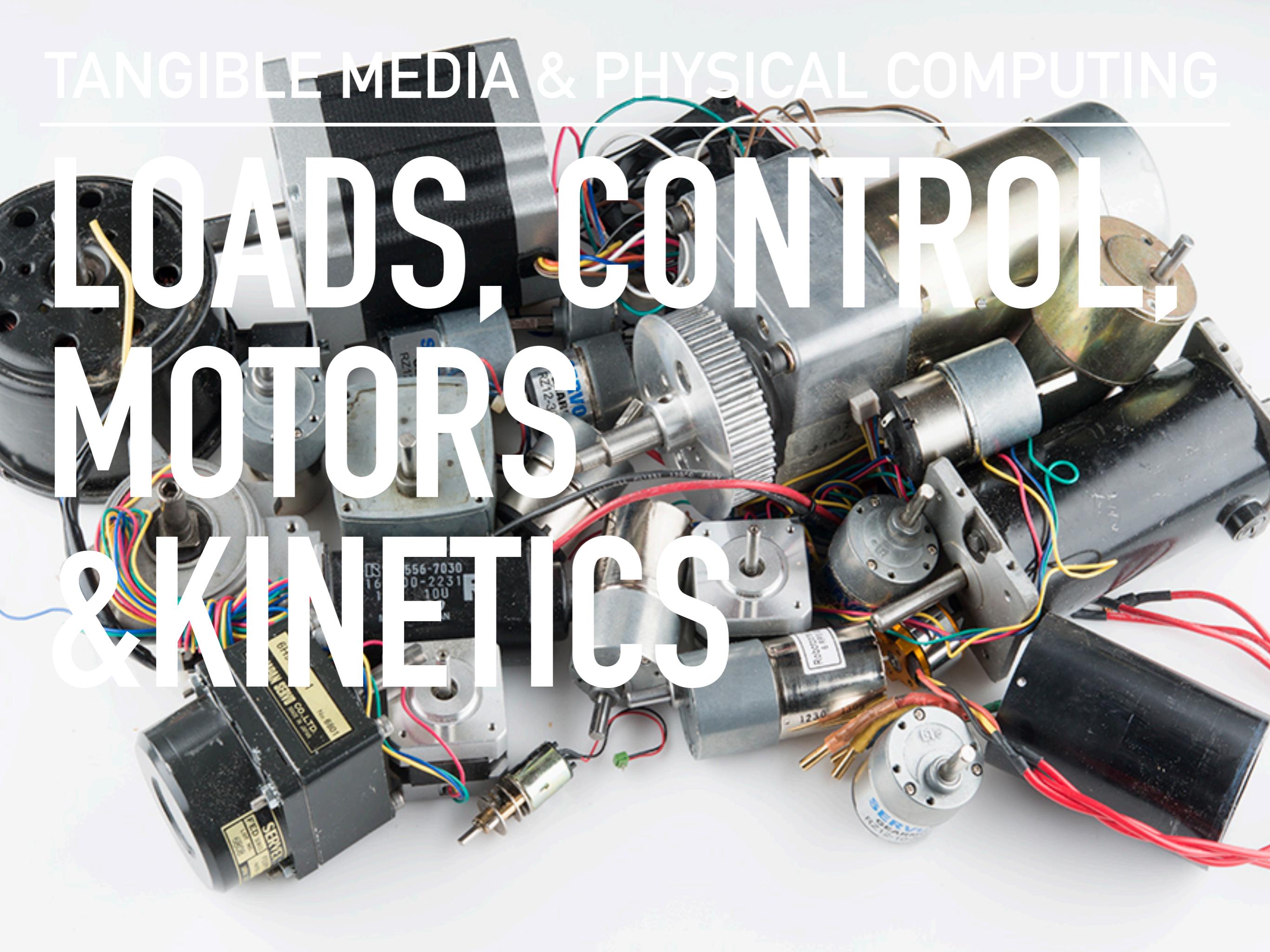


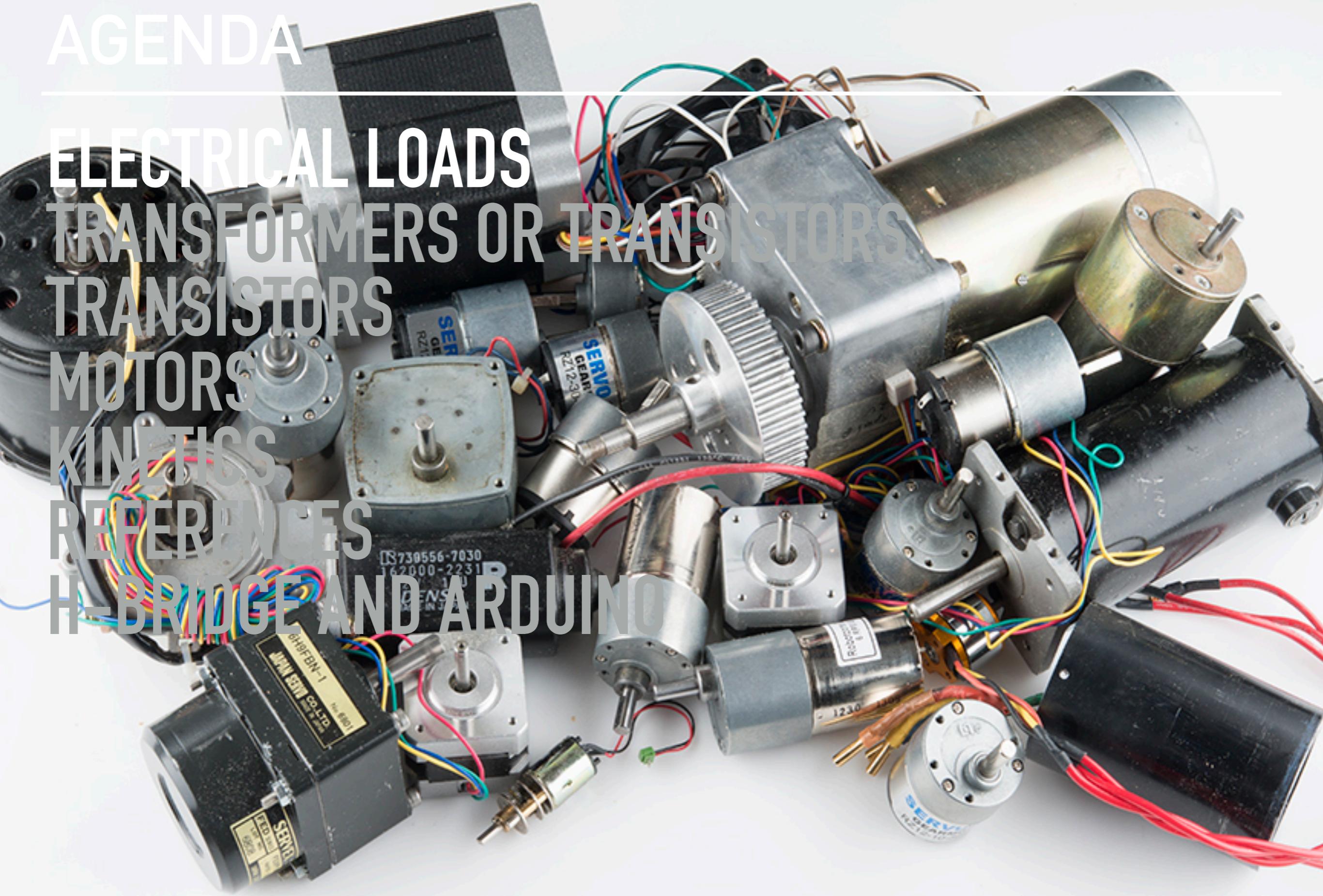
TANGIBLE MEDIA & PHYSICAL COMPUTING

LOADS, CONTROL, MOTORS & KINETICS



AGENDA

ELECTRICAL LOADS
TRANSFORMERS OR TRANSISTORS
TRANSISTORS
MOTORS
KINETICS
REFERENCES
H-BRIDGE AND ARDUINO



ELECTRICAL LOADS

AN **ELECTRICAL LOAD** IS AN ELECTRICAL COMPONENT OR PORTION OF A CIRCUIT THAT CONSUMES ELECTRIC POWER. THIS IS OPPOSED TO A POWER SOURCE, SUCH AS A BATTERY, WHICH PRODUCES POWER.

IN POWER CIRCUITS, **ELECTRICAL LOADS** MAY BE HIGH LUMEN LEDS, MOTORS (AC / DC), RESISTIVE WIRE (HEAT), AUDIO AMPLIFICATION AND ANY AC POWERED DEVICES.

THE TERM MAY ALSO REFER TO THE POWER CONSUMED BY A CIRCUIT.

AGENDA

The image shows a collection of electronic components, likely for a robotics or hobbyist project. It includes several servo motors, some with blue labels that read 'SERVO GEAR RZ12-30'. There's also a larger motor with a prominent metal gear attached. A breadboard with various colored wires is visible in the background. The components are densely packed, suggesting a complex setup.

TRANSFORMERS OR TRANSISTORS

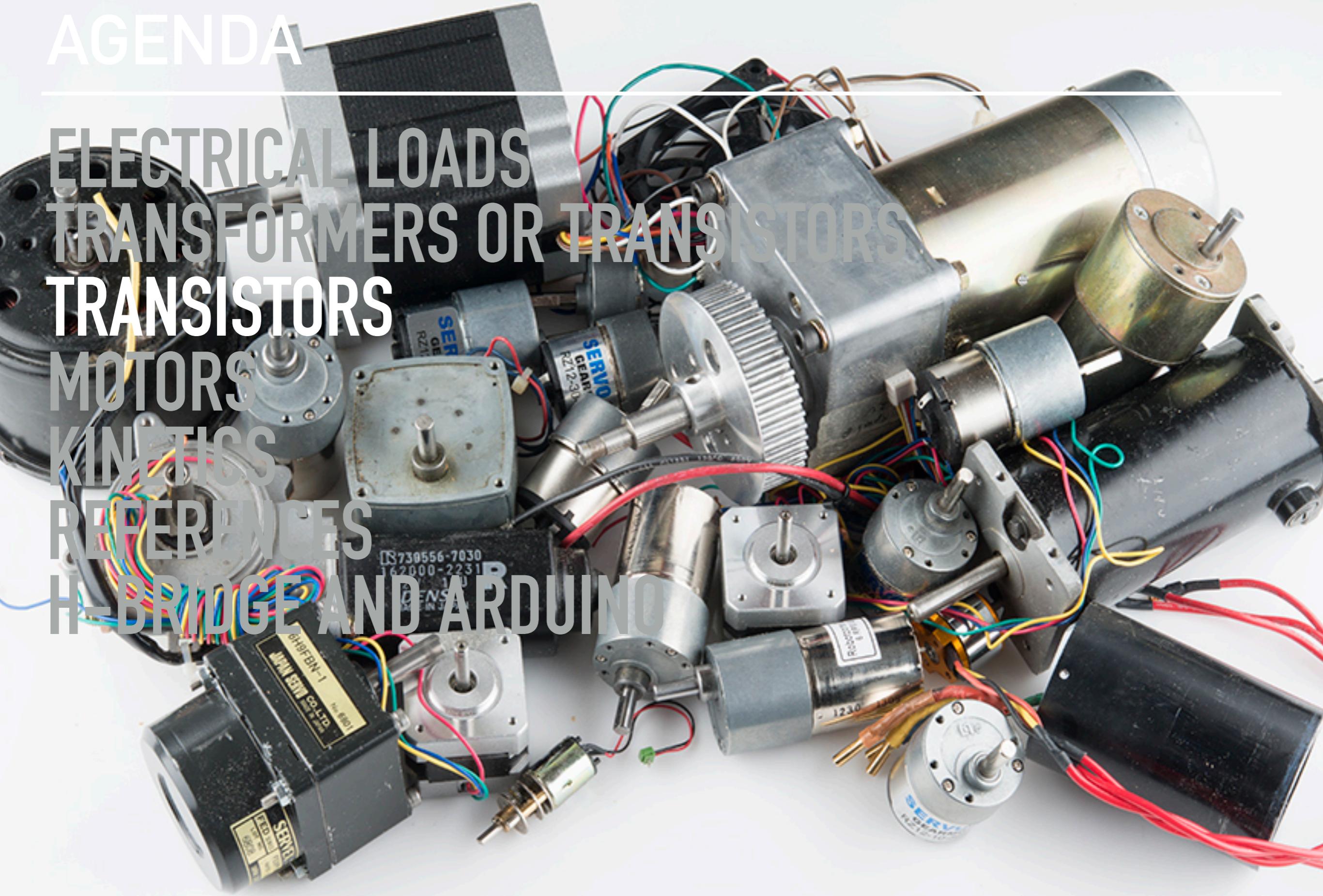
AMPLIFICATION OF POWER, THAT IS THE CORE FUNCTION OF A BJT (BIPOLAR JUNCTION) OR FET (FIELD EFFECT) TRANSISTOR.

TRANSFORMERS CAN ALSO **AMPLIFY POWER**, BUT AMPLIFICATION BY TRANSFORMER IS NOT QUITE AS EFFICIENT. YOU CAN GET MORE VOLTAGE BUT AT A LOWER CURRENT, OR MORE CURRENT, BUT AT A LOWER VOLTAGE.

TRANSISTORS CAN GIVE YOU AN INCREASE IN BOTH.

AGENDA

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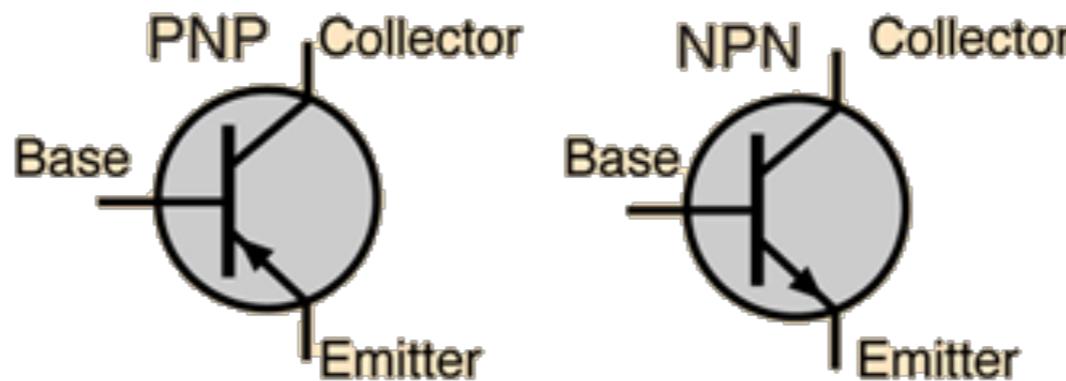
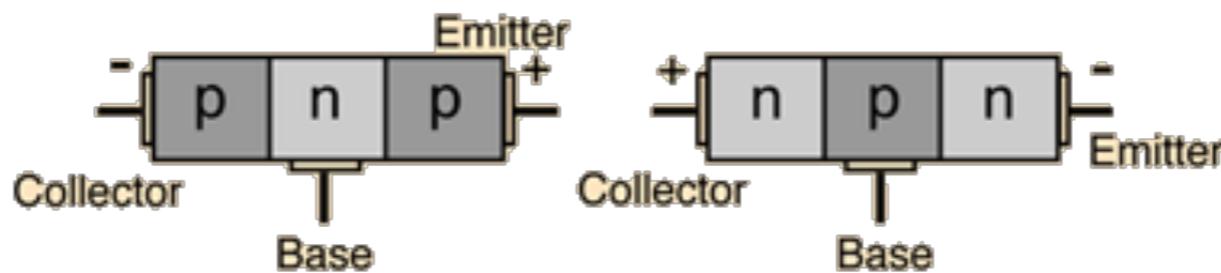
TRANSISTORS

TRANSISTORS ARE TRULY THE BASIS OF MODERN ELECTRONICS.

WE WILL FOCUS ON A SPECIFIC USE - CONTROLLING HIGH POWER CIRCUITS AND DEVICES WITH A LOW POWER (5V) MICROCONTROLLER.

TRANSISTORS - BJTS

BJTS - BIPOLAR JUNCTION TRANSISTORS. **BIPOLAR**, BECAUSE THEY USE TWO KINDS OF SILICON (NPN OR PNP). **JUNCTION**, BECAUSE SECTIONS OF THE TRANSISTOR ARE COMPOSED OF THOSE TWO DIFFERENT KINDS OF SILICON SET AGAINST EACH OTHER.



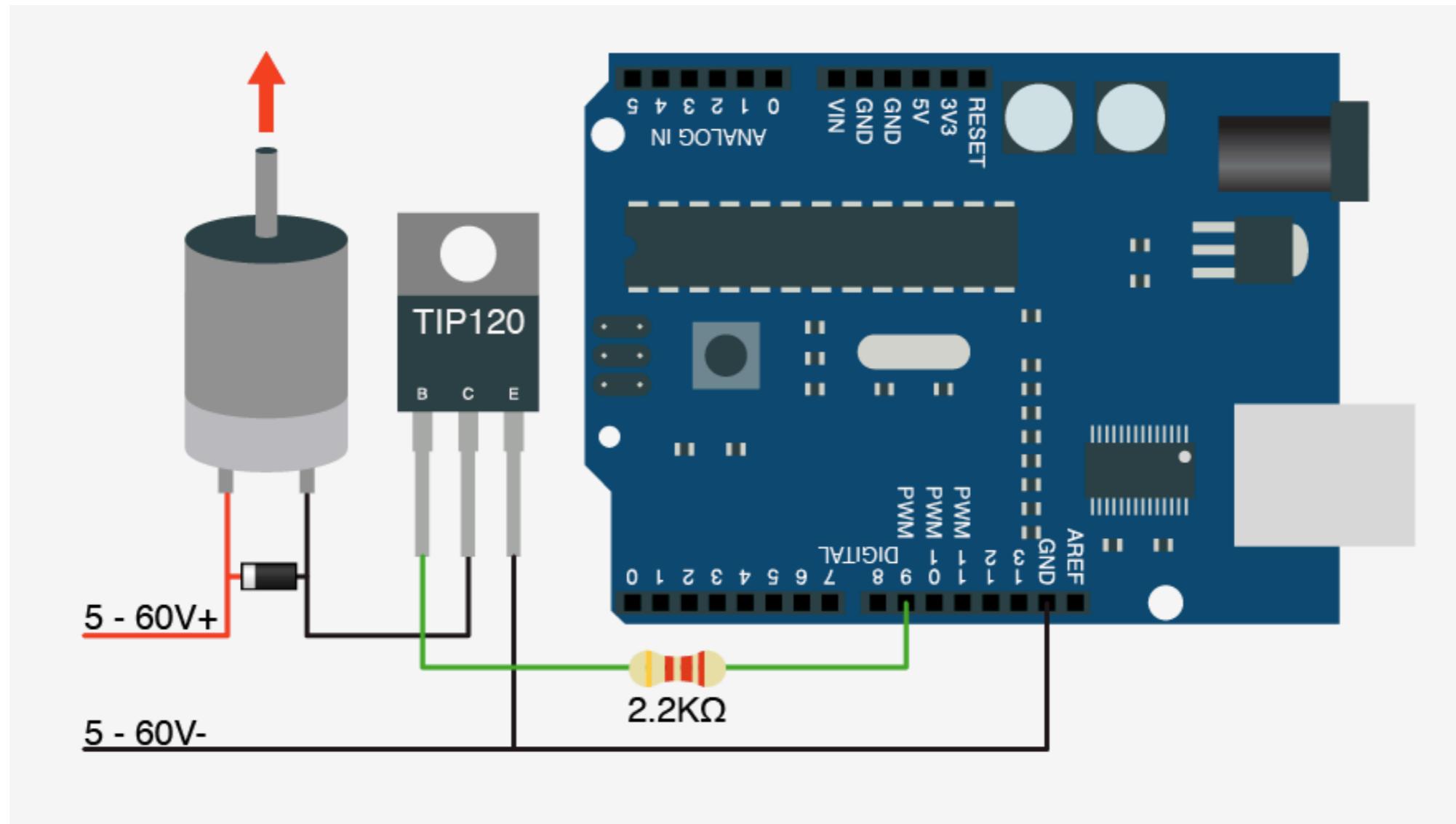
TRANSISTORS - BJTS

BJT OPERATION: A SMALL AMOUNT OF CURRENT FLOWING BETWEEN THE BASE AND Emitter CAUSES A LARGER CURRENT TO FLOW BETWEEN THE COLLECTOR AND Emitter - AMPLIFICATION (GAIN).

TRANSISTOR AS AN ELECTRICAL SWITCH. LOW CURRENT REQUIREMENT, 50NS SWITCHING, NO BOUNCING, PWM AND SINGLE CONTROL SIGNAL.

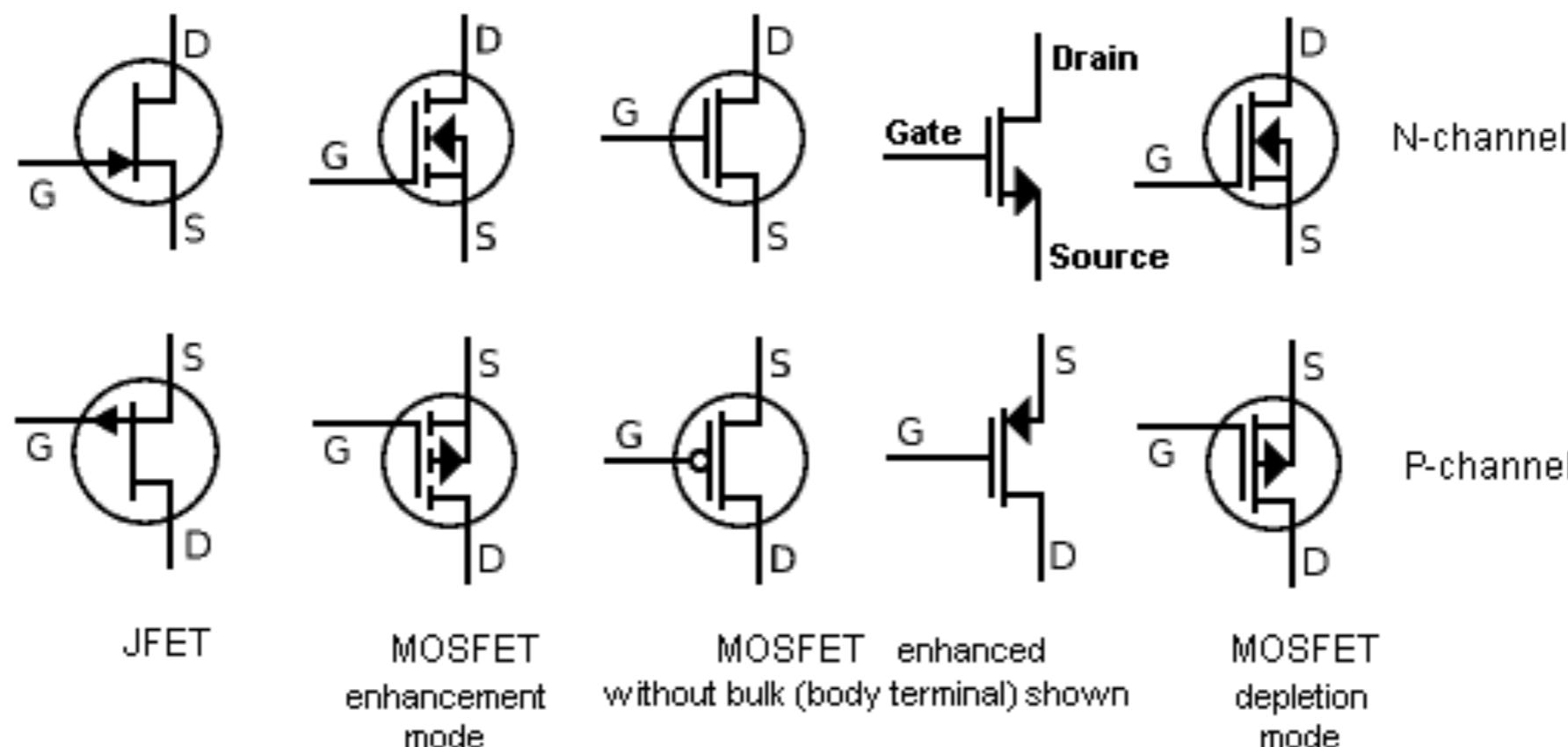
TRANSISTORS - BJTS

BJTS - DARLINGTON PAIR. WHEN YOU WANT TO CONTROL A REALLY LARGE AMOUNT OF CURRENT, MORE THAN A SINGLE TRANSISTOR'S GAIN CAN PROVIDE.



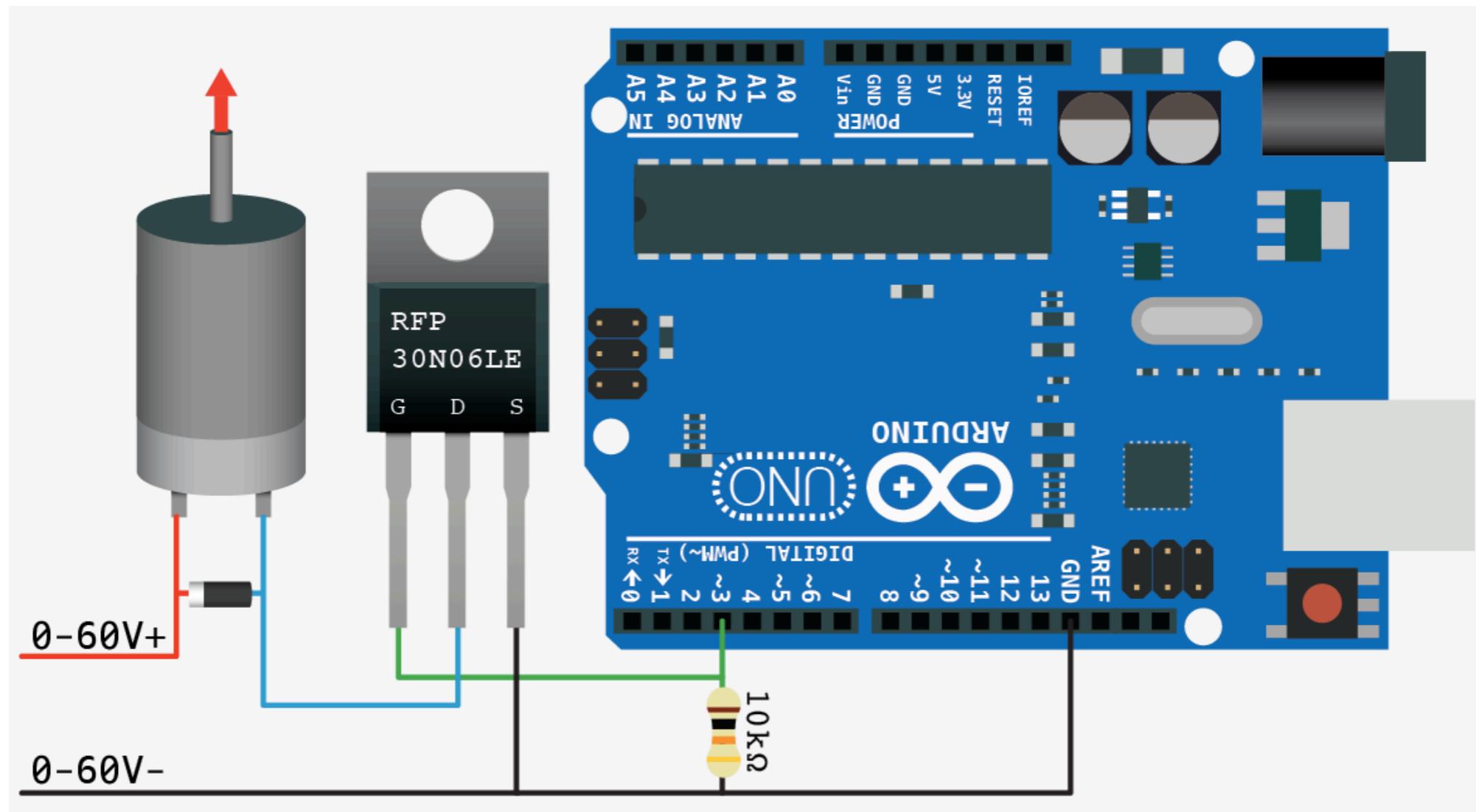
TRANSISTORS - FETS

FETS - FIELD EFFECT TRANSISTORS (MOSFETS), ARE A DIFFERENT APPROACH TO COMPOSING A TRANSISTOR. AN APPROACH THAT HAS SOME DISTINCT ADVANTAGES. ONE MAJOR ADVANTAGE - EFFICIENCY.



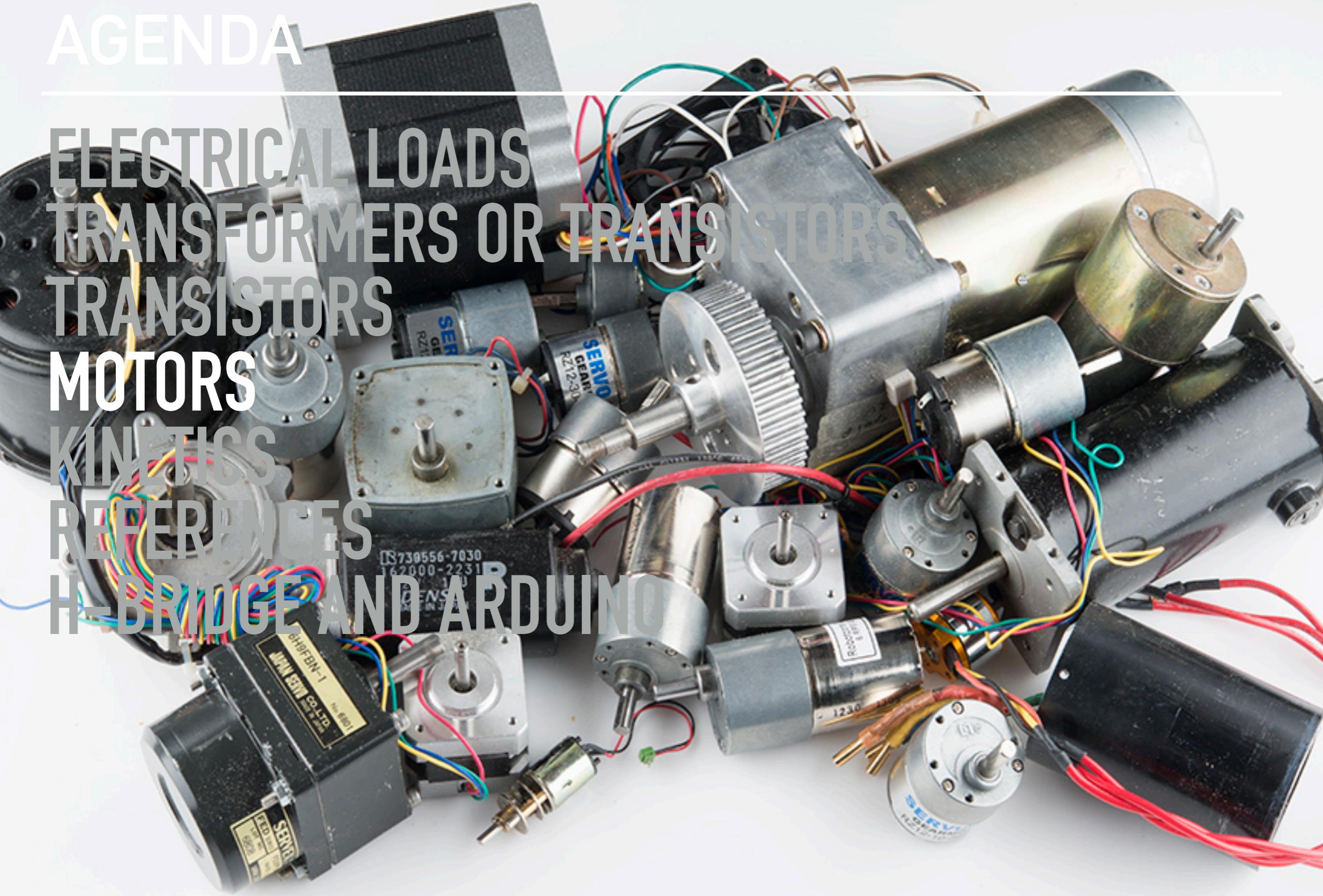
TRANSISTORS - FETS

FETS DON'T WASTE AS MUCH POWER. FETS ARE CONTROLLED BY A VOLTAGE AND NOT A CURRENT, UNLIKE A BJT CONTROL (BASE-EMITTER CURRENT).



AGENDA

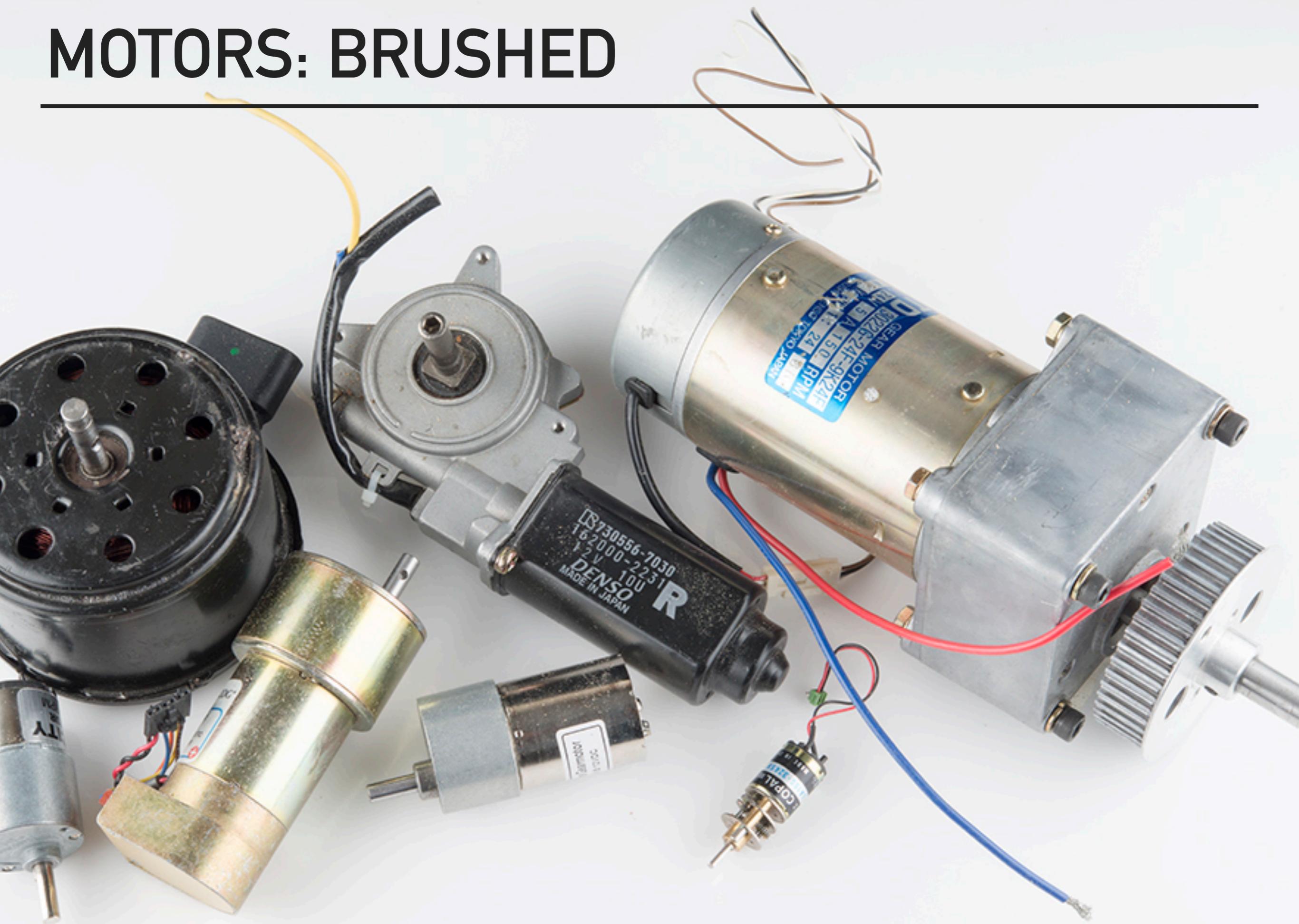
ELECTRICAL LOADS
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MOTORS

THERE ARE MANY TYPES OF MOTORS. BRUSHED, BRUSHLESS, STEPPERS, ALONG WITH DIFFERENT MOTOR ASSEMBLIES. THERE ARE SMALL ONES, FAST ONES, STRONG ONES. WHETHER YOU NEED BRUTE STRENGTH, BLINDING SPEED OR DELICATE PRECISION MOVEMENT, THERE IS A MOTOR DESIGNED FOR THE TASK.

MOTORS: BRUSHED



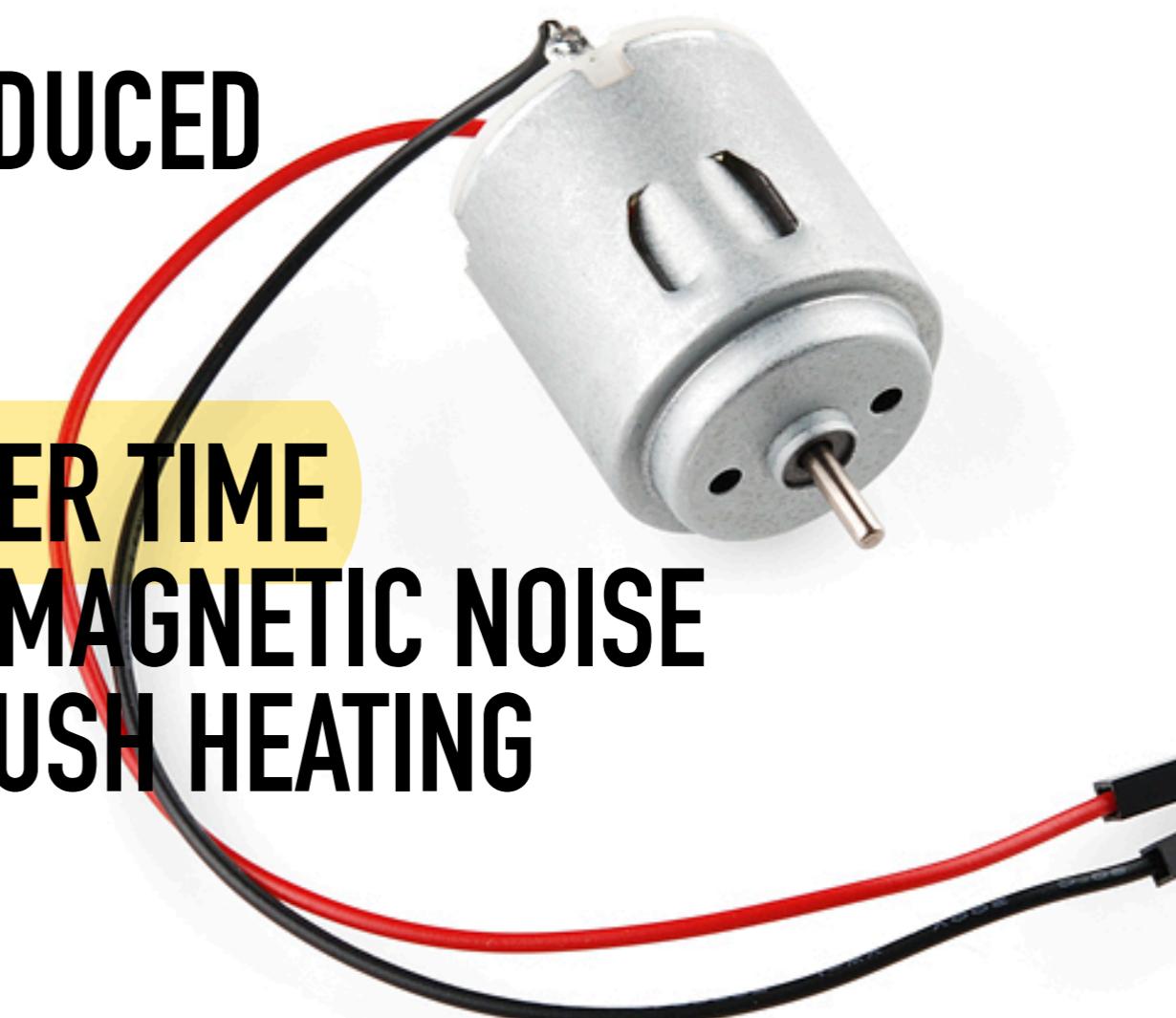
MOTORS: BRUSHED

ADVANTAGES

SIMPLE TO CONTROL
GOOD TORQUE @ LOW RPM
INEXPENSIVE AND MASS PRODUCED

DISADVANTAGE

BRUSHES WILL WEAR OUT OVER TIME
BRUSH ARCING AND ELECTROMAGNETIC NOISE
SPEED LIMITATION DUE TO BRUSH HEATING
NOISY



MOTORS: BRUSHED ANATOMY



End Cap

Brushes

Contacts

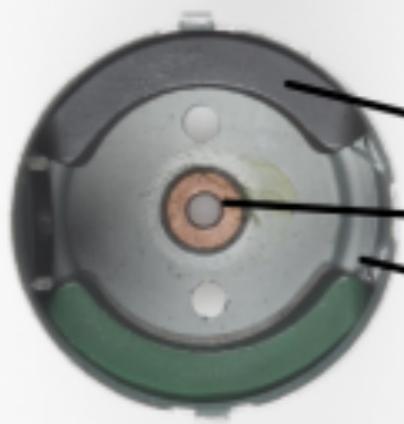


Rotor

Commutator

Windings

Axle

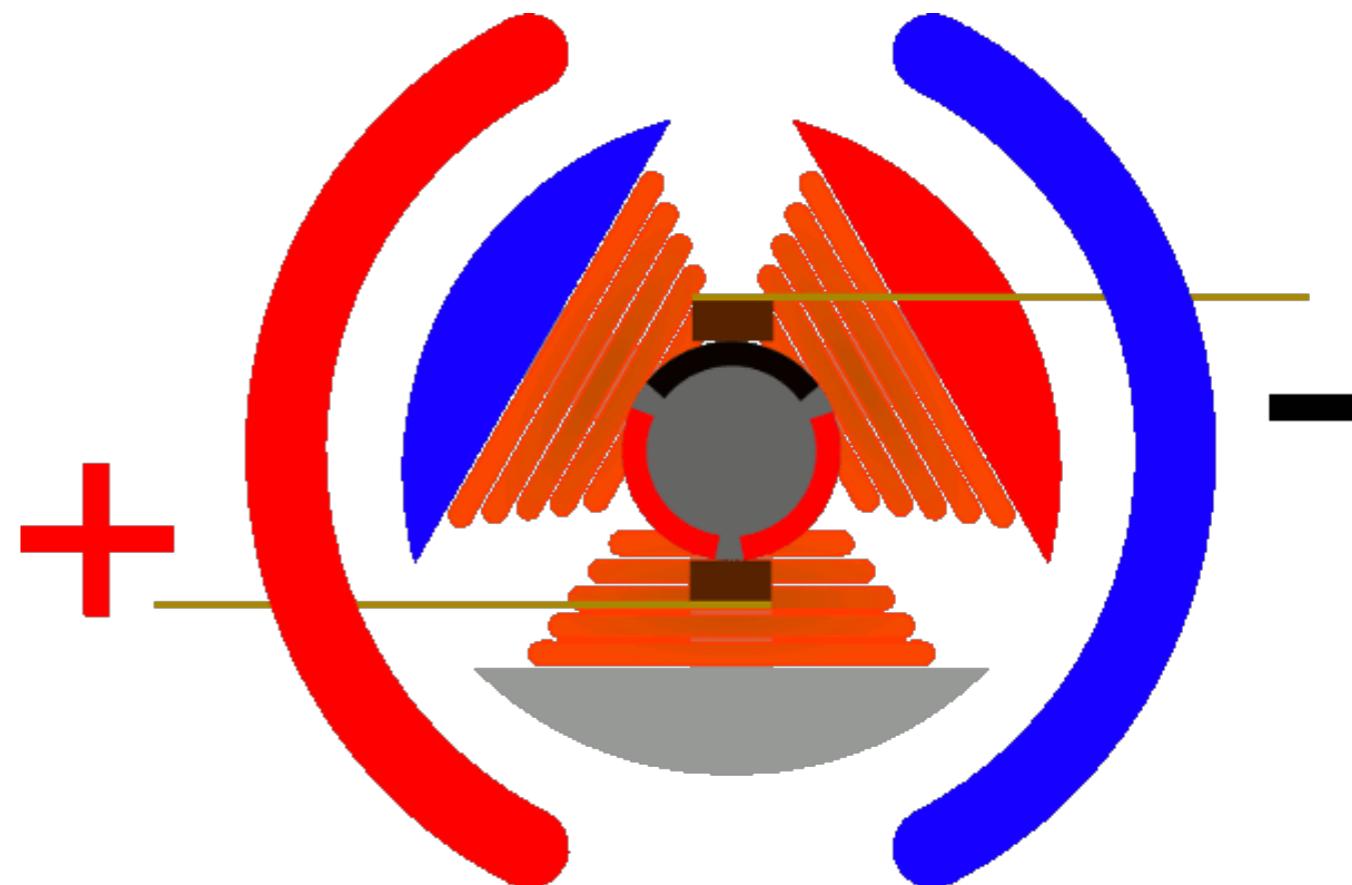


Stator

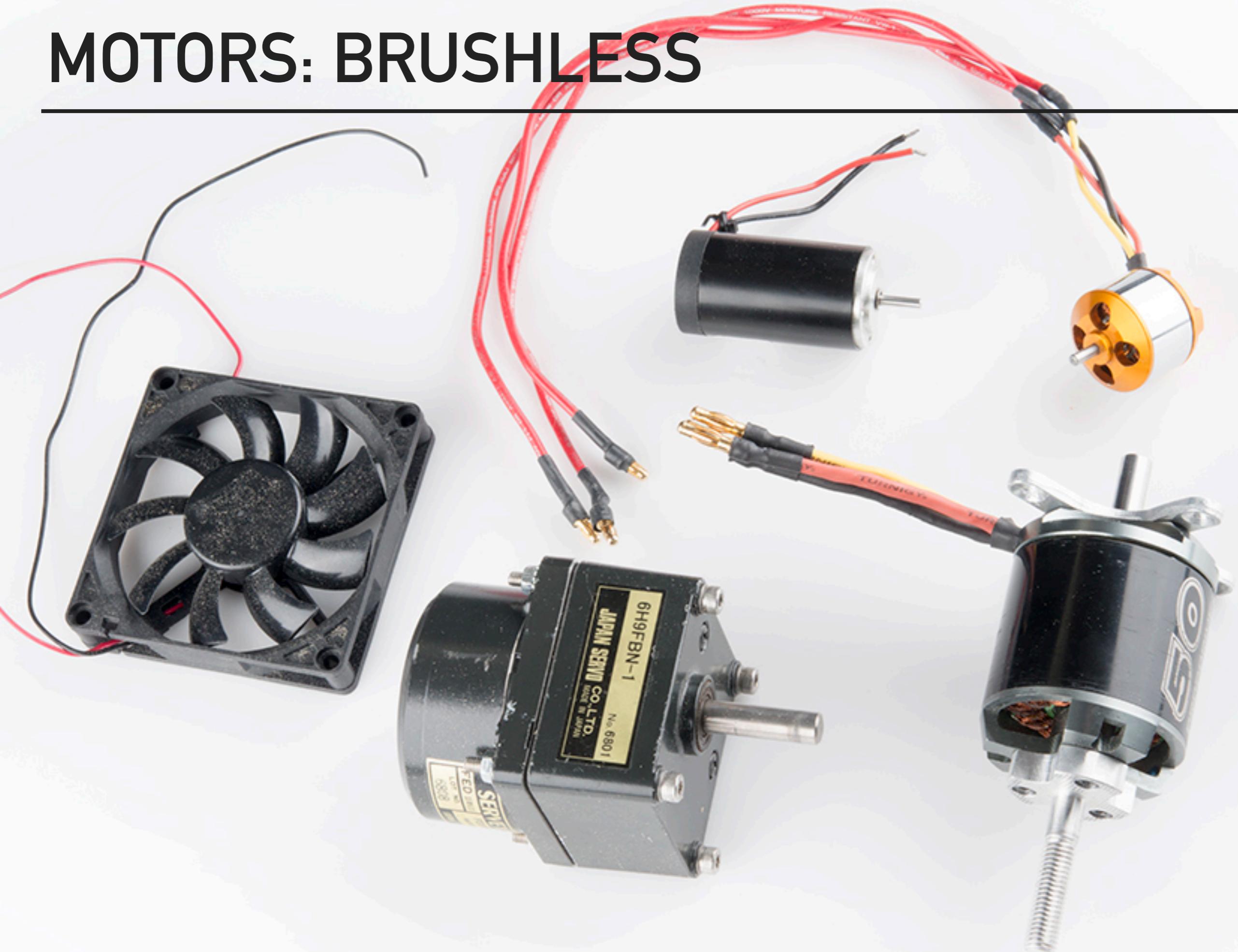
Magnets

Bushing

Can



MOTORS: BRUSHLESS



MOTORS: BRUSHLESS

ADVANTAGES

RELIABLE (NO BRUSH CONTACTS)

SILENT

HIGH SPEED

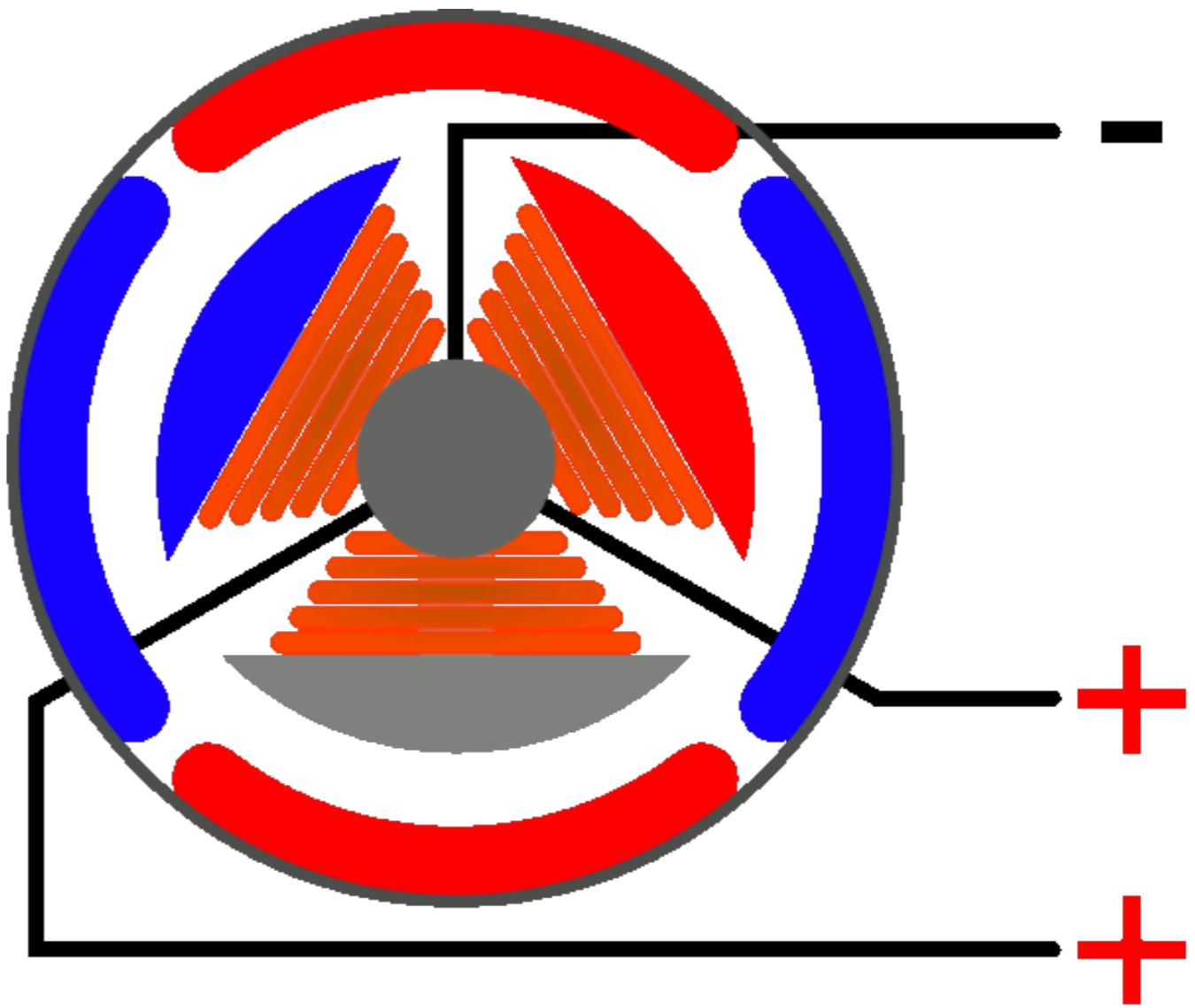
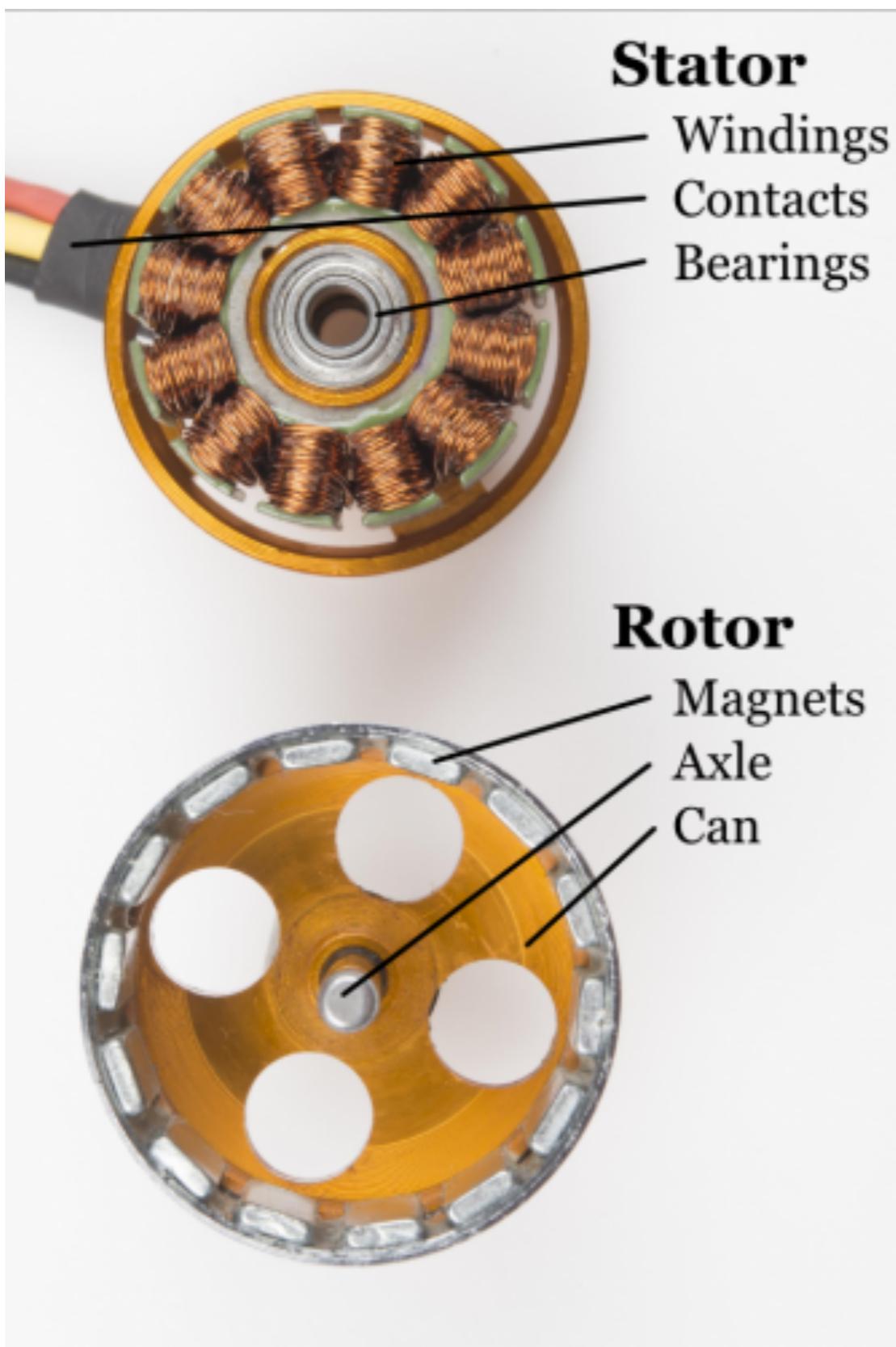
EFFICIENT (MINIMAL ELECTROMAGNETIC NOISE)

DISADVANTAGE

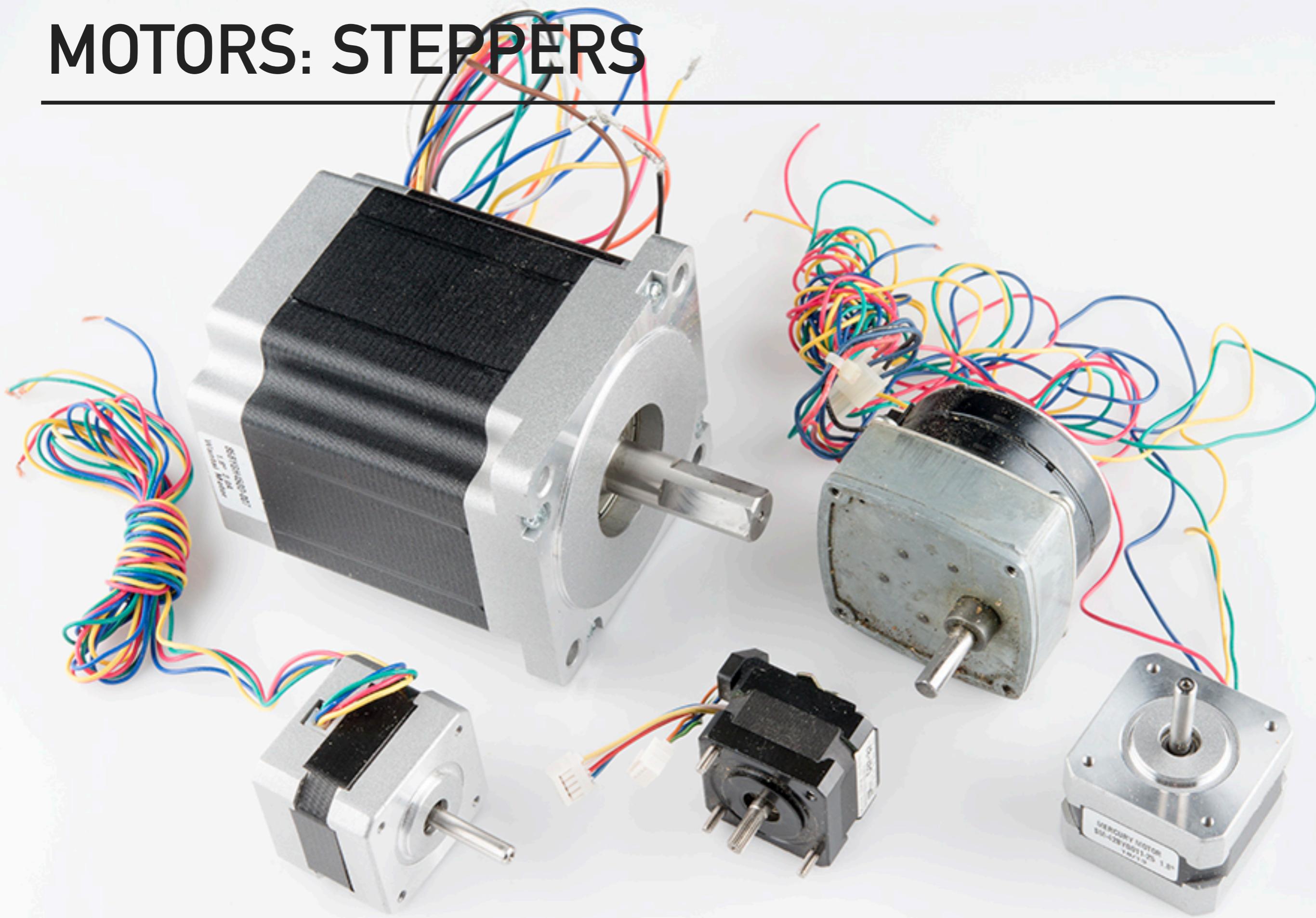
DIFFICULT TO CONTROL (SPECIALISED CONTROLLER)

REQUIRE SPECIALIZED GEARBOXES (MOTOR ASSEMBLY)

MOTORS: BRUSHLESS



MOTORS: STEPPERS



MOTORS: STEPPERS

ADVANTAGES

EXCELLENT POSITION ACCURACY

HIGH HOLDING TORQUE

HIGH RELIABILITY

STANDARD SIZE - NEMA8, NEMA11, NEMA14...

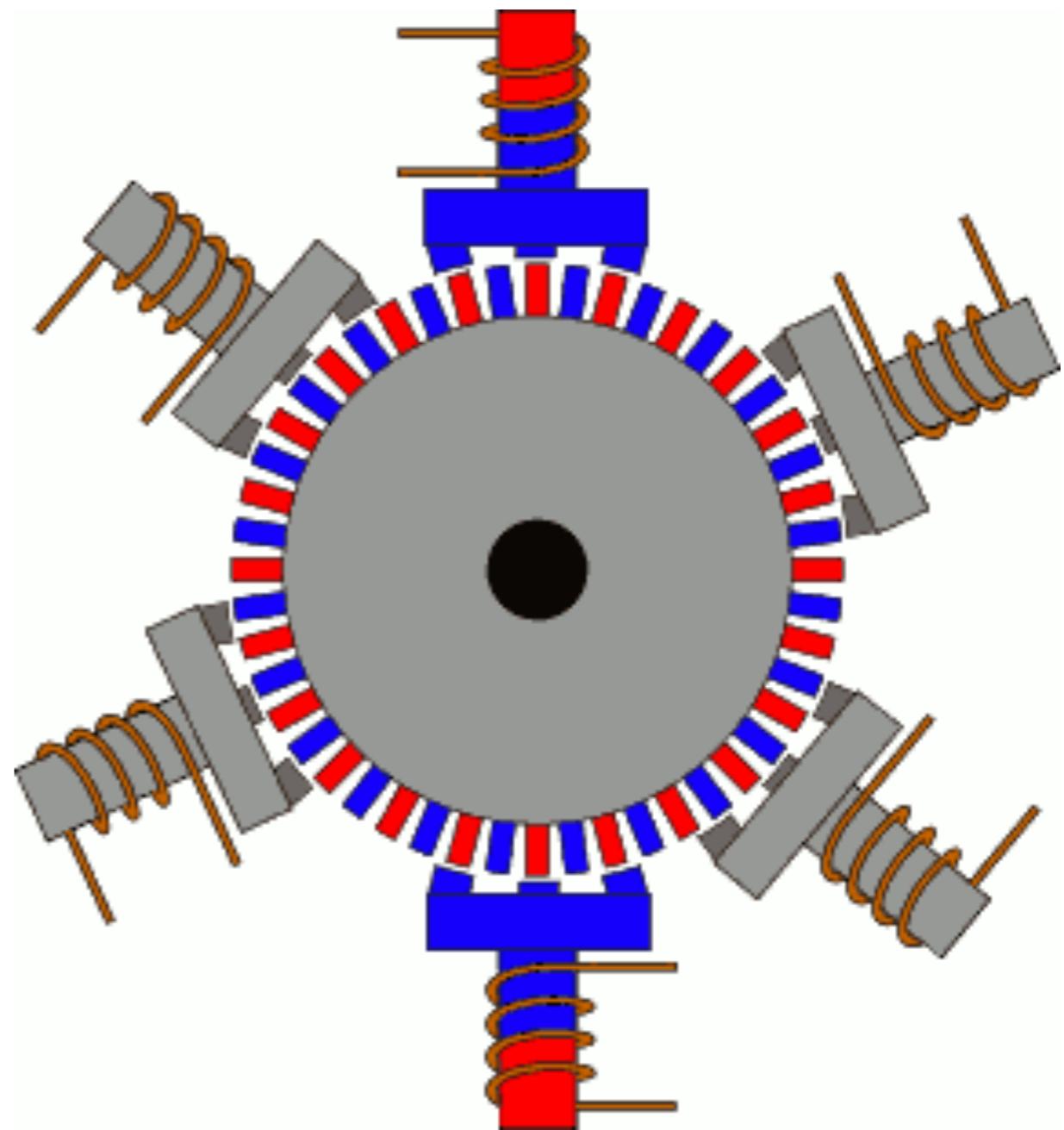
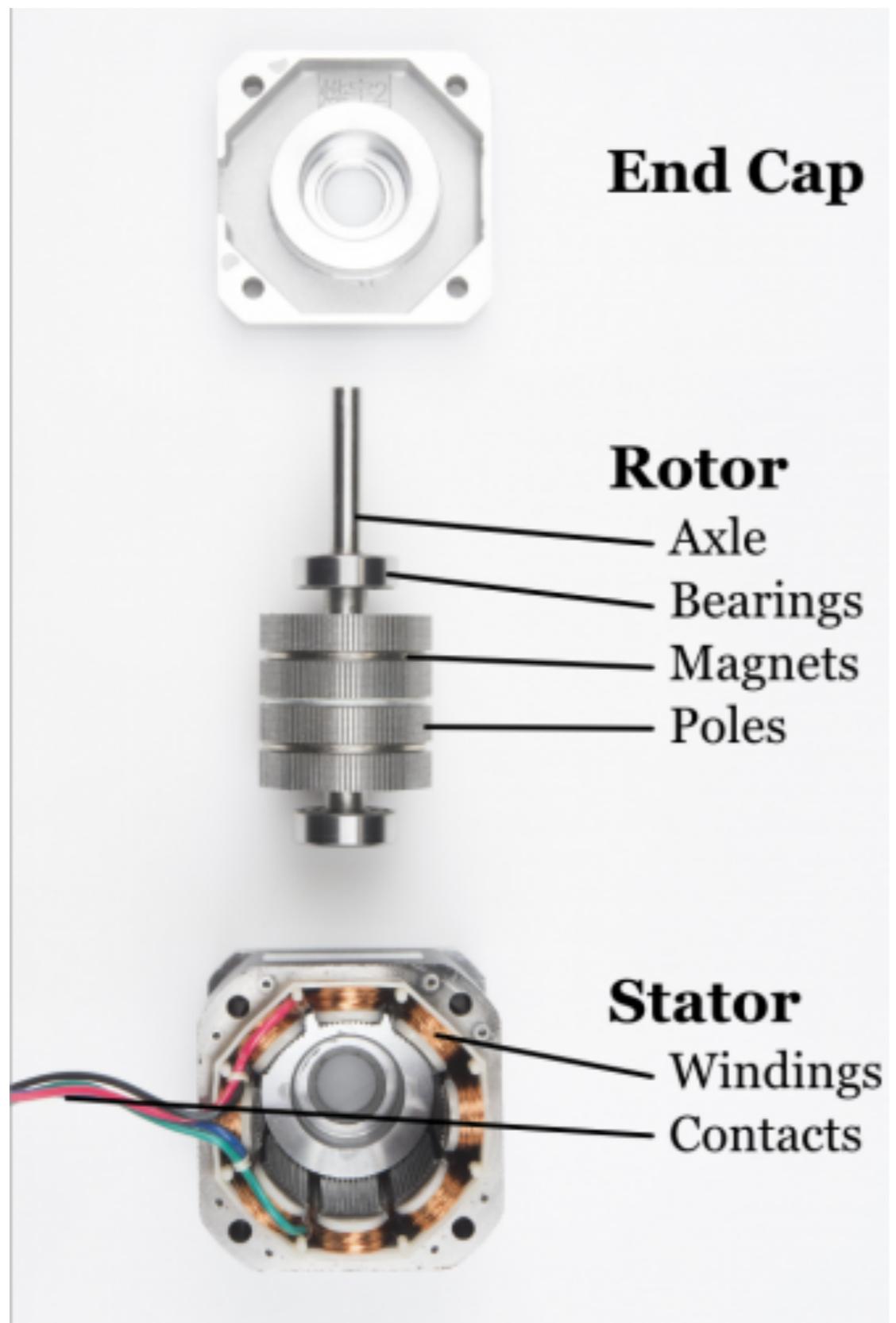
DISADVANTAGE

STEP SIZE LIMITS SPEED

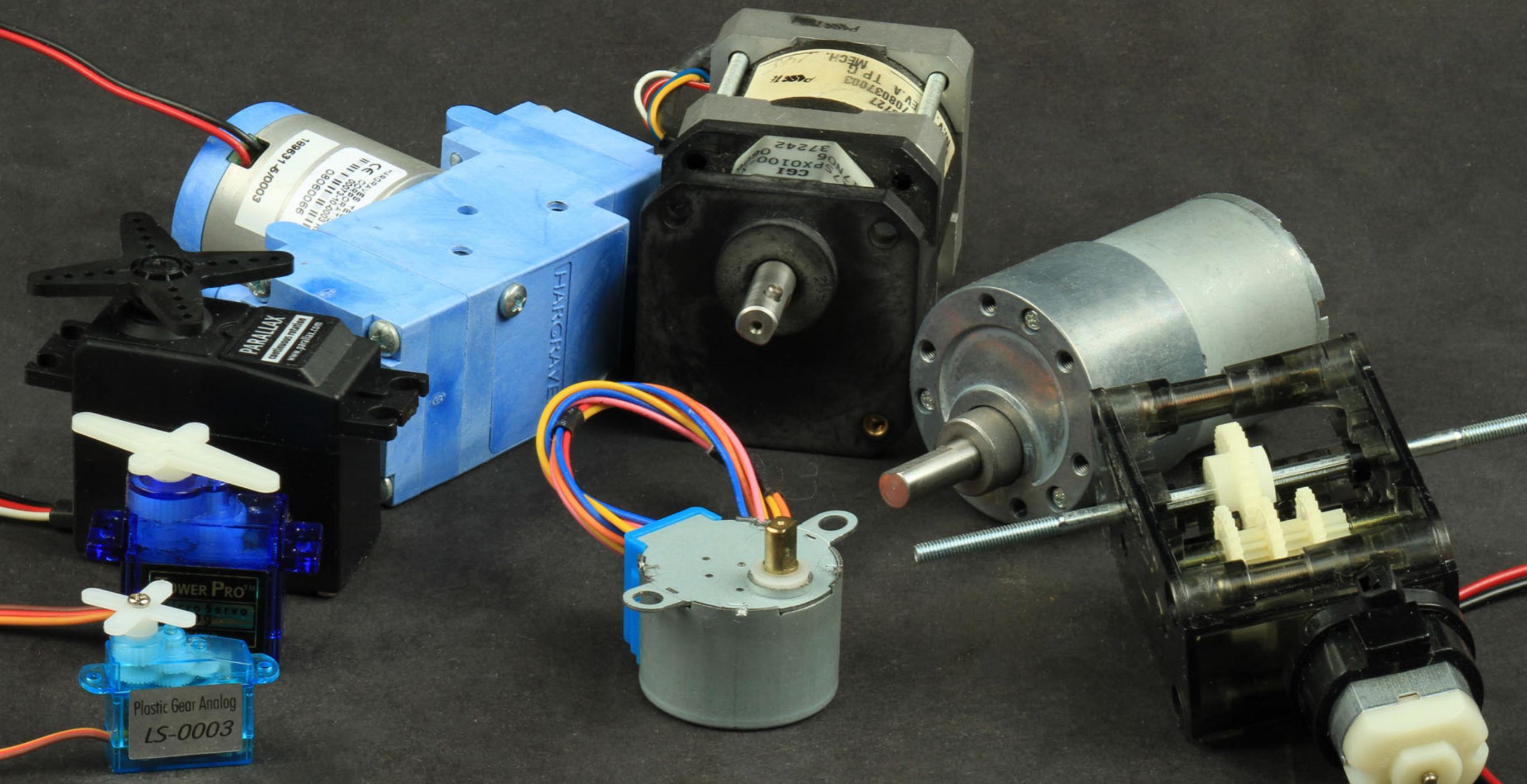
MAXIMUM CURRENT DRAW CONSTANT

HIGH LOADS - STEP SKIPPING

MOTORS: STEPPERS



MOTORS: ASSEMBLIES

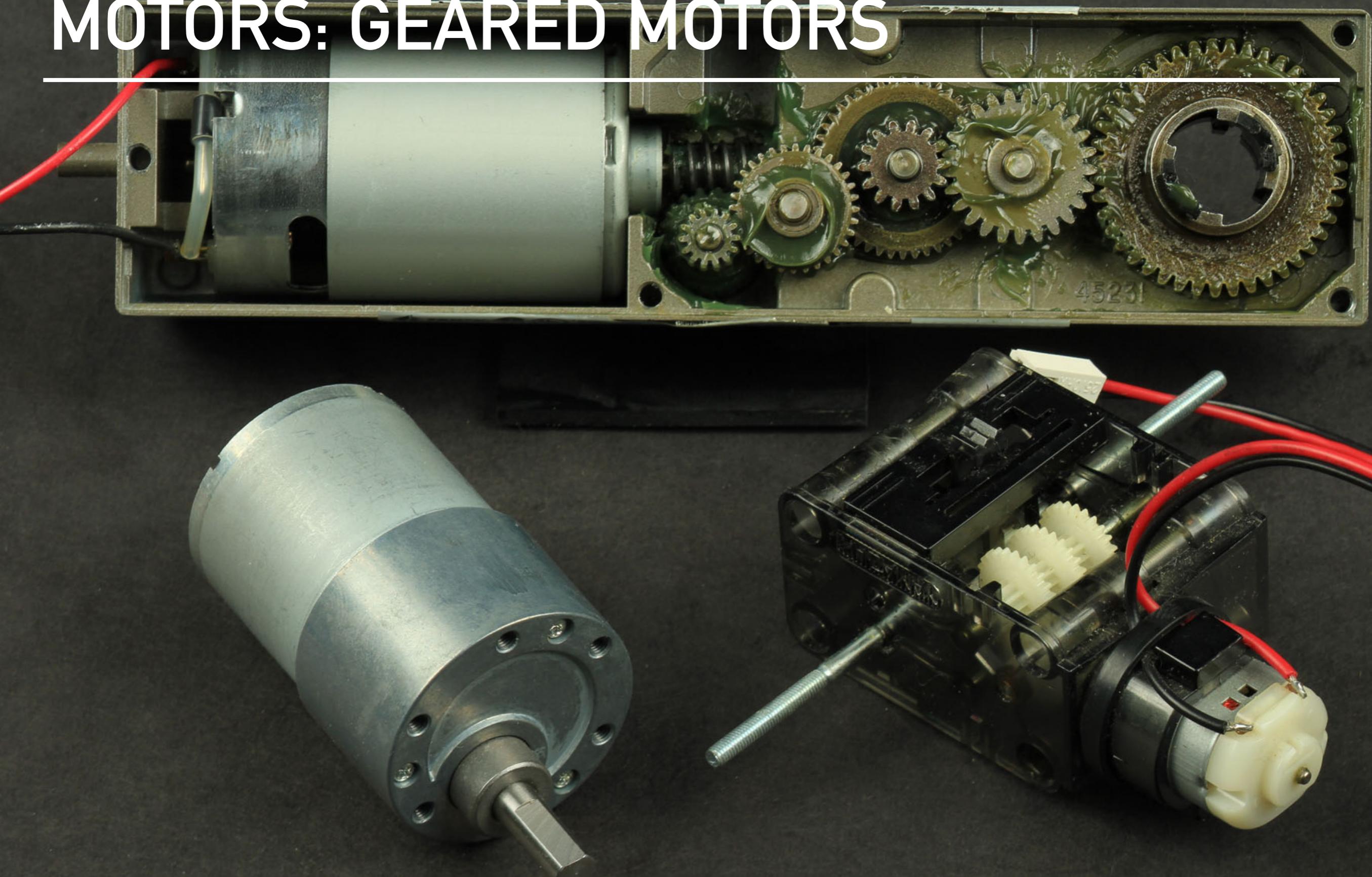


MOTORS: ASSEMBLIES

MOTORS IN THEIR ELEMENTAL FORM ARE NOT ALWAYS EASY TO WORK WITH - HOW TO HARNESS THE FULL POTENTIAL. DESIGNING AND BUILDING YOUR OWN GEAR-REDUCTION AND/OR CONTROL SYSTEM IS A LOT OF WORK.

MOTOR ASSEMBLIES HELP TO HARNESS THE RAW POWER OF MOTORS AND PACKAGE THEM INTO A FORM THAT CAN BE EASILY INTEGRATED INTO YOUR PROJECT.

MOTORS: GEARED MOTORS



MOTORS: GEARED MOTORS

ADVANTAGES

SPEED REDUCTION

INCREASE IN TORQUE (APPROPRIATE GEAR TRAIN)

DISADVANTAGE (LIMITATION)

FRICITION (PLASTIC GEAR TRAINS DECAY)

INERTIA - IMPEDANCE IN ACCELERATION

BACKLASH - GEAR TRAIN TOLERANCES

MOTORS: SERVO MOTORS



MOTORS: SERVO MOTORS

ADVANTAGES

LOW COST (RC SERVOS)

SIMPLE CONTROL (LOGIC LEVEL PULSE TRAIN)

VARIETY OF SIZES (MICRO, MINI, STANDARD)

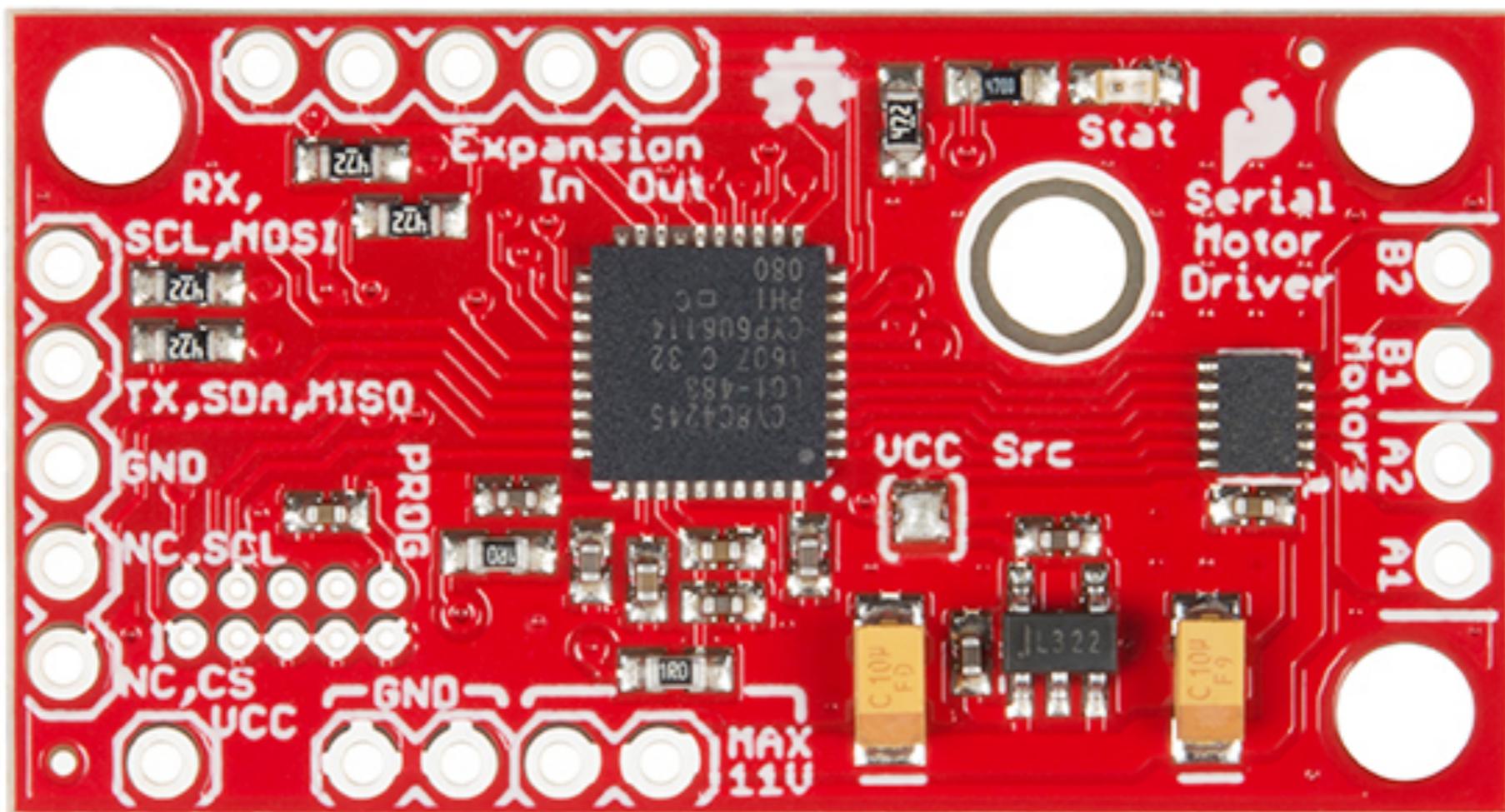
DISADVANTAGE (LIMITATION)

LIMITED RANGE OF MOTION (180 DEGREES)

MODERATE POSITIONING (DRIFT)

JITTER - FEEDBACK MECHANISM IN SERVO

MOTORS: CONTROL



MOTORS: POWER

MOTORS ARE POWER HUNGRY DEVICES. THEY ARE ALSO NOT VERY WELL BEHAVED LOADS AND CAN CAUSE SUPPLY FLUCTUATIONS THAT DISRUPT OTHER DEVICES POWERED FROM THE SAME SUPPLY.

MANY DIFFICULTIES WITH MOTORIZED PROJECTS STEM FROM POWER SUPPLY PROBLEMS.

MOTORS: VOLTAGE

IT IS IMPORTANT TO CHOOSE THE RIGHT VOLTAGE FOR YOUR POWER SUPPLY. TOO LOW A VOLTAGE WILL RESULT IN REDUCED PERFORMANCE.

TOO HIGH A VOLTAGE CAN DAMAGE YOUR CONTROLLER AND/OR YOUR MOTOR.

MOTORS: CURRENT

CURRENT DRAW IS DETERMINED BY THE MOTOR. AS LONG AS YOU STAY WITHIN THE VOLTAGE RATING FOR THE MOTOR, THE MOTOR WILL ONLY DRAW A SAFE AMOUNT OF CURRENT.

TO PROTECT THE POWER SUPPLY FROM OVERLOAD: MAKE SURE THAT THE CURRENT RATING FOR THE POWER SUPPLY IS AT LEAST AS HIGH AS THE MOTOR.

UNDERSTAND THE CURRENT RATINGS OF BOTH MOTOR AND CONTROLLER.

MOTORS: SAFETY

YOU WILL PROBABLY BURN OUT A MOTOR OR TWO. FOR SMALLER MOTORS, THIS USUALLY JUST MEANS SOME VERY SMELLY SMOKE. BUT LARGER MOTORS AND THEIR ASSOCIATED CIRCUITRY AND POWER SUPPLIES CAN BECOME A REAL HAZARD IF YOU ARE NOT CAREFUL.

BE CAREFUL AROUND LIVE CIRCUITS AND MOVING MACHINERY.

MOTORS: PROTECT YOURSELF

USE CAUTION WHEN HANDLING HIGH CURRENT POWER SOURCES, CIRCUITRY AND ATTACHED MACHINERY.

AVOID SKIN CONTACT WITH LIVE CIRCUITS.

SHORT CIRCUITS IN BATTERIES AND POWER SUPPLIES CAN RESULT IN FIRE AND/OR EXPLOSION. ALWAYS DOUBLE-CHECK POLARITY AND USE CAUTION WHEN MAKING CONNECTIONS.

MOTORS: PROTECT THE ELECTRONICS

UNDERSTAND THE CAPABILITIES OF THE COMPONENTS YOU ARE USING AND USE CARE WHEN CONNECTING THEM.

DON'T MAKE CONNECTIONS TO LIVE CIRCUITS. MAKE ALL CONNECTIONS FIRST BEFORE POWERING UP THE SYSTEMS.

OVERLOADED CIRCUITS CAN BE A FIRE HAZARDS.

MOTORS: PROTECT THE WIRING

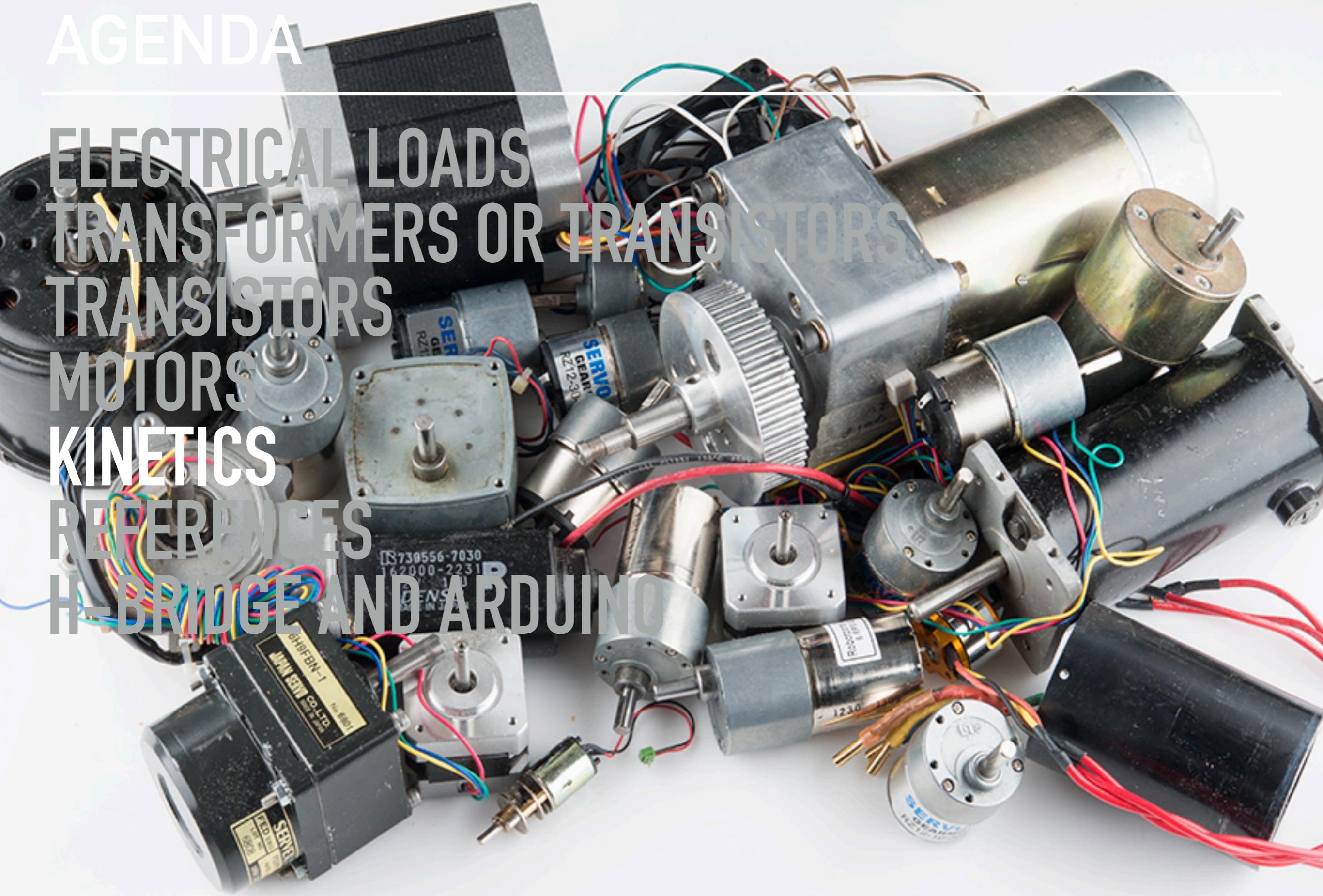
NEVER OVERLOAD WIRE. OVERLOADED WIRING CAN QUICKLY TURN RED-HOT AND BURN THROUGH INSULATION AND WHATEVER ELSE IS NEARBY.

ALWAYS USE A WIRE GAUGE LARGE ENOUGH TO HANDLE THE EXPECTED LOAD CURRENT.

IF YOUR POWER SUPPLY IS RATED FOR MORE CURRENT THAN THE WIRE, ADD A FUSE TO PROTECT AGAINST SHORT CIRCUITS.

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KINETICS

AUTOMATA = PHYSICS, MECHANICS AND CAMS.



KINETICS

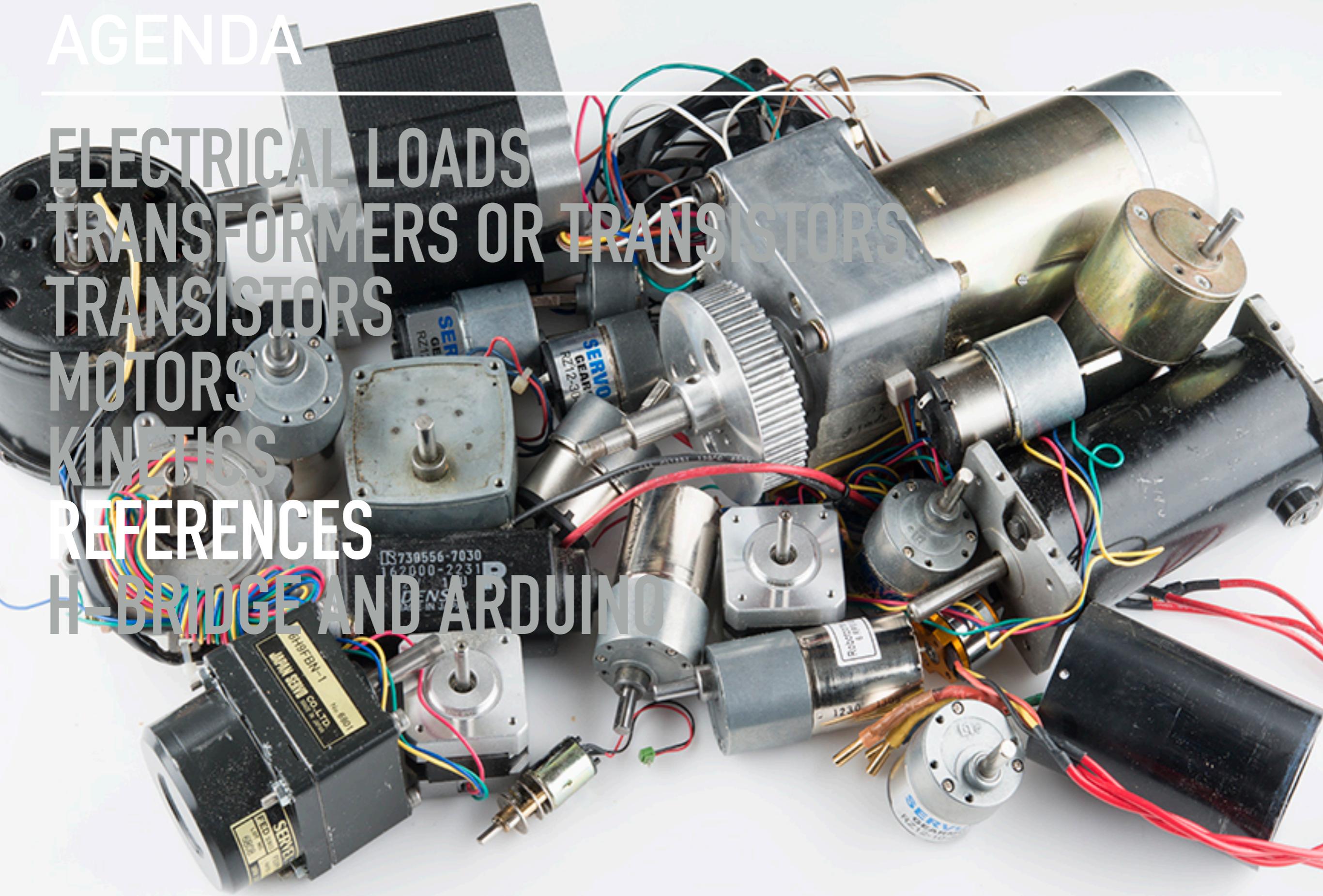
$$C = 2\pi * R$$

KINETICS

**RACK & PINION - WORM GEARS - GENEVA STOP - GEARS
- CHAIN & SPROCKET - CARDON GEAR - RECIPROCATING
MOTION - RATCHET - PISTONS - CRANK SLIDERS -
CRANKS - BELL CRANK - CAMS**

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REFERENCES

[ADAFRUIT MOTOR GUIDE](#)

[ADAFRUIT TRANSISTOR 101](#)

[ADAFRUIT STEPPERS GUIDE](#)

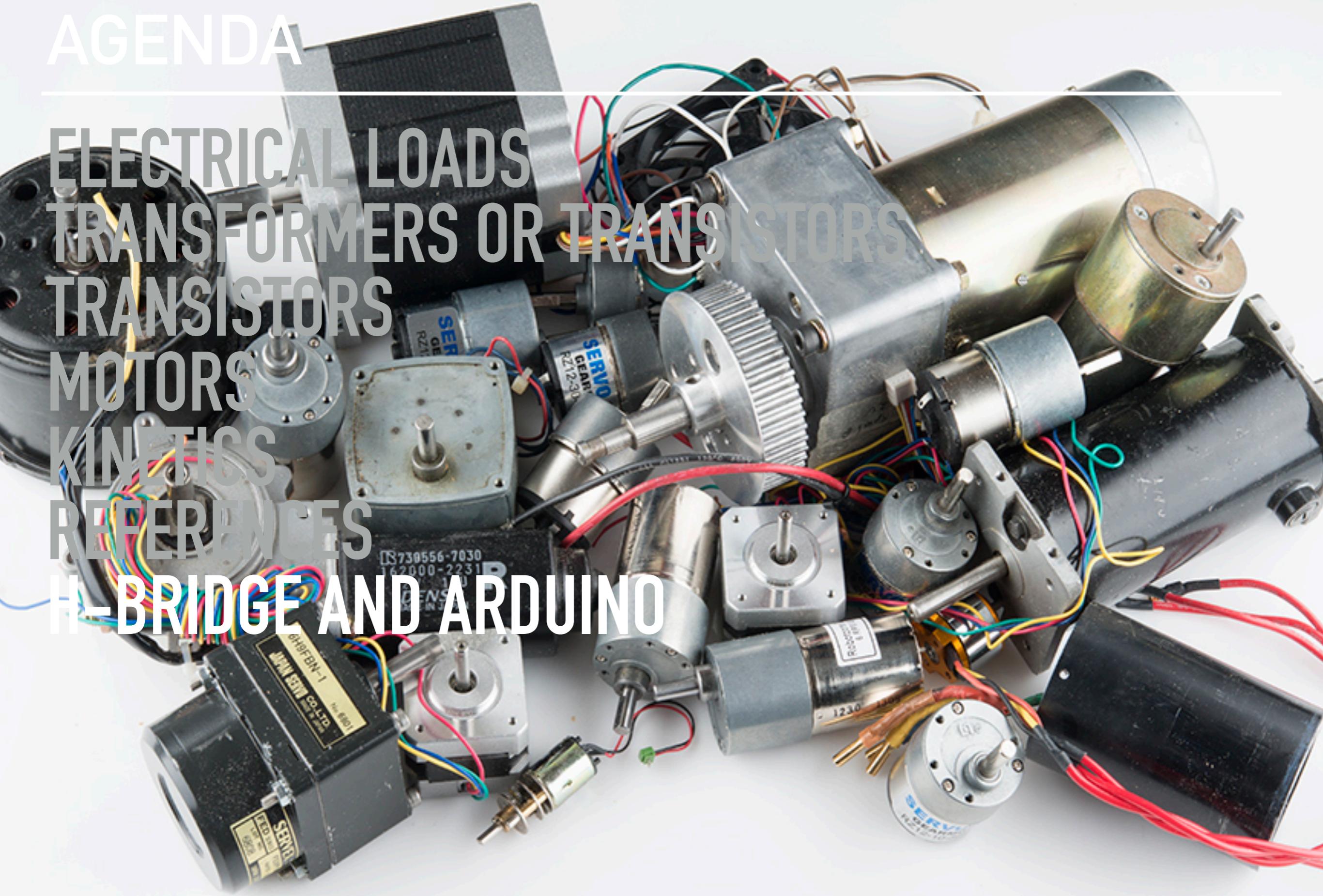
[SPARK FUN MOTORS](#)

[AUTOMATA MECHANISMS](#)

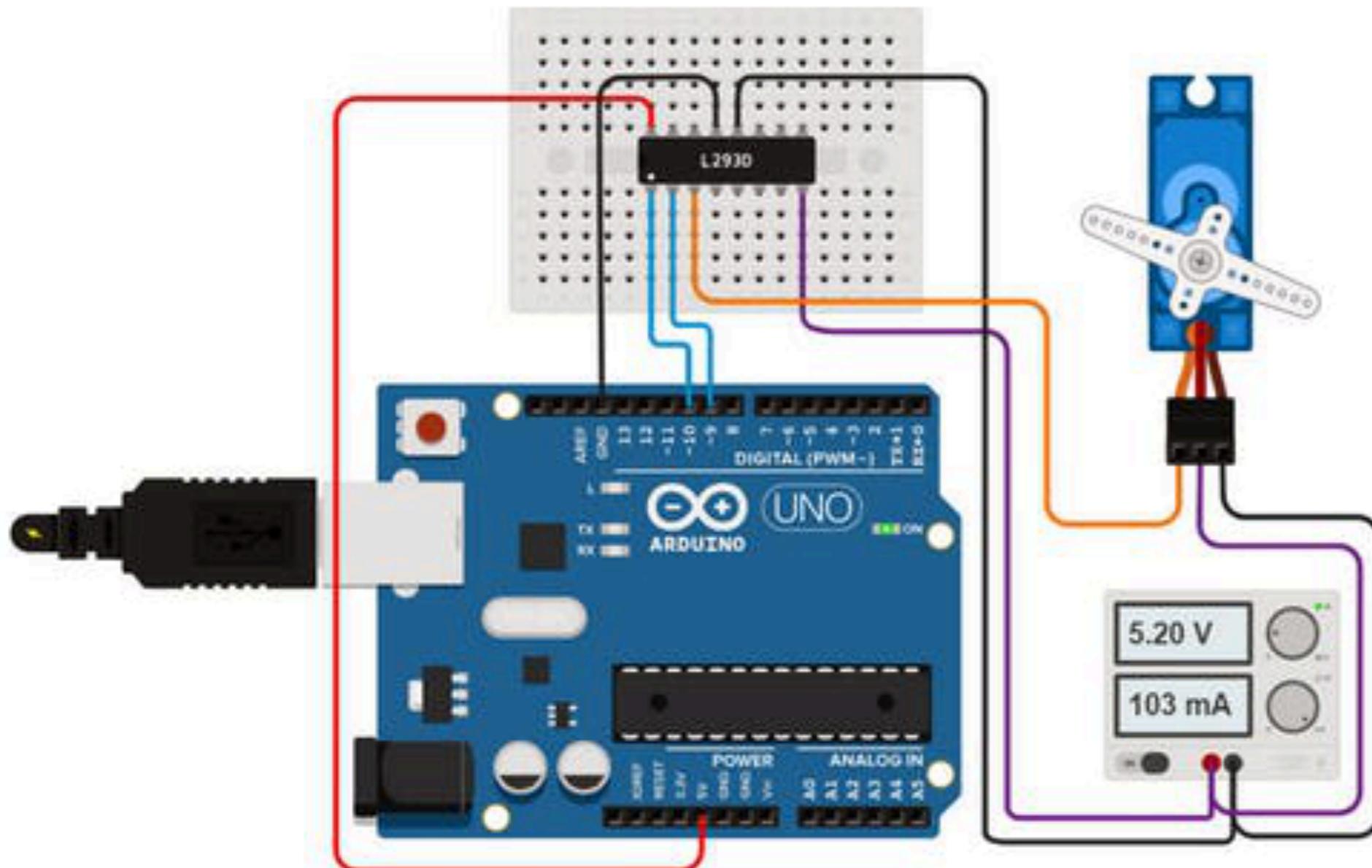
[SIMPLE MACHINES, MECHANISMS & CAMS](#)

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MOTORS



You have to connect GND pins of power supplies together.

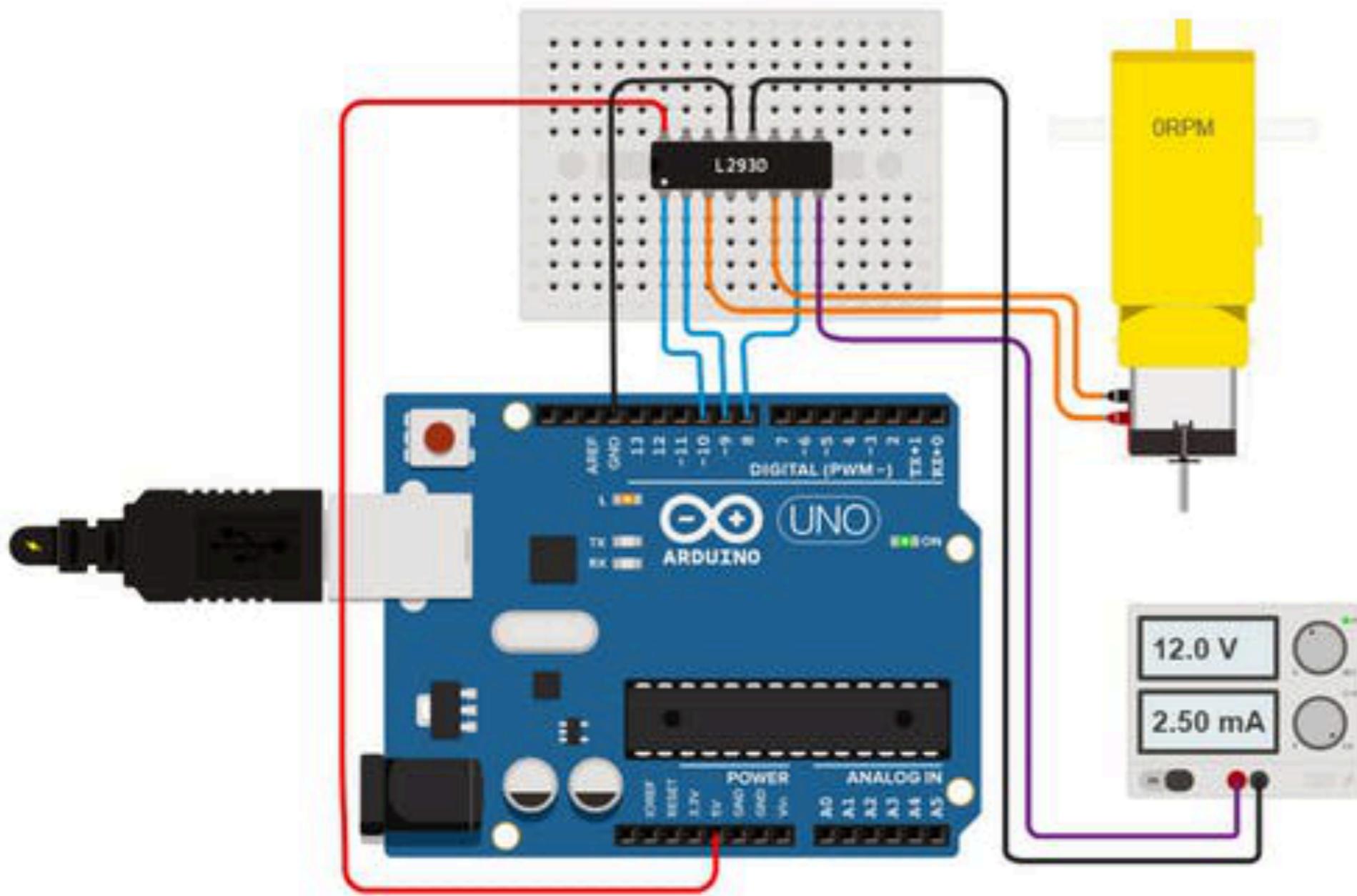
All GND pins in L293D Chip are connected together.

Choose correct wires for motors & power supply
Wires should carry 1Ampere current.

To control the speed of motor, connect the L293D Enable pins to Arduino PWM pins.
(PWM in UNO:3,5,6,9,10,11)

If you need the maximum power of driver, Power supply should provide 24V & 1A at least.

MOTORS



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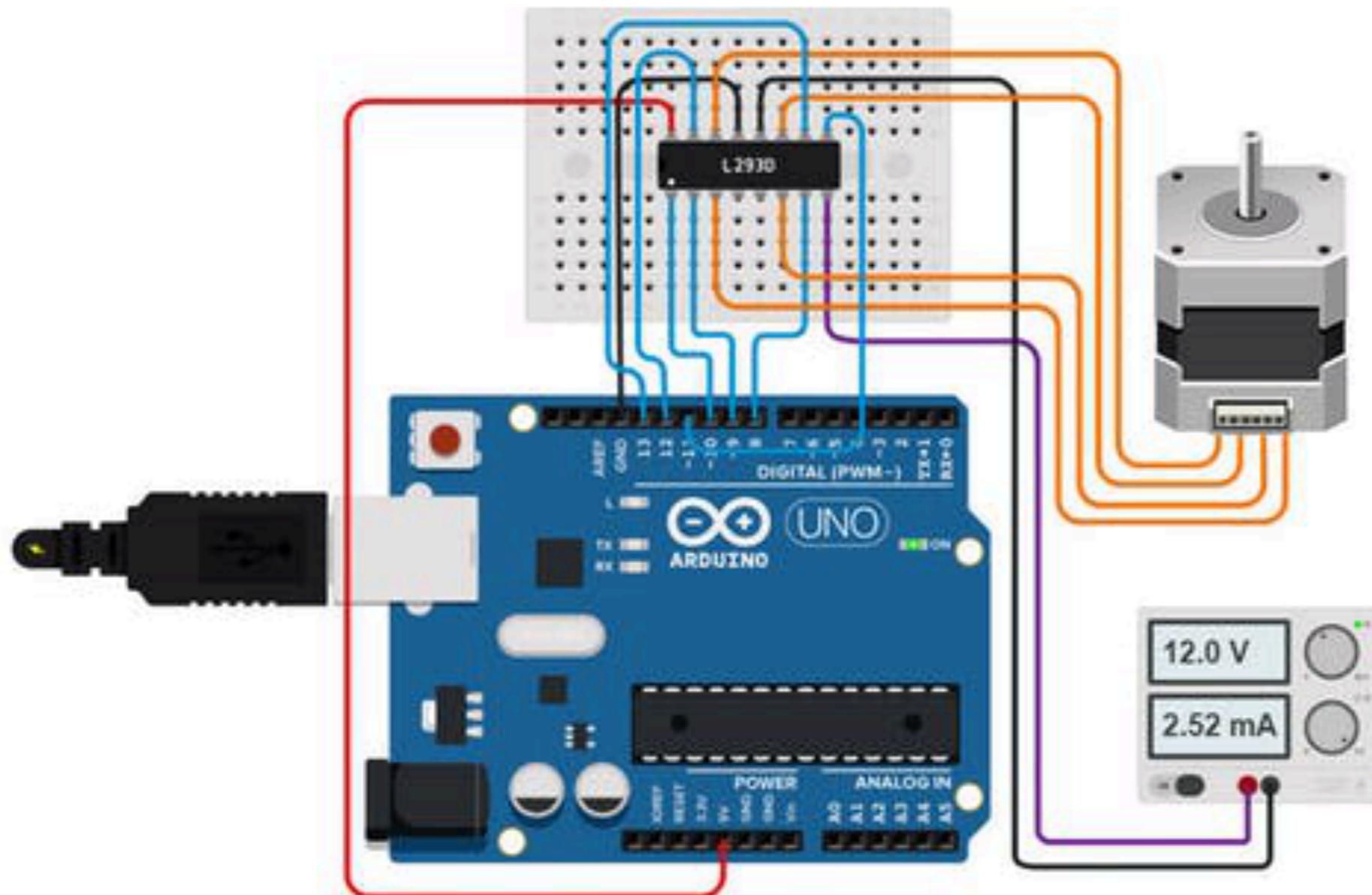
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