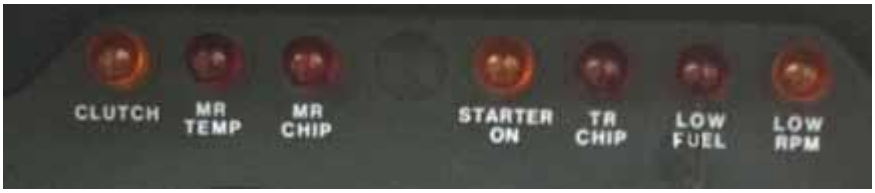
Robinson R22 Instrument Panel

This is a picture of the R22 panel which became standard with the Beta model. (Previous models were the Standard, HP, and Alpha). On the top and bottom row, the 2nd from left instrument position is for optional equipment. Earlier Robinson models had no space for optional flight instruments. In this particular helicopter, the bottom hole has been fitted with a VOR navigation display. The upper hole isn't being used and just has a plug in it to cover it over.

Warning Lights

Along the top you can see a set of warning lights. Earlier models of Robinson spread these all over the panel, in the Beta model they are nicely grouped along the top. Red lights indicate a situation the pilot must deal with immediately (typically by landing) while yellow lights are caution lights and may or may not indicate a serious problem.



CLUTCH

This light warns the pilot whenever the electro-mechanical rotor belt tensioning system is running. This system is activated automatically to maintain proper tension on the drive belts.

MR TEMP

This light is activated if the termocouple mounted above the input drive bearing of the main rotor transmission detects that the bearing is running hot.

MR CHIP

This light is activated if the magnetic plug on the bottom of the main rotor transmission has collected metal fragments. There are two electrodes seperated by a small gap, if metal particles in the oil collect across the gap the circuit is completed and the light is lit.

STARTER ON

This alerts the pilot to a hung starter.

TAIL ROTOR CHIP

The tail rotor gear box has a chip detector similar to the one on the main rotor transmission.

LOW FUEL

This light comes on when there is only 1 gallon of gas left in the helicopter. Proper flight planning by the pilot normally precludes the fuel level ever getting this low.

LOW RPM

This light comes on if main rotor RPM is below 95%. An audible horn also activates at the same time. If the collective is full down, a microswitch defeats this system so that it isn't constantly activated during startup and shutdown.

Flight Instruments

The main flight instruments occupy the upper section of the instrument panel where they are in clear view of the pilot.

Vertical Speed Indicator

In the upper left of the instrument panel we have the vertical speed indicator, or VSI.

In this close up picture, the blue arrow points at the zero adjustment screw. Each mark above the zero represents a climb rate of 100 feet per minute. Each mark below the zero represents a descent rate of 100 feet per minute.

Blank (optional) Position

The next location to the right is blank in this particular R22. Often this is the location that people will use for an attitude indicator (artificial horizon) if one is fitted.

Airspeed Indicator

The next spot over is the Airspeed Indicator. The outer scale is in knots (nautical miles per hour), the inner scale is marked in mph (miles per hour). The red line is marked at the VNE or "Never Exceed Speed" of 102 knots.

Dual Tachometer

The right hand instrument in the upper row is the dual tachometer:

The left hand needle indicates Engine RPM (revolutions per minute), the right hand needle indicates Main Rotor RPM. The colored arcs indicate normal, caution, and prohibited ranges. For instance, on the Engine side (left) there is a green arc from 97% to 104%. Above and below this are red, as the engine should not be operated outside this range during flight. However, if you look at the Rotor side (right) you will notice that green again goes from 97% to 104%, but below and above that there is a yellow area. This means the rotor system can be operated between 90% and 97%, and also from 104% to 110% while in flight. This allows the pilot a larger range of allowable RPM while autorotating. The yellow range between 60% and 70% is an area where the tail boom and main rotor resonate. It is marked yellow to warn pilots to avoid extended operation in this range during startup and shutdown.

Altimeter

On the right row, the left most instrument is the Altimeter:

This instrument senses barometric pressure and indicates height above sea level based on that pressure. Most altimeters (including this one) are *sensitive* altimeters in that the pilot can turn an adjusting knob to compensate for non-standard pressure. The altimeter looks a lot like a

clock, with a long arrow shaped indicator and a short arrow shaped indicator. The short indicator indicates thousands of feet. Here it is about 1/3 of the way from 0 to 1 because we are about 300 feet above sea level. The long indicator indicates in hundreds of feet. It is pointing at the 3, so we are at about 300 feet. Each mark between numbers is 20 feet, so we are indicating about 310 feet here. The long thin white indicator which goes up through the zero is the 10,000 foot marker. I've never seen that move much in a helicopter!

Blank (optional) Position

The gauge second from the left on the bottom row is an optional gauge.

In this case the helicopter has a VOR navigation radio installed. This is fairly rare in VFR helicopters because they tend to fly too low to pick up many VOR signals.

Manifold Pressure

The rightmost bottom gauge is the Manifold Pressure gauge:

The pilot uses this gauge to determine the throttle setting. In the R22 the pilot calculates a maximum manifold pressure given the current temperature and pressure. By calculating this maximum and not exceeding it, the pilot derates the engine from the 160 horsepower which is actually available, to the derated maximum which is 124 horsepower continuous, or 131 horsepower for up to 5 minutes. Derating the engine prolongs the useful life of the engine, making it more reliable than if full power was being used on a regular basis. It also means that full power is available to a higher altitude just as if the engine was turbocharged.

Robinson R22 middle Instrument Panel

The middle panel of the R22 contains the engine gauges and some of the cockpit controls. At the very top there are two warning lights, one for the alternator and one for oil pressure. Below those lights, on the top right, we have a cluster of engine gauges including ammeter, oil pressure, auxilliary fuel tank quantity, oil temperature, main fuel tank quantity, and cylinder head temperature. In the upper left, we have a clock, and below that a Carburetor Air Temperature Gauge.

Just below the carburetor air temperature gauge is a potentiometer which allows the pilot to adjust the brightness of the panel lights during night flight. Along the bottom, from left to right we have "Nav Lights" which turns on the red, green, and white position lights. Second from the left is the strobe light which activates a flashing light on the tail and optionally under the belly, then the clutch switch which activates the R22 electric rotor engagement clutch system. Next to that is the alternator switch, the battery switch, and the magnetos/starter key switch.

Robinson R22 lower Instrument Panel

The lower panel of the R22 contains the radio stack and various controls and indiators.

In the upper left is an electronic outside air temperature gauge. This is something I wish other manufacturers would do. It's much easier to read than the normal thermometer stuck through the overhead window trick. This one reads in either Farenheight or Celcius.

To the right of the OAT gauge, is the landing light switch, and a warning light that indicates that the rotor brake is engaged (so you won't try to start the helicopter with the brake activated). The big knob on the right opens the forward fresh air vent.

The radio stack in this case consists of a Loran navigational radio on top, a combination communications and navigation radio in the middle (which drives that VOR indicator on the upper panel) and a Mode C transponder on the bottom which makes the aircraft more visible on radar displays.

On the bottom panel upper left is the friction for the cyclic control. This can be used on the ground and in flight. To the right of that is the right trim knob which has the mixture guard sitting on it right now. The right trim device reduces the tendency of the cyclic to pull to the left in high speed flight. In flight the mixture guard is placed on the mixture control to prevent it being pulled in flight accidentally.

On the far right is the mixture knob. Here at sea level this is mostly used either full in when the engine is running, or full out to stop the engine. At high altitude you would pull the control part way out to prevent an over rich fuel mixture.

In the lower right corner of the photo you can see the carburetor heat control. This introduces heated air into the carburetor to melt any ice which has formed. Unlike most airplanes, this air is filtered and thus can be used on the ground.

Bell 206B Instrument Panel

This is a picture of a Bell 206BIII instrument panel:

Flight Instruments

All flight instruments are clustered on the right side of the instrument panel.

Altimeter

The altimeter is mounted in the upper right corner of the instrument panel.

Attitude Indicator

The attitude indicator (artificial horizon) is mounted just to the left of the altimeter. This is an electrically driven gyroscopic instrument.

Airspeed Indicator

The airspeed indicator is calibrated in both knots and miles per hour. The green arc shows the normally allowed operating range. The red line marks the maximum VNE (never exceed speed) of 130 knots. The VNE changes depending on weight of the aircraft and density altitude. At aircraft weights of 3,000 lbs and below, the VNE decreases by 3.5 knots per 1,000 feet above 3,000 feet density altitude. When the aircraft weight is above 3,000 pounds, the VNE goes down by 122 knots maximum, and decreases by 7 knots per 1,000 feet above 3,000 feet density altitude.

Other VNE limits are 80 knots above 85% torque (it bends the mast too much!), 87 knots with aft doors off, and 69 knots with forward doors off.

The blue line is a reminder to the pilot of maximum airspeed during autorotation of 100 knots.

Vertical Speed Indicator

The VSI is mounted directly below the altimeter in the JetRanger.

The vertical speed indicator is like an altimeter, but shows how *rapidly* altitude is changing. Between -1,000 feet per minute and +1,000 per minute, each mark indicates 100 feet per minute of vertical speed. Beyond 1,000 feet per minute each mark is 500 feet per minute. This particular gauge can show a maximum climb or descent rate of 6,000 feet per minute (which is 68 mph straight up or down!)

Directional Gyro

The directional gyro is mounted to the left of the VSI. It acts like a compass, exhibiting some of the errors that compasses do. The pilot uses the compass to periodically reset the directional gyro.

Dual Tachometer

The dual tachometer in the Bell JetRanger is mounted to the left of the directional gyro. Two concentric indicators display the main rotor RPM (Nr) and the power turbine RPM (N2):

The labeling on the gauge is confusing, since the words "ROTOR" and "POWER TURBINE" would lead you to believe that the rotor is the outer ring and the power turbine is the inner ring. In fact, it is just the opposite.

The green arcs depict the operating limits for the rotor and power turbine. The power turbine (N2) must be operated between 97% to 100%. The rotor (Nr) may be operated between 90% and 100%.

The yellow arc indicates a range the pilot should avoid, i.e. he should accelerate rapidly through this RPM range.

Turn Indicator and Inclinometer

Below the VSI is the combination Turn Indicator and Inclinometer. The turn indicator is an electrically driven gyro instrument showing rate of turn, or yaw. The inclinometer is a ball trapped inside a curved tube filled with kerosene or some other liquid which provides damping. The inclinometer is used to determine whether the aircraft is in trim.

VOR

In this particular aircraft a VOR display is mounted to the left of the Turn and Bank, below the directional gyro.

Engine Instrument Cluster

Other instruments are mounted to the left of the flight instruments. These include engine instruments, and instruments related to the rotor system.

Engine Oil

This is a dual instrument, displaying engine oil pressure on the left side, and engine oil temperature on the right. It is mounted in the upper left corner.

Engine oil pressure limits are based on Gas Producer (N1) RPM. Below 78.5% N1, minimum pressure is 50 PSI. Between 78.5 and 94.2% N1, minimum is 90 PSI. Above 94.2% N1, minimum pressure is 90 PSI and maximum pressure is 130 PSI.

Engine oil temperature limits are 0 degrees centigrade to 107 degrees centigrade.

Torque

This gauge is mounted just to the right of the Engine Oil gauge and indicates the torque output of the engine.

The continuous operating range for torque is 0-85%. The pilot may use between 85-100% torque for up to 5 minutes. A 5 second transient limit is set at 110%, but the pilot may not intentially use this amount of power.

Transmission Oil

This is a dual instrument, displaying main rotor transmission oil pressure on the left side, and main rotor transmission oil temperature on the right.

Oil pressure operating range is 30 to 50 psi. A maximum of 70 PSI is allowable during warmup.

Oil temperature operating range is between 15 to 100 degrees Centigrade.

Turbine Outlet Temperature (TOT)

This gauge is mounted just below the torque gauge, and indicates the turbine outlet temperature.

The maximum TOT for continuous operation is 738 degrees centigrade. A maximum TOT of 810 degrees centigrade may be used for up to 5 minutes. A transient limit of 843 degrees centigrade for 6 seconds is allowed, but the pilot may not use it intentionally. During startup and shutdown the TOT limits are between 810 and 927 degrees centigrade for a maximum of 10 seconds.

Fuel Quantity

This gauge displays gallons of fuel remaining in the fuel cell. JetRangers with serial numbers above 3567 have a gauge which goes up to 100 gallons. This one only goes up to 75, even though the fuel extender allows us to fit almost 100 gallons in the fuel cell.

Gas Generator RPM

This gauge displays turbine RPM (N1). Because the engine is a "free" turbine, the compressor and gas generator turbine can turn at one RPM while the "power" turbine turns at another RPM. The large pointer is calibrated in 2% increments. The little dial in the lower right of the instrument is calibrated in 1% increments. Each complete rotation of the little indicator represents 10%.

The N1 operating limitations are 105% maximum, transient limit of 106% for 15 seconds.

Generator Load and Fuel Pressure

This gauge is a dual instrument, displaying generator load on the left side, and fuel pump pressure on the right. Fuel pressure limitations are minimum 4.0 PSI, maximum 30.0 PSI. There are two electric boost pumps as well as the engine driven fuel pump. The engine driven fuel pump can supply sufficient fuel pressure to run the engine up to 6,000 feet. Either boost pump can provide enough additional pressure to run the engine up to maximum altitude, however both pumps must be operated in flight. If one boost pump fails, the pilot descends below 6,000 feet if possible, so that if the remaining boost pump fails the engine does not flame out. Failure of the engine driven fuel pump will always flame out the engine.

The loadmeter shows output of the generator as a percentage of maximum. The maximum allowable load is 70%.

Instrument Panels

Robinson R22 Instrument panel

Enstrom F28A Instrument Panel

Bell 206BIII JetRanger Instrument Panel