In creating instruments for studying the elements of astronavigational and inertial devices and also apparatus for testing electric motors, considerable demands are made upon the accuracy of the devices used for measuring and regulating the angular velocity. Widely employed in systems of these types are angle and angular-velocity converters with sensitive elements in the form of a disc having an annular ferromagnetic coating with magnetic marks imposed upon it at regular intervals. For applying the magnetic marks or graduation lines, the disk is set in rotation at an angular velocity \( \omega_0 \), and a signal of standard frequency \( f_0 \) is applied to the recording head.

The angular velocity measured by means of such a converter placed on a test platform will be

\[
\omega = \frac{\omega_0}{f_0} f,
\]

and the angle of rotation

\[
\alpha = \frac{\omega_0}{f_0} N.
\]

Here \( f \) and \( N \) are the repetition frequency and the number of magnetic marks, respectively.

Since the frequency \( f \) and the number of marks \( N \) may be measured to a high accuracy, it is clear that the error in measuring \( \omega \) and \( \alpha \) is mainly determined by the constancy of the angular velocity \( \omega_0 \). In precision devices it is therefore essential to use a stabilized electrical drive in order to impose the signal recordings. The process of applying the signal recordings consists of several cycles of rewriting. In each successive cycle the marks are imposed on the free track of a two-track signal recording, and the marks which were placed on the other track in the previous cycle are used as feedback signals. At the conclusion of each cycle the marks are erased from the track used as feedback converter.

It is clear that the use of a precision electric drive and the necessity of repeatedly rerecording greatly complicates the process of obtaining a signal record, without at the same time providing it with an adequately high quality.

In order to increase the accuracy of applying signal records, a well-known property of a gas laser with an annular resonator may be used; this lies in the fact that the difference frequency of the oppositely-propagating electromagnetic waves (beat signal) is a linear function of the angular velocity of rotation of the annular (ring) laser [1, 2]:

\[
\Delta v = K \omega,
\]

where \( K \) is a coefficient depending on the frequency of the working transition and also on the size and shape of the resonator.

For a resonator having the shape of an equilateral triangle with a side of \( l = 300 \text{ mm} \), at \( \lambda = 6328 \text{ A} \), \( K \approx 1,9 \cdot 10^6 \).

It follows from Eq. (3) that the number of periods of the beat signal passed through on rotating the annular laser through a specific angle (for example, one rotation) is constant for any particular laser. Hence the period of the beat signal corresponds to a specific angle of rotation; it does not depend on the angular velocity of rotation of the laser, but is simply determined by the value of the coefficient \( K \).

If we place an annular laser and a disc with a ferromagnetic track on one and the same rotating platform and apply a signal from the take-off device of the laser directly to the recording head, the signal recording may be applied in a single recording cycle. The accuracy of application of the magnetic marks will not depend on the character of the rotation of the platform, but will be entirely determined by the stability of parameters of the annular laser.

By applying the beat signal to the recording head through a frequency divider, we may easily regulate the interval between the marks or vary the interval in accordance with any desired law.

It must nevertheless be noted that Eq. (3) only constitutes a first approximation for \( \Delta \omega \). Actually the \( \Delta \omega = f(\omega) \) relationship is considerably more complicated, being also determined (as indicated earlier [3]) by the parameters of the working mixture, the resonator, and so on.

\[
\Delta \omega = K \omega + \beta(Q) + \gamma(n) + \eta(\eta),
\]

where \( \beta(Q) \) is a term characterizing the difference in the Q factor of the resonator for the oppositely-propagating waves, while \( \gamma(n) \) is a term characterizing the effects of back scattering in the resonator mirrors and the interaction of the electromagnetic waves on nonuniformities in the plasma of the gas-discharge tube.

Without analyzing various possible ways of reducing the last three terms in Eq. (4), we may say that, on satisfying certain requirements, the following condition may be achieved:

\[
\frac{\beta(Q) + \gamma(n) + \eta(\eta)}{K \omega_{\text{nom}}} \approx 10^{-5},
\]

where \( K \approx 2 \cdot 10^6 \); \( \omega_{\text{nom}} \approx \pi \text{ sec}^{-1} \).

By using a tube with a mixture of isotopes and ensuring active stabilization of the perimeter of the resonator of the annular laser, we may reduce the ratio in Eq. (5) by at least an order of magnitude.

It is important to emphasize that, before applying the signal recording, the laser must be properly certified, i.e., we must establish the value of one period

\[
\alpha_o = \frac{\alpha}{N},
\]

where \( \alpha \) is the angle measured by any precision method used for determining large angles, and \( N \) is the number of periods of the beat signal passed through on rotating the annular laser through an angle \( \alpha \).

We further note that the certified laser may be used in order to create multiple-digit magnetic code discs of high accuracy. For this purpose the beat signal from the take-off device of the laser is fed to each of the recording heads (the number of these being equal to the number of digits on the disc) through a separate frequency divider with a prespecified division factor. By using various combinations of division factors, we may apply practically any of the code masks generally used at the present time. The number of marks in the most "junior" digit is only limited by the density with which these may be applied.

Thus if we remember the high transconductance, linearity, and stability of the working characteristic of an annular laser, we see that the use of one of these is extremely promising in order to obtain precise signal recordings for angular-velocity converters with ferromagnetic coatings; this is entirely in accordance with experience.