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A LOW COST ELECTRICAL RUDDER INDICATOR FOR THE MEDIUM SIZED POWER VESSEL*

It is an electrical instrument to indicate the rudder angle of the vessel in degrees with respect to the bow of the vessel in the wheel house. This helps the man at the wheel in manoeuvring the vessel while sailing in general and particularly in the following occasions:

1. When the vessel is started at open sea after it was stopped for some time, the Rudder indicator helps the operator to know the set position of the rudder, enabling him to reset for the new course without delay. Otherwise the operator has to turn the steering wheel to the maximum of either port or starboard and then turn to the required direction.

2. While sailing on a straight course, the forces of wind and current and their effects on rudder can be noticed with the aid of the Rudder indicator.

3. At times the steering wheel may rotate, but the rudder may not move because of the failure of the coupling system. The Rudder indicator can confirm this situation indicating whether the rudder is moving or not while turning the wheel.

4. If any slack exist in the wire rope, connecting the steering wheel and the quadrant, this can be noticed through Rudder indicator.

5. While encircling a fish school using purse seine, the Rudder indicator helps in making big or small circle as required depending upon the school size.

Considering the utility of the instrument and non-availability of a commercial model in the local market, it was decided to design and fabricate one proto-type of the instrument for Cadalmin IX, a 43′ vessel of the Institute. Accordingly the instrument has been fabricated and tested on board the vessel and found successful. It consists of a rudder angle sensor mounted on the quadrant and a display panel in the wheel house with the appropriate electrical connections. The details of the instrument are described below with circuit diagram.

Principle of operation and design considerations

The mechanical movement of the rudder is converted into an electrical signal using a centre tapped potentiometer and fed to an indicator whose pointer movement is synchronised with the movement of rudder with 180° out of phase. The rudder is mechanically coupled to the steering wheel of the vessel which controls the rudder movement through the quadrant. The coupling arrangement is such that when the wheel is turned to the port side in order to turn the vessel to port, the rudder will move towards starboard side. The pointer of the indicator will deflect to the port indicating the direction of the turning of the vessel and vice-versa. The shaft of the angle sensor (potentiometer) is coupled to the quadrant of the vesse mechanically. The body of the pot meter is held by a metal frame fixed to the sides of the hatch. Hence the wiper of the pot meter is free to move when the shaft of the quadrant move. A DC supply of equal and opposite polarity is applied to the end of the pot meter and the common point of the supply source is connected to the centre tap of the pot meter. The centre zero D.C. Volt meter is connected across the centre tap and the wiper of the pot meter. When the steering wheel is rotated the quadrant moves as it is coupled mechanically through wire rope. Simultaneously the wiper of the pot meter moves as it is directly coupled with the quadrant. As the wiper moves the voltage given to the voltmeter is varied linearly. When the vessel is in midship, the position of the wiper is adjusted so as to be at zero volt. When the quadrant moves starboard side the wiper moves along +ve supply and when the quadrant moves port side the wiper travels along –ve supply. Accordingly the pointer of the voltmeter also moves along the starboard and port side respectively from the centre. The movement of the pointer has been calibrated in terms of angles in degrees. The maximum

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voltage permissible to be applied to the meter is equal to the full scale deflection voltage (FSD) of the meter. Hence the applied voltage to the circuits need be exactly equivalent to the FSD voltage or else the supply can be greater than the FSD voltage but it must be controlled to be equivalent to the FSD voltage, across the meter. Therefore a supply controlling circuit

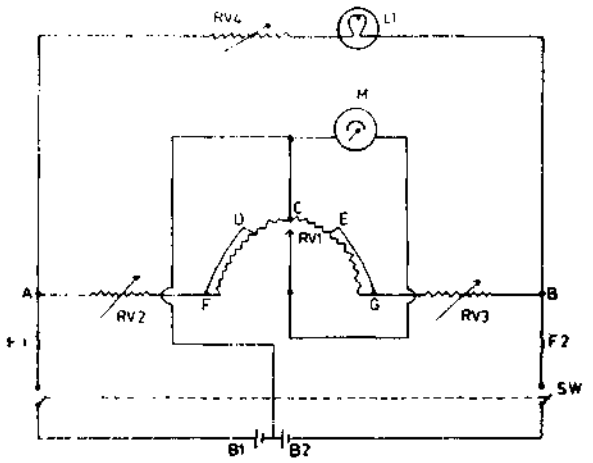

Fig. 1. Circuit diagram of electric rudder indicator

is also required to be incorporated. If the applied voltage is +12 V and the FSD is 3 V, two linear pot meters can be connected in series to the angle sensor, one at each end and the resistance can be adjusted so as to get exactly +3 V when the quadrant is fully starboard side and -3 V when the quadrant is moved fully to the port side. The value of the resistance need be so chosen considering the half section value of the resistance of the angle sensor and the voltage to be dropped across the series resistance, with the tolerance to adjust for the input supply variation. Therefore the minimum power supply required to operate the instrument is twice the FSD voltage plus the expected variation in the input supply source.

Circuit construction

RV_1 (fig. 1) is the wirewound variable resistance (potentiometer) of 1K ohm 7 watts with a centre tap, functioning as angle sensor. The ends of the sensor are connected to the opposite terminals of two 12 V batteries (Bl, B2) in series through the variable resistance RV_2, RV_3 of 1K each, dial lamp, fuse Fl, F2 and a double pole single throw switch. The DC voltmeter M of 3 V FSD with centre zero (3-0-3V) is connected across the centre tap of the sensor (RV_1) and its wiper. Also the centre tap is connected to common point of the 2 batteries. Ll is the dial lamp (24 V miniature type), connected across the supply through RV_4 (5K variable resistance).

Circuit explanation

When the switch is put on, it connects the 24 V supply to the circuits. The dial lamp Ll glows. The brightness of the light is controlled by the potmeter RV_4 (dimmer control). 24V is applied across RV_2, RV_1 and RV_3 in series. Voltage between centre tap of RV_1 and the + ve terminal of the battery is + 12 V and the centre tap of RV_1 and -ve terminal of the source is -ve 12 V. The movement of the wiper is restricted to 40° either side from centre, C to D and C to E because this is the limit to which the quadrant of the vessel can travel. Hence the rest of the portion of the variable resistance is shorted out in either side (DF and EG). Keeping the wiper at the centre C, the RV_2 and RV_3 is adjusted to have + 3 V between CD and -3V between CE. Now when the wiper is at the centre the meter reads zero. When it moves towards D the meter deflects to the star board side from the centre. When the wiper is moved towards 'E' the pointer deflects towards port side.

The meter has been fixed with a calibrated dial to read the position of the quadrant in degrees upto the maximum of 40° in both port and star board sides. Port and starboard side of the dial has been painted with red and green respectively.

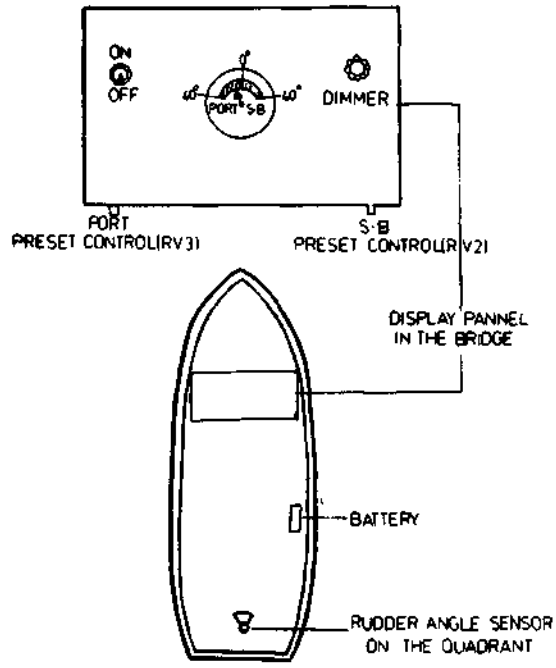

Fig. 2. Location diagram of rudder indicator on board Cadalmin IX

Installation, test and calibration

The electrical components RV_2, RV_3 and RV_4 along with the indicator meter are mounted in a perspex box (8″ x 5″ x 2″) and fixed in the wheel house of the boat (Fig. 2 and 3). RV_1 is in a 2″ x 2″ x 2″ metal box filled with greese and fixed at the quadrant (Fig. 4). 10 amp 4 core cable connects the 24 V supply from the main box to RV_1 pot meter (the sensor), and brings the signal to the indicator. The common point

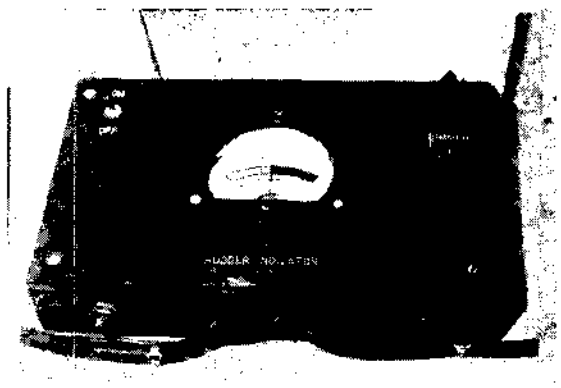

Fig. 3. Display unit

of the battery is connected to the centre tap of the sensor (RV_1) by a single core wire. Battery supply is connected from the wheel house to the main box through the switch. Equipment was installed in the vessel Cadalmin IX on 7–4–81 and was calibrated by adjusting RV_2 and RV_3 to read 40° either side while rotating the steering wheel to the maximum of starboard and port side respectively. Performance test was carried out by sailing the vessel in the open sea and found functioning satisfactorily.

As the vessel Cadalmin IX was equipped with 24 V battery (2 batteries of 12 V each) the rudder indicator was designed to work on 24 Volt. Same system can work with 9 Volts also (6 number dry cells of 1.5 v each), by resetting the present control RV_2 and RV_3. This has been confirmed by testing at the laboratory.

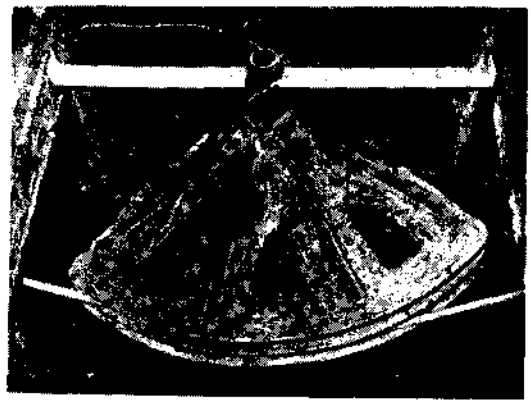

Fig. 4. Angle sensor at the quadrant of the vessel

Therefore if this instrument is required to be installed on board a vessel where 24 V battery provision is not there, it can be operated with 6 number dry cells of 1.5 V each,ie. 9 volt supply with the centre tap. All the required parts for the instrument are available locally. The approximate cost of the materials including the cable is Rs. 350/- only.

Routine check and maintenance

Before sailing the vessel, the display should be checked by rotating the steering wheel to the maximum of port and starboard sides to confirm the pointer moves to 40° in both side correspondingly. If not, the preset control RV_2 and RV_3 are to be adjusted so as to have 40° reading. The position of the rudder angle sensor is required to be checked once in a week to confirm that it is held properly. It is preferred to have general external cleaning daily on and around the angle sensor.