# VELOCITY SENSORS OF ROTATION TECHNOLOGICALS UNITS ON GRAIN COMBINES AND DIRECTIVES FOR THEIRS CALIBRATION

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**Summary:** Determination of power on transport-technological units of combines is necessary for true configuration of power, for monitoring of combine work and monitoring deviation from optimal work regime as well as for monitoring of circulation grain mass. Measurement of rotation velocity on technological units of combines is implement by proximity switches. Its may be montire radial or axial. System mistakes during measurement debug by calibration of sensors.

**Key words:** technological units of combine, velocity, sensors, calibration.

## 1. INTRODUCTION

Determining the balance of power is done by measuring combines angular velocity over the speed and measuring the torque on the output shaft.

Measuring the size of these shafts at all, it would be expensive, impractical and often unnecessary, so it is necessary to make the right choice back in to be installed measuring devices, so that on the basis of these measuring points can be found almost all the power circuits of interest to combine. One possible choice of measuring points is shown in Figure 1

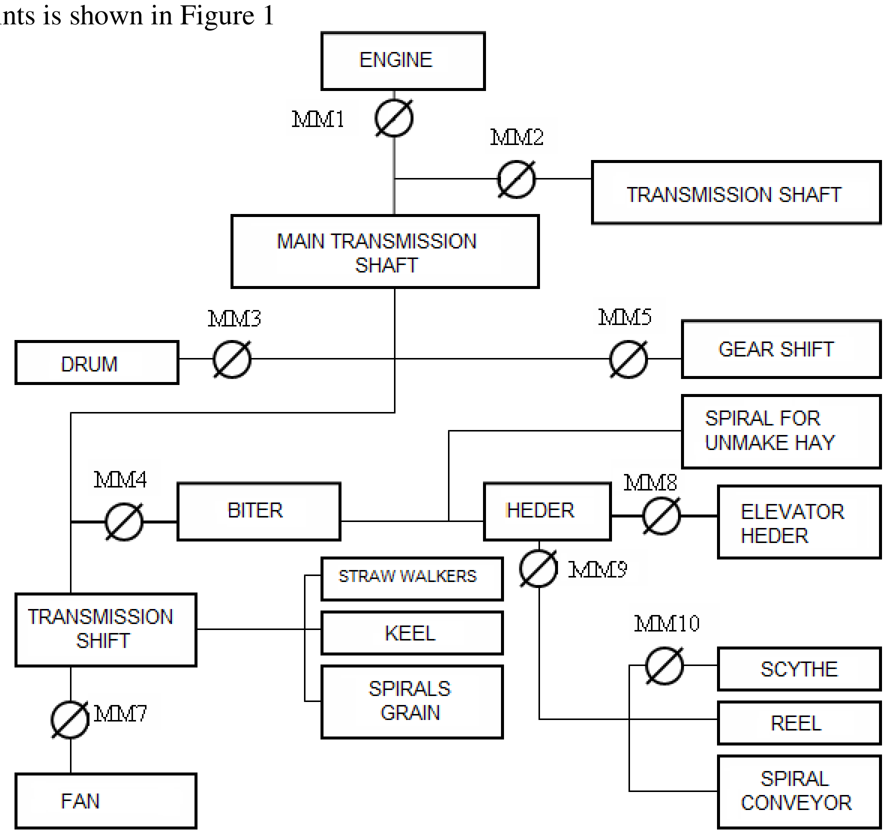


Figure 1: Measurement points for balance measurements [2]

Measurement of angular velocity is reduced to measuring the speed back, and this, in turn, the application of the proximity sensor (proximity switch) to the respective sprockets or shaft bearings in the shaft whose speed wants to measure.

Proximity sensors have an output signal that is changed when the nearby larger or smaller than a certain value. As a result, often referred to as relay switches or sensors, whose name depends on the physical principles on which to work: inductive, capacitive, optoelectronic, and so on. The speed of rotation is determined by counting the pulses which are generated when passing an object (such as sprocket teeth) in front of the sensor.

Proximity sensors are cheap, simple and durable and characterized by high technological and metrological value. Their information capacity of a bit small, but nevertheless plays an important role and are represented in automatic control systems where the harvester has the role of measuring angular velocity. Terminology, and static electrical characteristics, design, cable connectors, housings, test and test procedures, and their other important properties are laid down in European standards EN 50008 - EN 50044.

Inductive proximity sensors are easily mounted on the combines, where only should keep in mind that the supporting structure must not act on the inductivity of sensors. When measuring a speed of a shaft by means of adequate sprockets located on, or is coupled, inductive sensor can be mounted radially to the axis of the shaft and sprocket (Figure 2a) or axially to the axis (Fig. 2b).

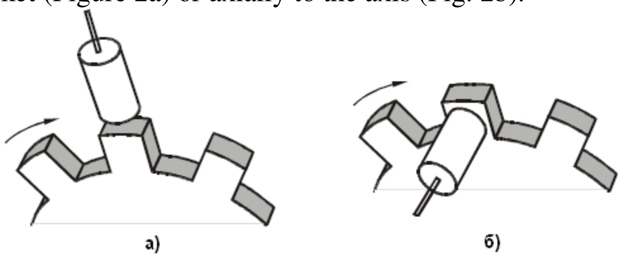

Figure 2: Installation of cylindrical inductive proximity sensor:
a) radial, b) axial

## 2. DISCUSSION

The number of turn reel (RPM) depends on the combines speed, yield and maturity of the crop situation that is at odds because of overripe crop is necessary to reduce the speed winches to prevent leakage of grain from the class. RPM is 0-50 o/min winches and is measured by inductive proximity sensor mounted radially in relation to the sprocket chain drive winch gear for the left side of the header (Figure 3). Indirectly determined by using speed and the speed of rotation of the wheel.

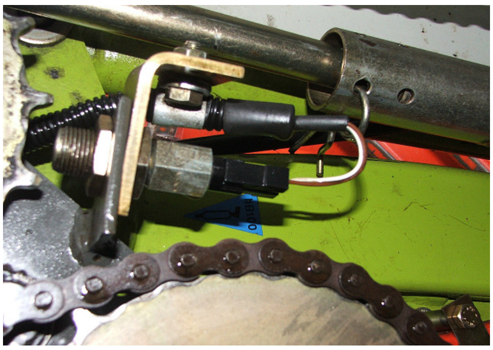
Figure 3: Inductive sensor rotation speed reel, [1]

Elevator header must be sure that mass transport are optimal from the spiral conveyor to system drum-underdrum. Depending on the yield surface of parts of the field and the amount of cutting height and grain weight can vary significantly, so the elevator has to adapt to it. Therefore the opening of the combine header or slat type conveyor can also become unwanted and "bottleneck" of the combine when it comes to mass flow of grain, that is the place to be congestion, so it is very important to look at the speed of the conveyor. Insight into the conveyor speed is acquired through an inductive proximity sensor that measures the speed of the upper elevator shaft on which the header strip and placed (Figure 4). Nominal speed depends on the required bandwidth combines, but the average was about 400 o/min.

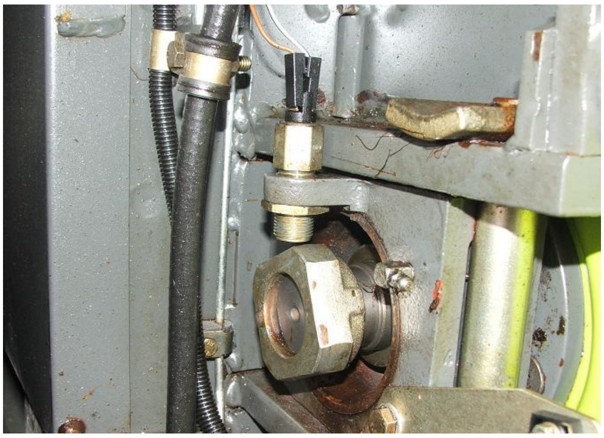

Figure 4: Inductive sensor speed elevators header, [1]\

Number of turn (RPM) drum and its speed of rotation is essential for the proper make grains. Slow drum means increased percentage of unmake grain that enters the straw walkers with a straw, and too fast drum means an increase in grain damage and losses in grain quality. From this, it apparently stems the importance of measuring the speed of the drum and if necessary, to its regulation. RPM is in the interval of the order of 300-1500 r/min taking into account the various kinds of grain, moisture and maturity.

RPM repulsive bitter and its speed of rotation must be adjusted to the amount of mass that reaches from the straw make apparatus. Biter slow repulsive mean his "congestion" of straw make device and repulsive biter too fast can lead to a spreading of straw. From this, it apparently stems the importance of measuring the speed of bitter and repulsive as appropriate to its regulation, and speed is of the order 900 o/min, and certainly depends on the speed of the drum. Inductive position sensor for measuring the speed is shown in Figure 5.

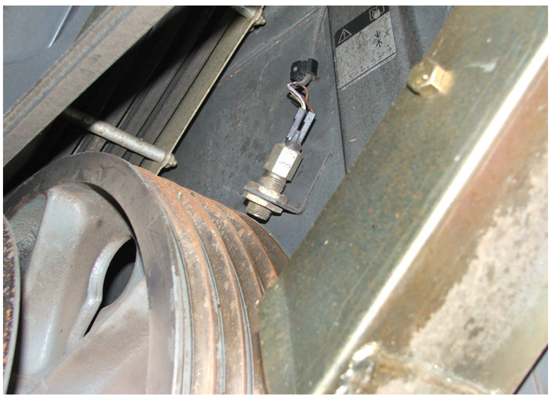

Figure 5: Inductive speed sensor repulsive biter, [1]

RPM crankshaft straw walkers and straw spreader shaft speed and the corresponding measures by the same inductive proximity sensor that is placed on the shaft shaker, radially relative to the shaft, close to the hexagonal element, so that it registers the passage of the scalp in addition to the active sensor surface (Fig. 6). It is essential that the straw walkers and the spreader to be absolutely consistent, because the collision could occur due to breakage due to collision of these two elements, so they drive their common and equal speed. Their speed must be measured and controlled, if necessary, because too slow crankshaft vibration means a reduced number of straw walkers and consequently less agitation and less straw and grain shaking backward. RPM these two elements is the order of 150 – 205 o/min.

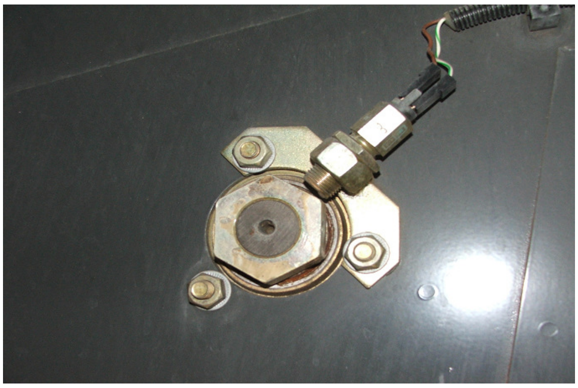

Figure 6: Inductive sensor crank rotation speed
straw walkers and returned back straw spreader, [1]

RPM collection plane crankshaft is measured exactly the same as in the straw walkers, with a value greater speed and approximately 350o/min. It also adjusts the amount of chaff under the ears of the unmake under drum reaches to a collection level.

Sieve also oscillate along the same lines as the straw walkers and collecting plane, thus causing oscillation cam or crank shafts that rotate at the same rate as in the collection plane, except that the number of oscillations of the lower screen is slightly larger. The measurement is the same principle.

The volume of air flow is directly proportional to fan RPM or speed of rotation of the shaft where the fan is installed, so it is necessary to measure and manage the necessary speed. Inductive position sensor for measuring the speed of the fan speed is shown in figure 7., its value is the order of 400-1000 o/min and is dictated by the degree of "contamination" of grain to get on the chaff sieve.

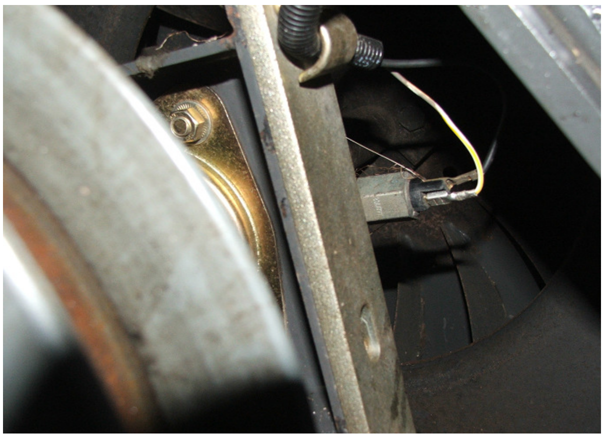

Figure 7: Proximity sensor fan speed, [1]

In the case of lower productivity of other technological devices, particularly devices for make grains, increases the amount of broken unmake grains and ears to return to the clearance between the drum and the re under drum make, so the more necessary and more speed conveyor. Hence the need arises for measuring the velocity at this point. RPM of the two transporters about 450 o/min.

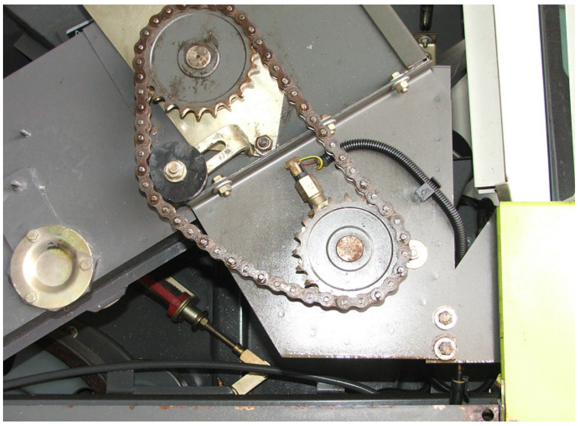

Image 8: Inductive sensor speed elevators and a spiral transporter to return unmake grains in make apparatus, [1]

**3. SENSOR CALIBRATION**

Given the large number of causes, which are conditional, error is not easily classified. According to one of the possible classification (Figure 9) errors are divided into two major groups: determinable and indeterminable. Identifiable faults are those that are in any way to determine - sometimes only in theory, a random or indeterminable observed only when repeated measurements of the same size. Therefore, objectively speaking, no un set errors, which means that the division of the determinable and indeterminable subjective. The higher economic and weather features and better equipment, the greater the possibility of indeterminable mistakes become identifiable. That's why I said that because of the presence of random errors result unreliable (inaccurate), and that the presence of possible systematic errors resulting incorrect.

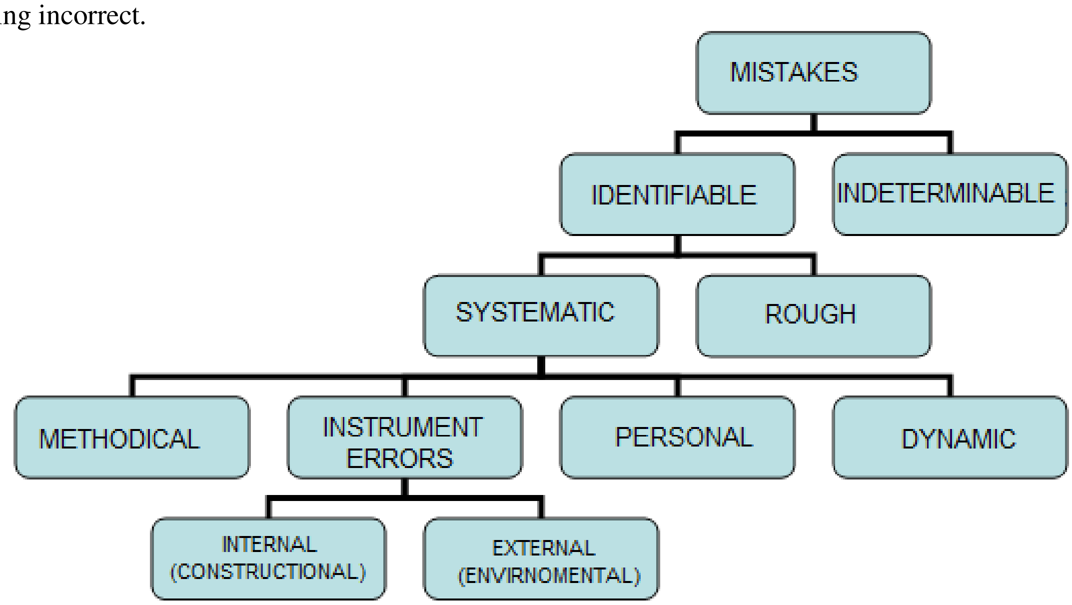


Figure 9: Classification of measurement errors, [5]

Identifiable faults are divided into systematic and rough. Systematic caused by imperfections: the measuring process, measuring instruments, the extent, nature and size of the measured physical environmental factors. Rough errors occur primarily due to carelessness of designers and installers or their inexperience. The automatic control technique is characterized by dynamic errors of measuring devices, which are manifested in measurements of physical quantities changing with time. In all these errors can be expressed in an additive or multiplicative, or proportional or non-linear or character.

Engineering measurement result always contains an error which is the summary - consisting of two parts, systematic and random errors. Their relationship depends on the measuring devices used and the conditions in which the measurement is performed. What is the contribution of systematic and random errors as it can only be concluded on the basis of one result.

Systematic calibration errors are eliminated, which represents the position a character, or maybe just the main characters, the metering device or unit in operation indicator value of the measurand with a standard or accurate instrument. Checking the instruments in the whole range of changes measured by using a size standard to reduce errors, one of the most common method in practice. Calibration to eliminate systematic errors only.

Random errors are manifested as a dispersion of measurement results. In a series of measurements of the same value of the measurand obtained different indications. Quantitative measures can be expressed dispersed with a standard deviation. For example, measure the speed of the drum which combines the actual value 1000 o/min. In the six measurements obtained values 1045, 940, 1000, 1030, 990 and 995 o/min, figures 10a. The mean of these measurements is 1000o/min, that is equal to the actual vrdnosti. However, the dispersion of results due to the action of random factors is very large. Thus, the measuring device has a systematic error equal to zero, but random error is large. In other words, by measuring the speed of rotation of the drum with a large number of repeat measurements, ideally with an infinite number of repetitions, we get an accurate measurement of 1000 o/min result, and as the average of the results of all individual measurements, but if we perform only one measurement, which is the sole the case when working the combine, it is likely to get a result that deviates significantly from the actual.

By measuring the same speed of 1000 o/min with another measuring device, the measured values: 950, 949, 950, 952, 949 and 950 o/min, the figure 10b. In this case the average value is less than the actual 50 o/min as a result of systematic errors. Showing the dispersion of the tachometer is small, which means that the random error is negligible.

Measuring device may have a large distribution of results, and also the large deviation from the actual mean value, figure 10v. It is best to measuring device produces results with a small distribution and mean value equal to the actual value, figure 10d.

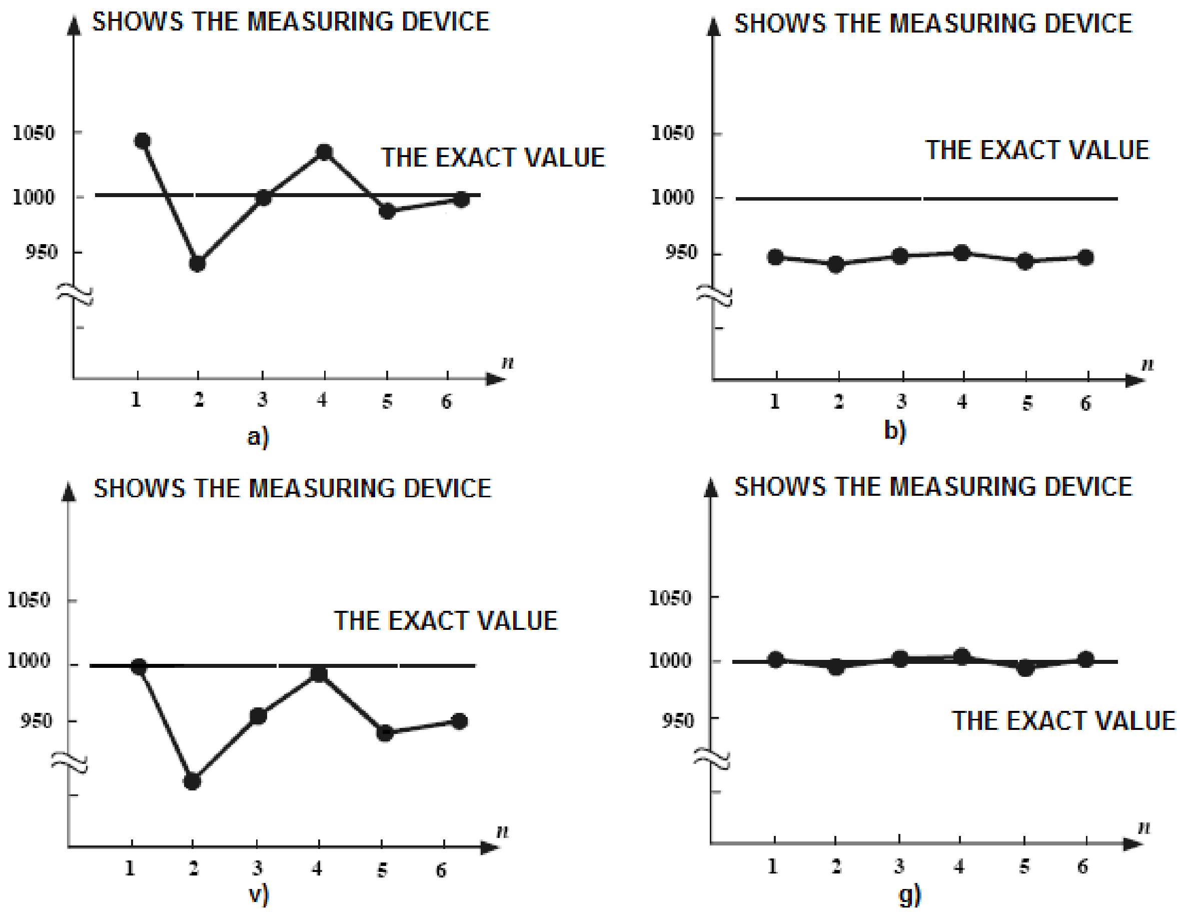


Figure 10: Relationship between systematic and random errors: a) accurate measurements with a sample of results (accurate and inaccurate), b) inaccurate measurement without a sample of results (not true, accurate), v) with spreading false measurement results (inaccurate and imprecise), g) accurate measurement without a sample of results (true and precise)

## 4. CONCLUSION

Inductive sensors have proved to be reliable gauges angular speed of technological devices combine. The harsh conditions may still come to the occurrence of systematic errors of measurement.

In the process of automatic regulation usually one value is measured only once. If the measurement of the speed measuring device that implements a large distribution of demonstrations (Figure 10a and 10v), it is unlikely to be a true measurement. Such an instrument must be repaired or replaced. Measuring device that has only a systematic error (Figure 10b) should be calibrated (calibrated) for its removal, then it can be used.

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