CHAPTER XIII

AUTO PILOT

GENERAL

The autopilot is basically used when a ship has to steer a set course for a long time without alteration because any deviation from the set course is controlled electronically and automatically. This will not only relieve the helmsman from steering duties but is also more efficient because as soon as the ship devintes from the set course, corrective action is taken immediately using requisite amount of helm to bring the ship back to the set course. This is achieved by comparing the course to steer as set by the navigator with the ship's heading obtained from gyro or magnetic compass, any difference between the two will cause an error and correcting helm is applied to the rudder such that the heading is brought to the same value as the set course. With the use of autopilot over a long period of time, the average speed of the ship increases as the ship does not zig zag across the track and this will also ensure that ship's steering gear operates to a minimum. A good automatic steering system also reduces the fuel consumption. Since the manoeuvering characteristics of ship depends on the type of ship, length, beam and also varies with trim, loading and weather condition etc., certain critical controls have to be set optimally to obtain efficient automatic steering. The autopilot must have indicators to show whether the steering is on manual or autopilot and the change over switch must be on or near the steering panel itself.

SIMPLIFIED BLOCK DIAGRAM

The course to be steered is selected by the course selector knob while the present heading of the ship is indicated on the gyro or the magnetic compass. As shown in figure 1, the output from a gyro or a magnetic compass is coupled to the comparator in the control unit along with the input signal from manual course setting control. Any difference between the two signals causes an output error signal whose magnitude is proportional to the difference between the two signals and hence the comparator is also referred to as proportional control. In addition to the proportional control, the control unit also consists of derivatives and integral controls, which analyses the signals from the gyro or magnetic compass and the course selector. A summing amplifier is used to obtain a resultant error signal from these three controls.

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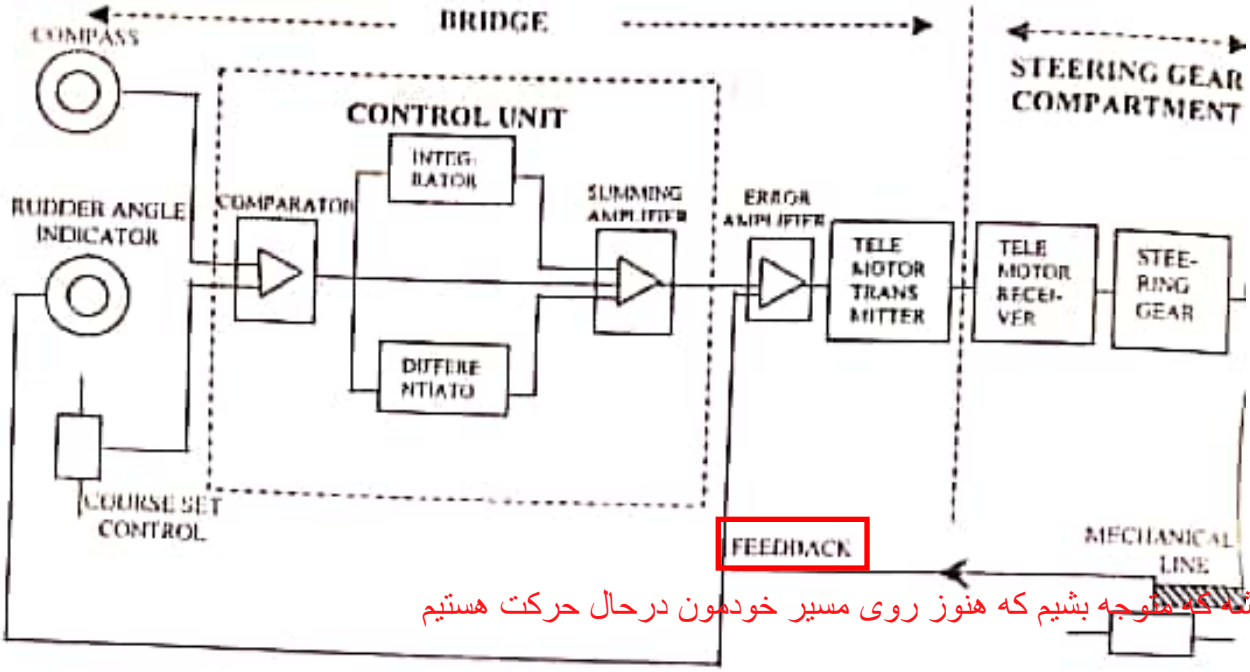


Figure I
Simplified Block Diagram of Autopilot

This error signals is fed to the error amplifier, which also gets feedback signals from the rudder, consisting of rudder position and its movement. The output of the error amplifier is fed via telemotors to the steering gear unit and in turn operates the rudder. The telemotor has two units i.e. transmitter and receiver which are situated on the bridge and steering gear compartment respectively. There will be no output from the control unit when the difference between the two signals is zero and hence no movement of the rudder results.

DETAILS OF CONTROL UNIT

In order to maintain the ship's course as accurately as possible, the helm must be provided with data regarding the ship's movement relative to the course to steer line. It is achieved by electronic circuits with the help of the following controls, which forms the heart of the control unit –

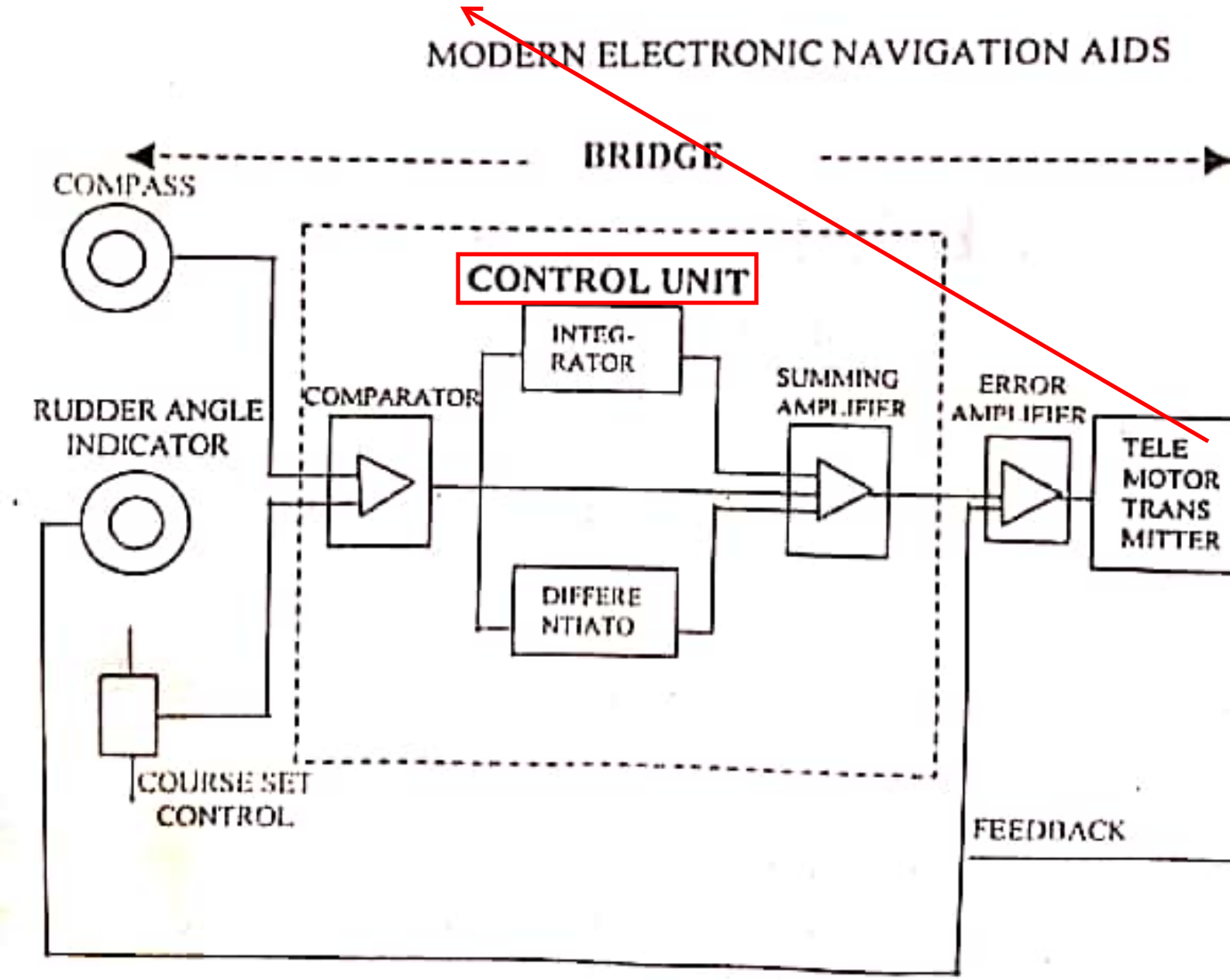
- Proportional control
- Derivative control and
- Integral control

PROPORTIONAL CONTROL

The effect on steering when only proportional control is applied causes the rudder to move by an amount proportional to the off – course error from the course to steer and the ship will oscillate on either side of the required course - line as shown in figure 2.

control unit : بخضی از دستگاه که اگر در زمان باد یا جریان جهت
تغییر میکند این وسیله مقداری که دوباره به مسیر برگردد را نشان میده

بخشی است که دستورات کنترل یونیت را به استیر میرساند ویک فید بک ارسال میکند که دستورات انجام شد



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When the ship has gone off course to port from the course to steer as shown in figure 2, an error occurs and helm has to be used to alter the course to starboard so as to bring the ship back on the set course.

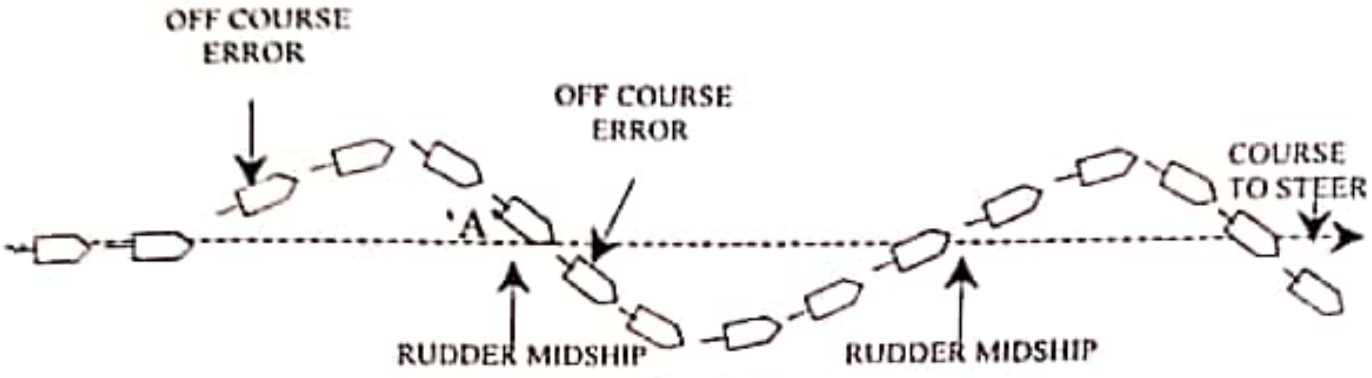

Figure2
Motion of the ship due to proportional control only

As the ship starts to return to the set course, the helm is gradually reduced and finally when the ship is back on the set course, the helm is removed. The rudder will be amidship as the ship approaches its course at point A causing an overshoot resulting in ship to go more to starboard than the requires course. Correcting data is now applied causing a port turn to bring the ship back to its original course line.

DERIVATIVE CONTROL

In derivative control the rudder is shifted by an amount proportional to the rate of change of ship's deviation from the course. As shown in figure 3, any deviation of course to port will cause correcting rudder to be applied to starboard.

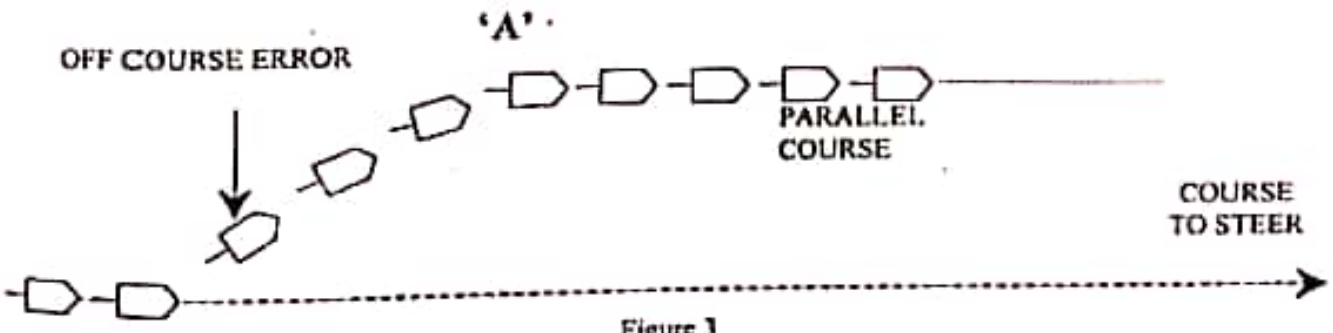

Figure 3
Motion of the ship due to derivative control only

The rate of change of course decreases with the result that automatic rudder control decreases and at point A, the rudder will return to midship position as shown in figure 3. The ship will now make good a course, which is parallel to the required course and will continue to do so.

An ideal combination of both proportional and derivative control produces a more satisfactory return to course as shown in figure 4.

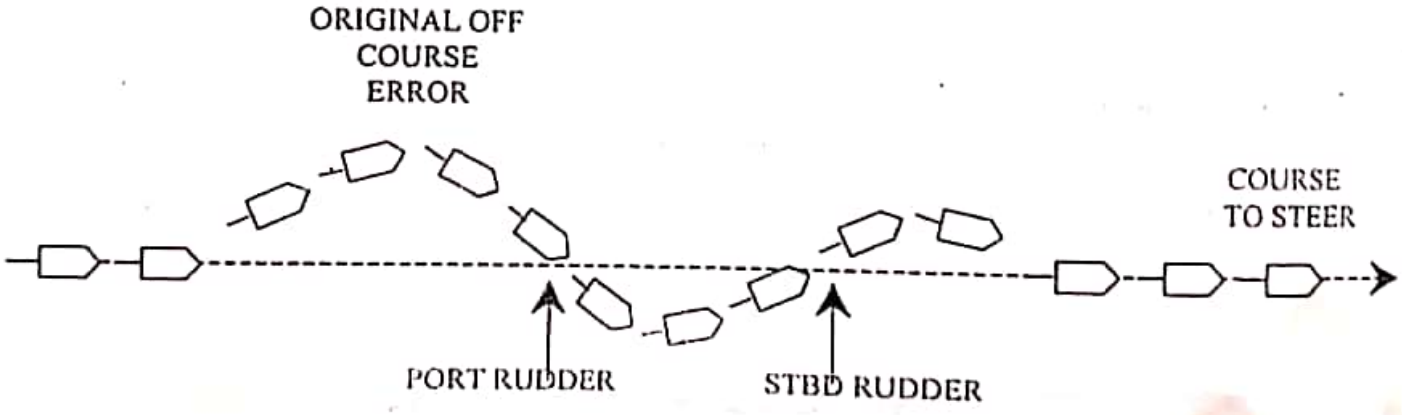

Figure 4
Motion of the ship due to combined effect

INTEGRAL CONTROL