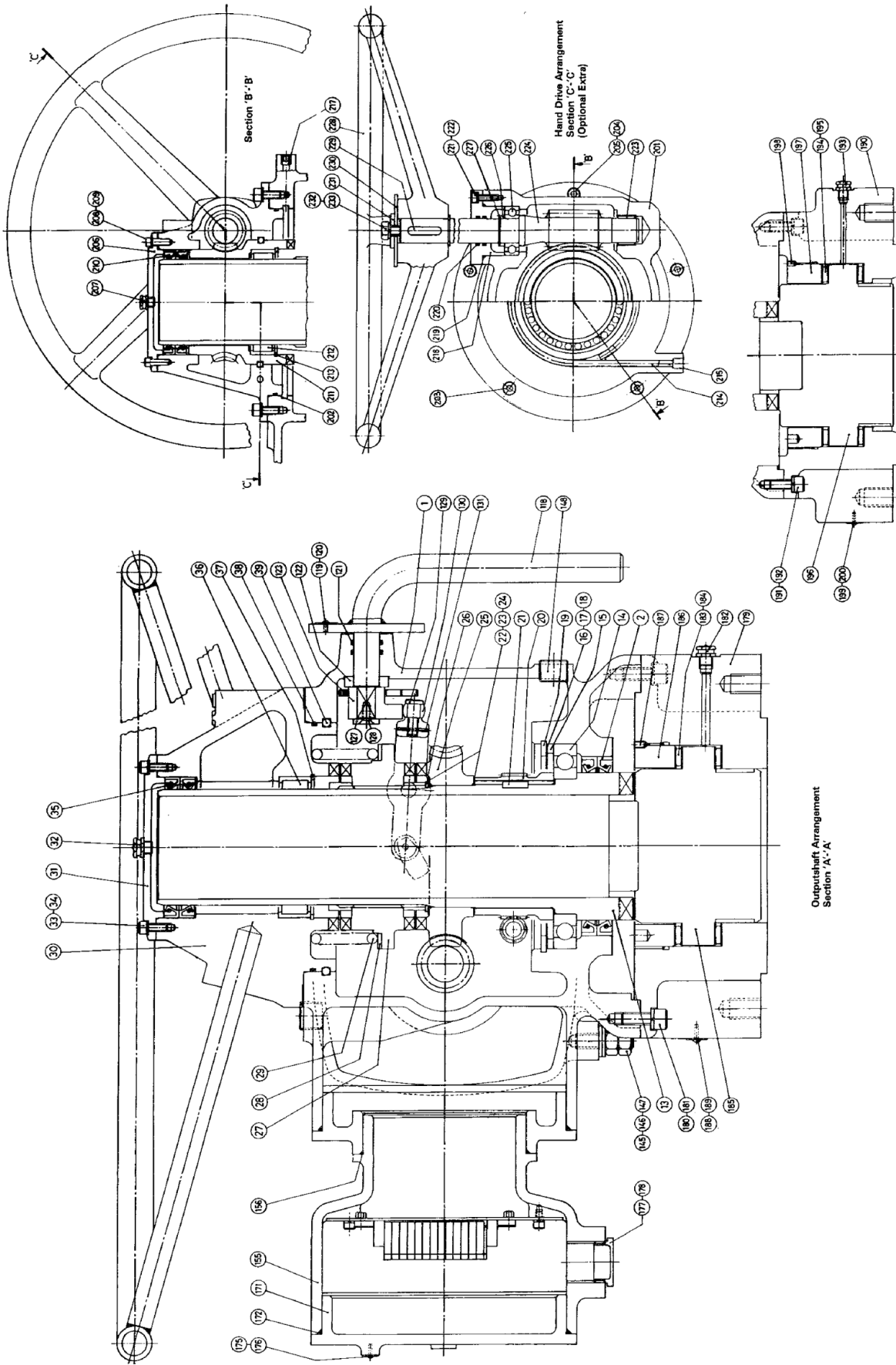
Cable entries: Actuator without switchgear:  
2 off M25-1.5 pitch  
1 off M32-1.5 pitch

Actuator with switchgear:  
Detachable undrilled gland plate

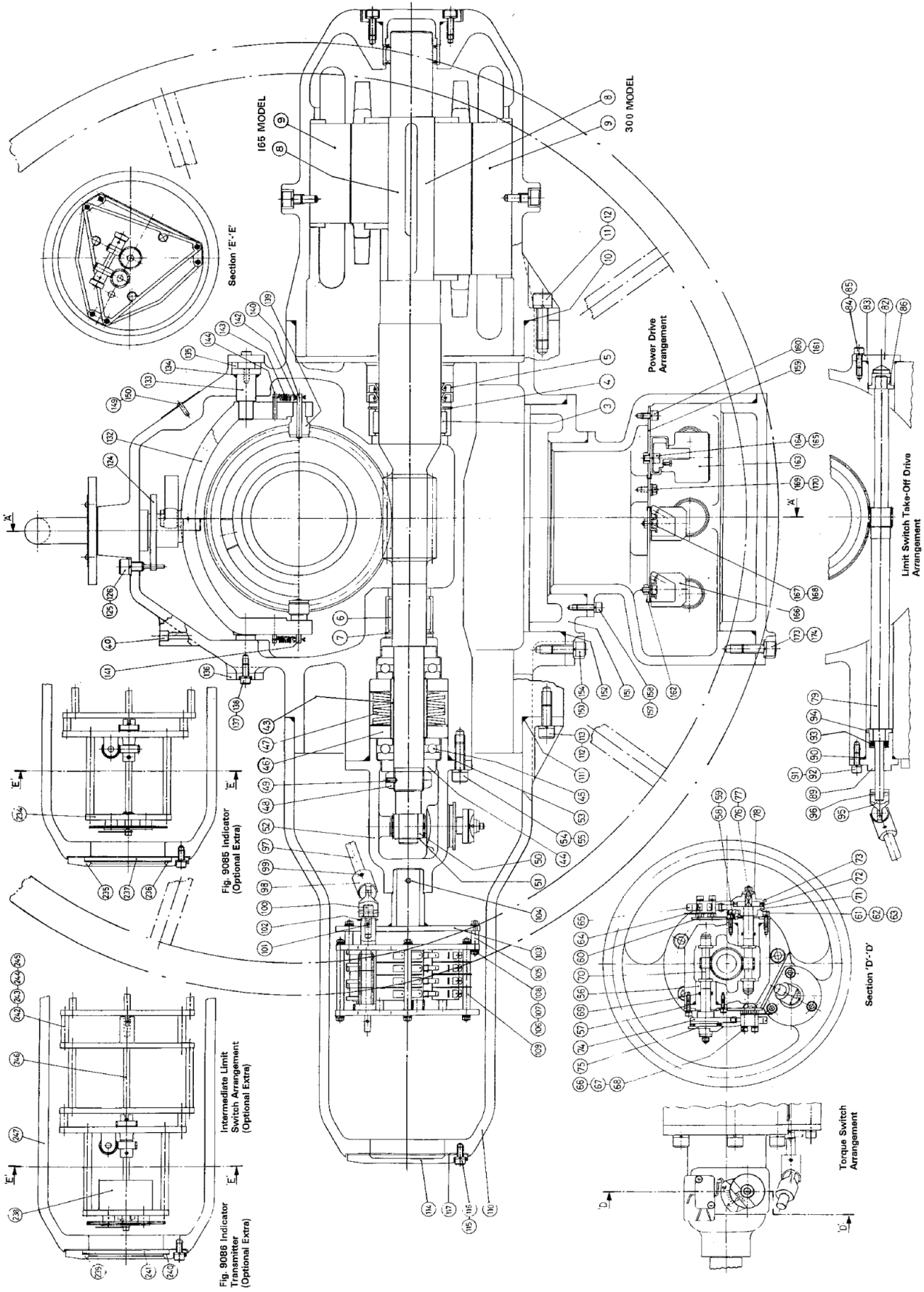
Weight: 175 kg (385 lb) gross



GENERAL ARRANGEMENT AND DIMENSIONS OF FIG. AA300 & AA165 ACTUATORS (3.1. FIG. 1)



**SECTIONAL ARRANGEMENT OF FIG. AA300 & AA165 ACTUATORS  
(3.2.1 FIG. 2a)**  
Refer to 3.2.3. for parts list



**SECTIONAL ARRANGEMENT OF FIG. AA300 & AA165 ACTUATORS  
(3.2.2 FIG. 2b)**  
Refer to 3.2.3. for parts list

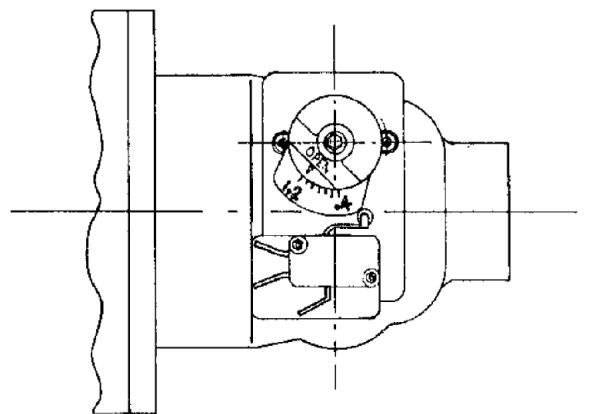
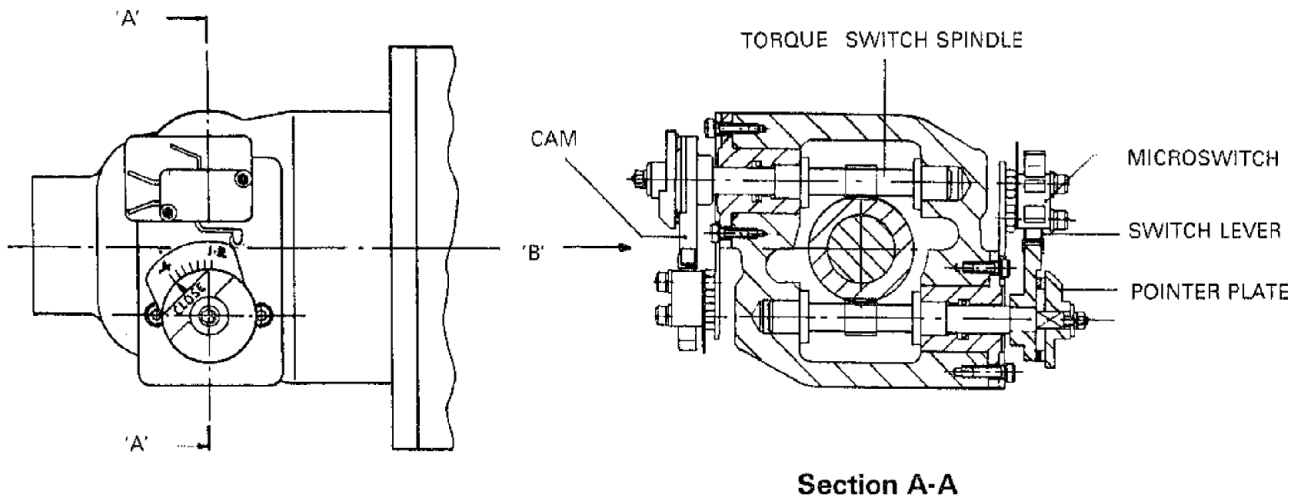
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|----------|--------------------------------|---------|----------|----------------------------------|---------|----------|----------------------|---------|----------|--------------------|---------|----------|-------------|---------|
| 1        | MAIN HOUSING                   | 1       | 66       | CAPSCREW                         | 4       | 132      | CLUTCH FORK          | 1       | 196      | THRUST WASHER      | 1       |          |             |         |
| 2        | OIL SEAL                       | 2       | 67       | PLAIN WASHER                     | 4       | 133      | PIVOT                | 2       | 196      | DRIVE SLEEVE BLANK | 1       |          |             |         |
| 3        | NEEDLE ROLLER BEARING          | 1       | 68       | SPRING WASHER                    | 4       | 134      | 'O' RING             | 2       | 197      | RING NUT           | 1       |          |             |         |
| 4        | CIRCLIP                        | 4       | 69       | 'O' RING                         | 2       | 136      | RETAINING PLATE      | 4       | 198      | GRUBSCREW          | 1       |          |             |         |
| 5        | OIL SEAL                       | 2       | 70       | TORQUE SWITCH SPINDLE            | 2       | 137      | CAPSCREW             | 4       | 199      | NAMEPLATE          | 1       |          |             |         |
| 6        | NEEDLE ROLLER BEARING          | 1       | 71       | CAM PLATE                        | 1       | 138      | SPRING WASHER        | 1       | 200      | HAMMER DRIVE SCREW | 2       |          |             |         |
| 7        | CIRCLIP                        | 1       | 72       | CLUTCH RING                      | 2       | 139      | CLUTCH ROLLER        | 2       |          |                    |         |          |             |         |
| 8        | WORMSHAFT ASSY.                | 1       | 73       | INDEX POINTER                    | 1       | 140      | RIGHT HAND LATCH     | 1       |          |                    |         |          |             |         |
| 9        | STATOR HOUSING ASSY.           | 1       | 74       | CAM PLATE                        | 1       | 141      | LEFT HAND LATCH      | 1       |          |                    |         |          |             |         |
| 10       | 'O' RING                       | 1       | 75       | INDEX POINTER                    | 1       | 142      | SPLIT PIN            | 2       |          |                    |         |          |             |         |
| 11       | CAPSCREW                       | 4       | 76       | NUT                              | 2       | 143      | LATCH SPRING         | 2       |          |                    |         |          |             |         |
| 12       | SPRING WASHER                  | 4       | 77       | SPRING WASHER                    | 2       | 144      | PIN                  | 2       |          |                    |         |          |             |         |
| 13       | OUTPUT SHAFT                   | 1       | 78       | WASHER                           | 2       | 145      | EARTHING STUD        | 1       |          |                    |         |          |             |         |
| 14       | BALL BEARING                   | 1       | 79       | LIMIT SWITCH TAKE OFF GEAR SHAFT | 1       | 146      | PLAIN WASHER         | 2       |          |                    |         |          |             |         |
| 15       | SPACER                         | 1       | 82       | BEARING HOUSING                  | 1       | 147      | NUT                  | 2       |          |                    |         |          |             |         |
| 16       | SHIM                           | A.R.    | 83       | 'O' RING                         | 1       | 148      | PRESSURE PLUG        | 2       |          |                    |         |          |             |         |
| 17       | SHIM                           | A.R.    | 84       | CAPSCREW                         | 3       | 149      | NAMEPLATE            | 2       |          |                    |         |          |             |         |
| 18       | SHIM                           | A.R.    | 85       | SPRING WASHER                    | 3       | 150      | HAMMER DRIVE SCREW   | 2       |          |                    |         |          |             |         |
| 19       | CIRCLIP                        | 1       | 86       | FLANGED BEARING                  | 1       | 156      | TERMINAL BOX HOUSING | 1       |          |                    |         |          |             |         |
| 20       | LIMIT SWITCH TAKE OFF PIN(ION) | 1       | 88       | BEARING HOUSING                  | 1       | 156      | 'O' RING             | 1       |          |                    |         |          |             |         |
| 21       | KEY                            | 1       | 89       | BEARING HOUSING                  | 1       | 157      | CAPSCREW             | 4       |          |                    |         |          |             |         |
| 22       | SHIM                           | A.R.    | 90       | 'O' RING                         | 1       | 157      | SPRING WASHER        | 4       |          |                    |         |          |             |         |
| 23       | SHIM                           | A.R.    | 91       | CAPSCREW                         | 3       | 158      | SPRING WASHER        | 4       |          |                    |         |          |             |         |
| 24       | SHIM                           | A.R.    | 92       | SPRING WASHER                    | 3       | 159      | MOUNTING PLATE       | 1       |          |                    |         |          |             |         |
| 25       | WORMWHEEL                      | 1       | 93       | 'O' RING                         | 1       | 160      | CAPSCREW             | 3       |          |                    |         |          |             |         |
| 26       | CIRCLIP                        | 1       | 94       | FLANGED BEARING                  | 1       | 161      | SPRING WASHER        | 3       |          |                    |         |          |             |         |
| 27       | SLIDING CLUTCH                 | 1       | 95       | UNIVERSAL COUPLING               | 1       | 162      | GRONMET STRIP        | 1       |          |                    |         |          |             |         |
| 28       | SPRING SEAT WASHER             | 1       | 96       | SPRING P'N                       | 2       | 163      | TERMINAL BOARD       | 1       |          |                    |         |          |             |         |
| 29       | SPRING                         | 1       | 97       | DRIVE SHAFT                      | 1       | 164      | CHEESE HEAD SCREW    | 2       |          |                    |         |          |             |         |
| 30       | HANDWHEEL                      | 1       | 98       | UNIVERSAL COUPLING               | 1       | 165      | SPRING WASHER        | 2       |          |                    |         |          |             |         |
| 31       | SPINDLE COVER                  | 1       | 99       | SPRING PIN                       | 2       | 166      | TERMINAL BOARD       | 2       |          |                    |         |          |             |         |
| 32       | LUBRICATOR                     | 1       | 100      | STUB SHAFT                       | 1       | 167      | CHEESE HEAD SCREW    | 4       |          |                    |         |          |             |         |
| 33       | CAPSCREW                       | 4       | 101      | SPRING PIN                       | 1       | 168      | SPRING WASHER        | 4       |          |                    |         |          |             |         |
| 34       | SPRING WASHER                  | 4       | 102      | CIRCLIP                          | 1       | 169      | EARTHING SCREW       | 2       |          |                    |         |          |             |         |
| 35       | OIL SEAL                       | 2       | 103      | L.S. MOUNTING PLATE              | 1       | 170      | PLAIN WASHER         | 2       |          |                    |         |          |             |         |
| 36       | NEEDLE ROLLER BEARING          | 1       | 104      | SPRING PIN                       | 1       | 171      | COVER                | 1       |          |                    |         |          |             |         |
| 37       | CIRCLIP                        | 1       | 105      | PILLAR                           | 3       | 172      | 'O' RING             | 1       |          |                    |         |          |             |         |
| 38       | 'O' RING                       | 1       | 106      | NUT                              | 6       | 173      | CAPSCREW             | 4       |          |                    |         |          |             |         |
| 39       | RETAINER                       | 1       | 107      | PLAIN WASHER                     | 6       | 174      | SPRING WASHER        | 4       |          |                    |         |          |             |         |
| 40       | GRUBSCREW                      | 1       | 108      | SPRING WASHER                    | 6       | 175      | WARNING PLATE        | 4       |          |                    |         |          |             |         |
| 41       | SLEEVE                         | 1       | 109      | LIMIT SWITCH ASSY.               | 1       | 176      | HAMMER DRIVE SCREW   | 2       |          |                    |         |          |             |         |
| 42       | WASHER                         | 2       | 110      | LIMIT SWITCH COVER               | 1       | 177      | 32mm CONDUIT PLUG    | 2       |          |                    |         |          |             |         |
| 43       | THRUST BALL BEARING            | 2       | 111      | 'O' RING                         | 1       | 178      | 25mm CONDUIT PLUG    | 2       |          |                    |         |          |             |         |
| 44       | WASHER                         | 2       | 112      | CAPSCREW                         | 4       | 179      | THRUST BASE          | 1       |          |                    |         |          |             |         |
| 45       | DISC SPRING                    | 8       | 113      | SPRING WASHER                    | 4       | 180      | CAPSCREW             | 4       |          |                    |         |          |             |         |
| 46       | LOCKNUT                        | 2       | 114      | BLANKING PLATE                   | 1       | 181      | SPRING WASHER        | 4       |          |                    |         |          |             |         |
| 47       | GRUBSCREW                      | 1       | 115      | CAPSCREW                         | 3       | 182      | LUBRICATOR           | 4       |          |                    |         |          |             |         |
| 48       | GEAR SLEEVE                    | 1       | 116      | SPRING WASHER                    | 3       | 183      | THRUST NEEDLE CAGE   | 2       |          |                    |         |          |             |         |
| 49       | CIRCLIP                        | 1       | 117      | GASKET                           | 1       | 184      | THRUST WASHER        | 4       |          |                    |         |          |             |         |
| 50       | TORQUE SWITCH HOUSING          | 1       | 118      | HAND/AUTO LEVER                  | 1       | 185      | DRIVE SLEEVE BLANK   | 1       |          |                    |         |          |             |         |
| 51       | 'O' RING                       | 1       | 119      | NAMEPLATE                        | 1       | 185      | RING NUT             | 1       |          |                    |         |          |             |         |
| 52       | CAPSCREW                       | 5       | 120      | HAMMER DRIVE SCREW               | 2       | 187      | GRUBSCREW            | 1       |          |                    |         |          |             |         |
| 53       | SPRING WASHER                  | 5       | 121      | 'O' RING                         | 2       | 188      | NAMEPLATE            | 1       |          |                    |         |          |             |         |
| 54       | BEARING HOUSING                | 2       | 122      | SPACER                           | 1       | 189      | HAMMER DRIVE SCREW   | 2       |          |                    |         |          |             |         |
| 55       | 'O' RING                       | 2       | 123      | CAM                              | 1       |          |                      |         |          |                    |         |          |             |         |
| 56       | CAPSCREW                       | 6       | 124      | SPIRAL SPRING                    | 1       |          |                      |         |          |                    |         |          |             |         |
| 57       | SPRING WASHER                  | 6       | 125      | SPRING RETAINER                  | 1       |          |                      |         |          |                    |         |          |             |         |
| 58       | T.S. MOUNTING PLATE            | 2       | 126      | SPRING WASHER                    | 1       |          |                      |         |          |                    |         |          |             |         |
| 59       | CAPSCREW                       | 4       | 127      | WASHER                           | 1       |          |                      |         |          |                    |         |          |             |         |
| 60       | PLAIN WASHER                   | 4       | 128      | COUNTERSUNK SCREW                | 1       |          |                      |         |          |                    |         |          |             |         |
| 61       | SPRING WASHER                  | 4       | 129      | FOLLOWER PIN                     | 1       |          |                      |         |          |                    |         |          |             |         |
| 62       | INSULATING PLATE               | 2       | 130      | CAM FOLLOWER                     | 1       |          |                      |         |          |                    |         |          |             |         |
| 63       | MICRO SWITCH                   | 2       | 131      | SPRING PIN                       | 1       |          |                      |         |          |                    |         |          |             |         |
| 64       |                                |         |          |                                  |         |          |                      |         |          |                    |         |          |             |         |
| 65       |                                |         |          |                                  |         |          |                      |         |          |                    |         |          |             |         |

A.R.—AS REQUIRED  
 ★ DEPENDS ON CLIENTS REQUIREMENTS OF VOLTAGE & FREQUENCY  
 + DEPENDS ON CLIENTS REQUIREMENTS OF OUTPUT SPEED

**PARTS LIST FOR FIG. AA300 & AA165 ACTUATORS  
 (3.2.3)**  
 Refers to Sectional Arrangement Drawings 3-2.1. & 3-2.2. Fig 2a & 2b.

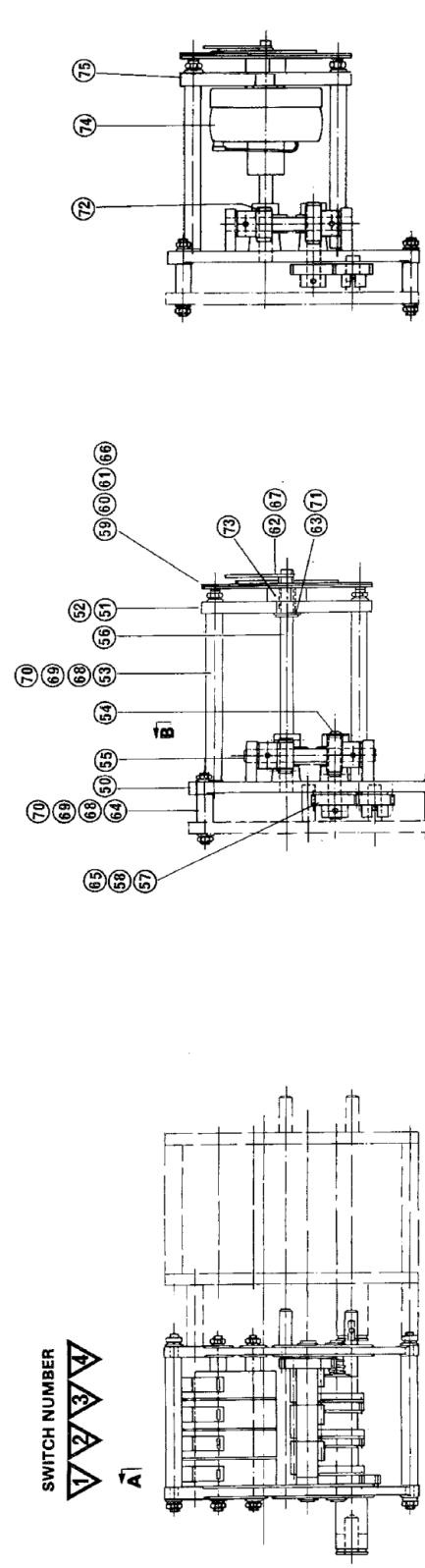
ITEMS 30 TO 41 ARE NOT REQUIRED WHEN USING THE FOLLOWING OPTION:  
 HAND DRIVE ARRANGEMENT  
 GEAR HOUSING  
'O' RING  
CAPSCREW  
SPRING WASHER  
CAPSCREW  
SPINDLE COVER  
LUBRICATOR  
CAPSCREW  
SPRING WASHER  
OIL SEAL  
WORMWHEEL  
NEEDLE ROLLER BEARING  
CIRCLIP  
RETAINER  
RETAINER PLUG  
SELF TAPPING SCREW  
GRUBSCREW  
'O' RING  
'O' RING  
CAPSCREW  
SPRING WASHER  
NEEDLE ROLLER BEARING  
WORMSHAFT  
BALL BEARING  
SPACER  
CIRCLIP  
HANDWHEEL  
KEY  
NAMEPLATE  
WASHER  
SETScrew  
SPRING WASHER  
ITEM 114 IS NOT REQUIRED WHEN USING THE FOLLOWING 2 OPTIONS:  
 POSITION INDICATOR ARRANGEMENT  
 VALVE POSITION INDICATOR ASSY.  
 WINDOW CLAMP  
 GASKET  
 WINDOW  
 POSITION INDICATOR TRANSMITTER ARRANGEMENT  
 STANDARD POTENTIOMETER ASSY.  
 WINDOW CLAMP  
 GASKET  
 WINDOW  
 ITEM 10 & 11 ARE NOT REQUIRED WHEN USING THE FOLLOWING OPTION:  
 INTERMEDIATE LIMIT SWITCH ARRANGEMENT  
 PILLAR  
 NUT  
 PLAIN WASHER  
 SPRING WASHER  
 LIMIT SWITCH ASSY.  
 LIMIT SWITCH COVER

ITEMS 179 TO 189 ARE NOT REQUIRED WHEN USING THE FOLLOWING OPTION:  
 HIGH THRUST BASE ARRANGEMENT  
 THRUST BASE ASSY.  
 CAPSCREW  
 SPRING WASHER  
 LUBRICATOR  
 THRUST WASHER  
 DRIVE SLEEVE BLANK  
 RING NUT  
 GRUBSCREW  
 NAMEPLATE  
 HAMMER DRIVE SCREW  
 ITEM 179 TO 189 ARE NOT REQUIRED WHEN USING THE FOLLOWING OPTION:  
 HIGH THRUST BASE ARRANGEMENT  
 THRUST BASE ASSY.  
 CAPSCREW  
 SPRING WASHER  
 LUBRICATOR  
 THRUST WASHER  
 DRIVE SLEEVE BLANK  
 RING NUT  
 GRUBSCREW  
 NAMEPLATE  
 HAMMER DRIVE SCREW



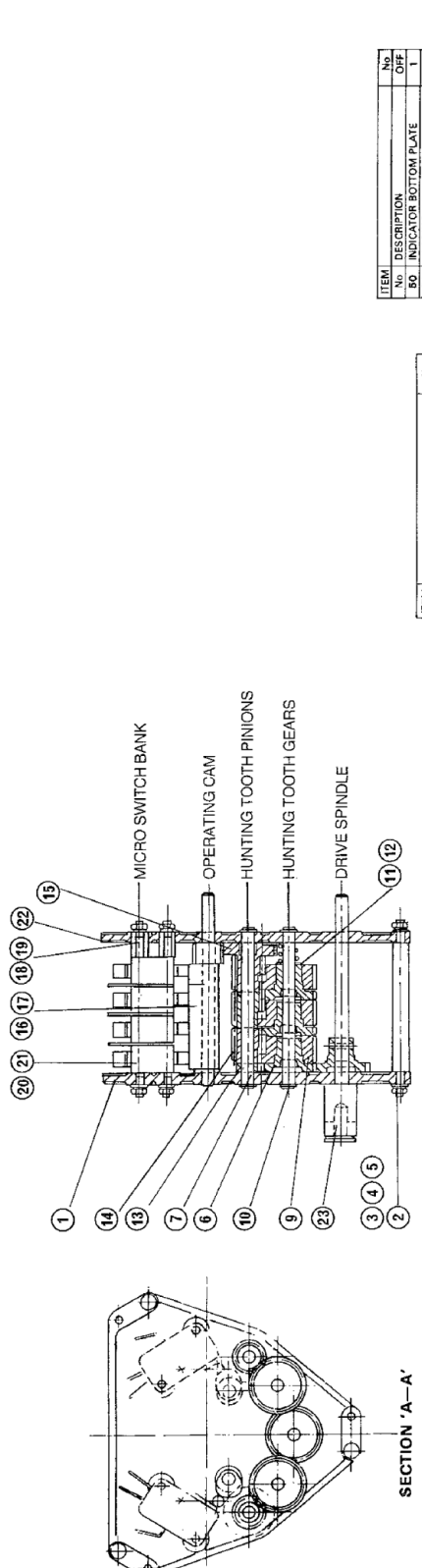
View on Arrow 'B'

**ARRANGEMENT OF TORQUE SWITCH  
(3.3. FIG. 3)**



**A)** 2 BANK LIMIT SWITCH  
**B)** FIG. 9085 INDICATOR

ADDITIONAL SWITCH BANKS AS REQD.



TYPICAL DEVELOPED SECTION OF LIMIT SWITCH GEAR TRAIN AND CAM.

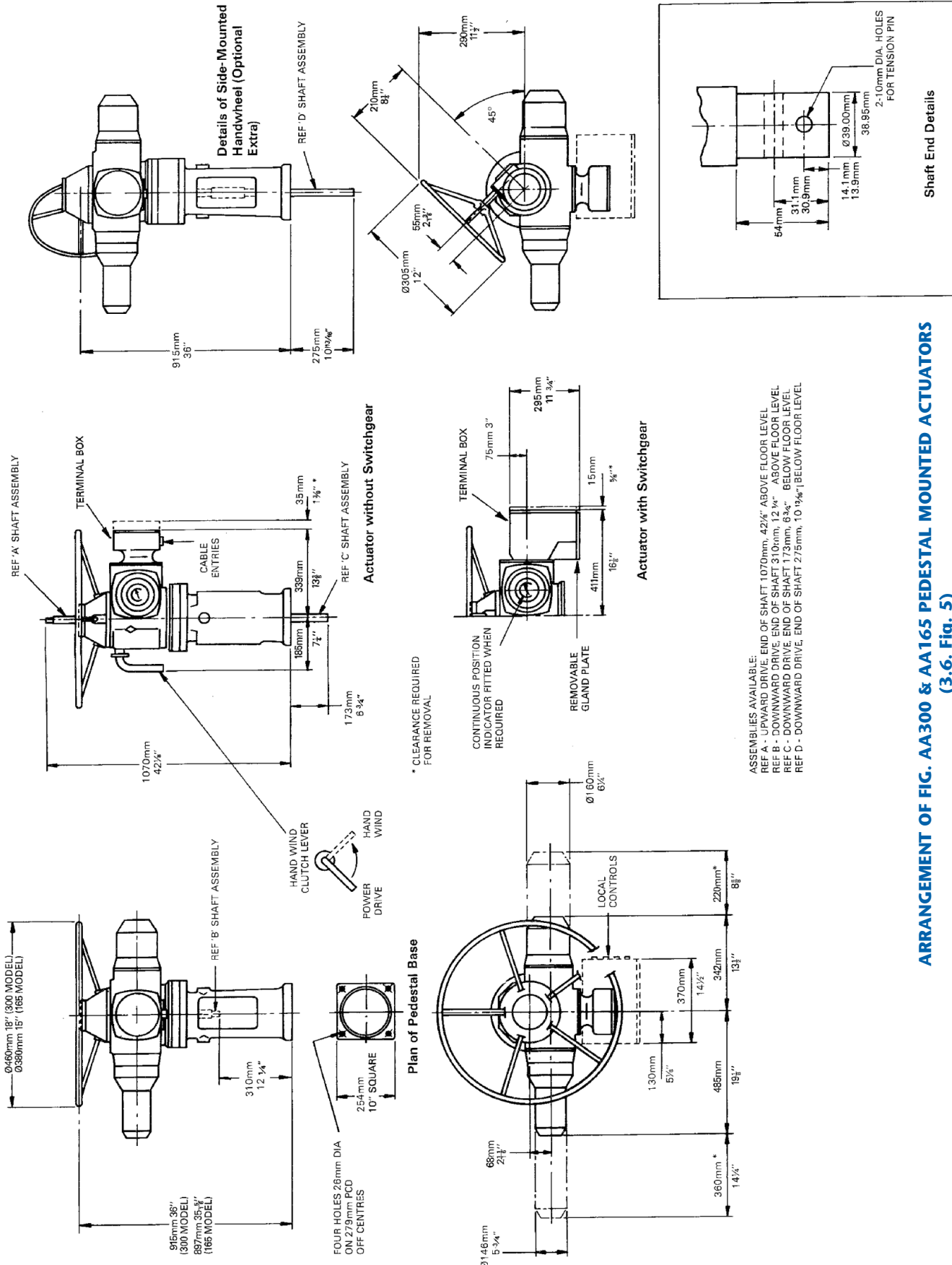


FIG. 9086 INDICATOR TRANSMITTER

| ITEM No. | DESCRIPTION            | No OFF |
|----------|------------------------|--------|
| 60       | INDICATOR BOTTOM PLATE | 1      |
| 61       | BEARING                | 1      |
| 62       | TOP PLATE              | 1      |
| 63       | PULLAR                 | 3      |
| 64       | CHANGE GEAR SPINDLE    | 1      |
| 65       | CHANGE GEAR SPINDLE    | 1      |
| 66       | POINTER SPINDLE        | 1      |
| 67       | SPUR GEAR              | 1      |
| 68       | SPUR GEAR              | 1      |
| 69       | INDEX PLATE - CFEN     | 1      |
| 70       | INDEX PLATE - SHUT     | 1      |
| 71       | CLAMPING PLATE         | 1      |
| 72       | POWER WASHER           | 7      |
| 73       | POWER WASHER           | 3      |
| 74       | PULLAR                 | 6      |
| 75       | SPRING PIN             | 2      |
| 76       | SCREW - C/SUNK H/D     | 2      |
| 77       | SCREW-CHEESE HD        | 1      |
| 78       | NUT                    | 12     |
| 79       | SPRING WASHER          | 12     |
| 80       | PLAIN WASHER           | 12     |
| 81       | PLAIN WASHER           | 12     |
| 82       | PLAIN WASHER           | 12     |
| 83       | PLAIN WASHER           | 12     |
| 84       | PLAIN WASHER           | 12     |
| 85       | PLAIN WASHER           | 12     |
| 86       | PLAIN WASHER           | 12     |
| 87       | PLAIN WASHER           | 12     |
| 88       | PLAIN WASHER           | 12     |
| 89       | PLAIN WASHER           | 12     |
| 90       | PLAIN WASHER           | 12     |
| 91       | PLAIN WASHER           | 12     |
| 92       | PLAIN WASHER           | 12     |
| 93       | PLAIN WASHER           | 12     |
| 94       | PLAIN WASHER           | 12     |
| 95       | PLAIN WASHER           | 12     |
| 96       | PLAIN WASHER           | 12     |
| 97       | PLAIN WASHER           | 12     |
| 98       | PLAIN WASHER           | 12     |
| 99       | PLAIN WASHER           | 12     |
| 100      | PLAIN WASHER           | 12     |

| ITEM No. | DESCRIPTION            | No OFF |
|----------|------------------------|--------|
| 1        | INDICATOR BOTTOM PLATE | 1      |
| 2        | BEARING                | 1      |
| 3        | TOP PLATE              | 1      |
| 4        | PULLAR                 | 3      |
| 5        | CHANGE GEAR SPINDLE    | 1      |
| 6        | CHANGE GEAR SPINDLE    | 1      |
| 7        | POINTER SPINDLE        | 1      |
| 8        | SPUR GEAR              | 1      |
| 9        | SPUR GEAR              | 1      |
| 10       | INDEX PLATE - CFEN     | 1      |
| 11       | INDEX PLATE - SHUT     | 1      |
| 12       | CLAMPING PLATE         | 1      |
| 13       | POWER WASHER           | 7      |
| 14       | POWER WASHER           | 3      |
| 15       | PULLAR                 | 6      |
| 16       | SPRING PIN             | 2      |
| 17       | SCREW - C/SUNK H/D     | 2      |
| 18       | SCREW-CHEESE HD        | 1      |
| 19       | NUT                    | 12     |
| 20       | SPRING WASHER          | 12     |
| 21       | PLAIN WASHER           | 12     |
| 22       | PLAIN WASHER           | 12     |
| 23       | PLAIN WASHER           | 12     |
| 24       | PLAIN WASHER           | 12     |
| 25       | PLAIN WASHER           | 12     |
| 26       | PLAIN WASHER           | 12     |
| 27       | PLAIN WASHER           | 12     |
| 28       | PLAIN WASHER           | 12     |
| 29       | PLAIN WASHER           | 12     |
| 30       | PLAIN WASHER           | 12     |
| 31       | PLAIN WASHER           | 12     |
| 32       | PLAIN WASHER           | 12     |
| 33       | PLAIN WASHER           | 12     |
| 34       | PLAIN WASHER           | 12     |
| 35       | PLAIN WASHER           | 12     |
| 36       | PLAIN WASHER           | 12     |
| 37       | PLAIN WASHER           | 12     |
| 38       | PLAIN WASHER           | 12     |
| 39       | PLAIN WASHER           | 12     |
| 40       | PLAIN WASHER           | 12     |

**GENERAL ARRANGEMENT & PARTS LIST OF 2 BANK LIMIT SWITCH INDICATOR (3.4. & 3.5. Fig. 4)**



**ARRANGEMENT OF FIG. AA300 & AA165 PEDESTAL MOUNTED ACTUATORS (3.6. Fig. 5)**

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