

PRELIMINARY DESIGN PRESENTATION

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NEEDS ANALYSIS

Needs Statement:

Industrial and building systems require a safe, cost-effective and reliable method to remove mineral scale build-up from ø100-150mm pipes, where existing solutions such as chemical cleaning, pigging, and jetting are either hazardous, resource intensive or ineffective at hard deposits.

Problem Definition:

Design a low-cost robotic system that can navigate ø100-150mm pipe, mechanically remove scale and improve flow performance while being able to adapt to varying pipe sizes and geometries.

DESIGN SPECS: Objectives

Criteria	Objectives	Unit of Measurement	Notes
Pipe diameter compatibility	$\leq \varnothing 90$	mm	
Water sealed electronic enclosure	IP54	-	Solids (5): Dust protection Liquids (4): splashing water
Navigation of bends	90	Degrees	
T-Junction entry	$\geq 80\%$ success	%Trials	Ability to enter branch on demand
Scale removal effectiveness	≥ 50	%	Removal of CaCO ₃ /rust deposits
Cost	≤ 750	\$	University allocated budget
Traction/adhesion force	≥ 5	N	Maintain grip while engaged
Movement speed	≥ 0.1	m/s	Continuous travel without stalling
Mass	< 20	kg	Lightweight for retrieval and mobility
Live video transmission	480p, 10fps	pixels, fps	Assists in operator navigation of pipe system

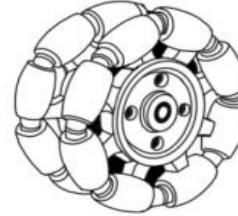
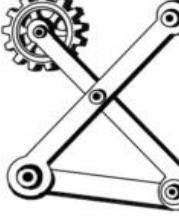
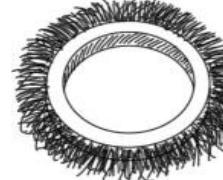
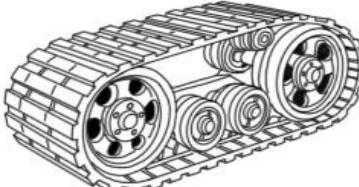
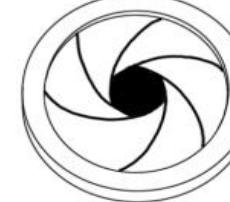
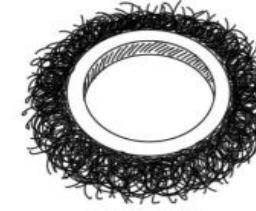
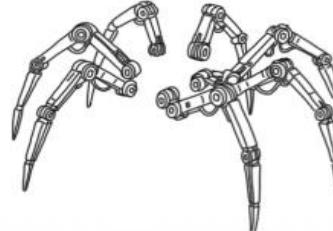
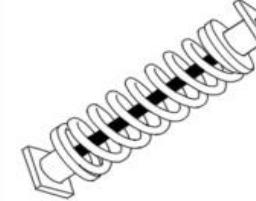
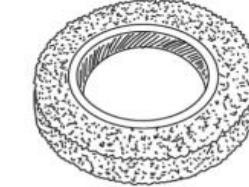
DESIGN SPECS: Constraints

Criteria	Constraint
Size/Operation	<ul style="list-style-type: none">The system must fit within ø100mm inner pipe diameterThe system must operate reliably in wet conditions
Cleaning Performance	<ul style="list-style-type: none">The system must mechanically remove >50% of simulated mineral scaleThe system must complete one cleaning cycle without permanent pipe damage
Safety & Reliability	<ul style="list-style-type: none">The system must be retrievable via tether in the event of power loss or failure
Monitoring & Feedback	<ul style="list-style-type: none">The system must transmit live video

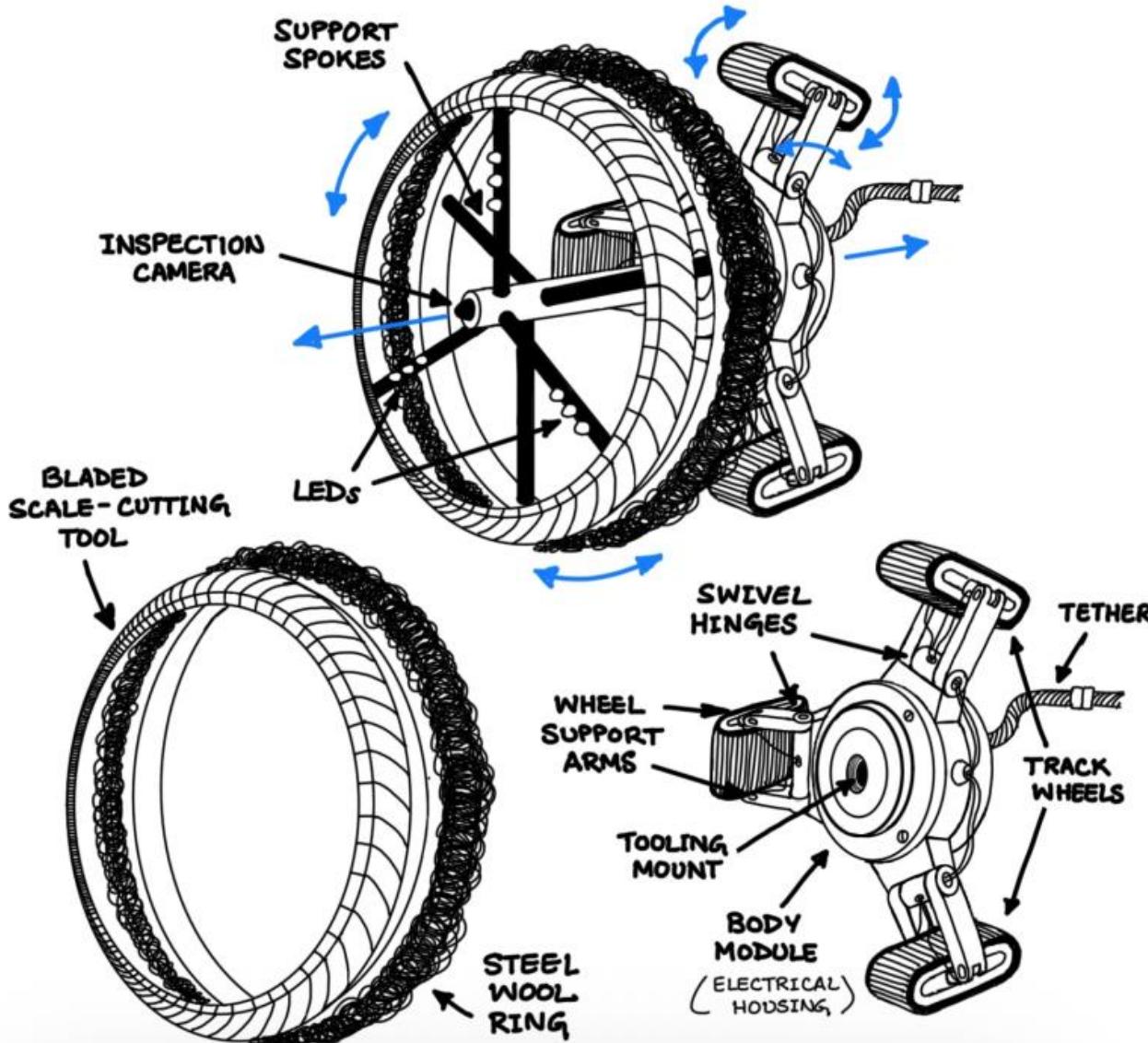
DESIGN SPECS: Criteria

Criteria	Reason
Size	Size of robot must be small enough to fit comfortably in ø90mm pipes
Mass	Light weight robot allows for easy transport
Speed	Move as efficient as a water jetting machine
Cost	Overall cost of the solution must be within budget
Manufacturability	Minimal number of parts and simple mechanism
Waterproofing	Work in damp/water splashing conditions
Mobility	Ability to move smoothly within pipes, including bends and junctions
Durability	Resistance to abrasion, chemicals, moisture
Precision	Ability to clean without damaging pipe walls

MORPHOLOGICAL CHART

OPTION	MOVEMENT	SIZING	CLEANING
①	 OMNI-DIRECTIONAL WHEELS	 GEAR-LINKAGE MECHANISM	 PLASTIC BRISTLES
②	 TRACK WHEELS	 SHUTTER MECHANISM	 STEEL WOOL
③	 SPIDER LEGS	 SPRING LOADED	 SANDING ATTACHMENT

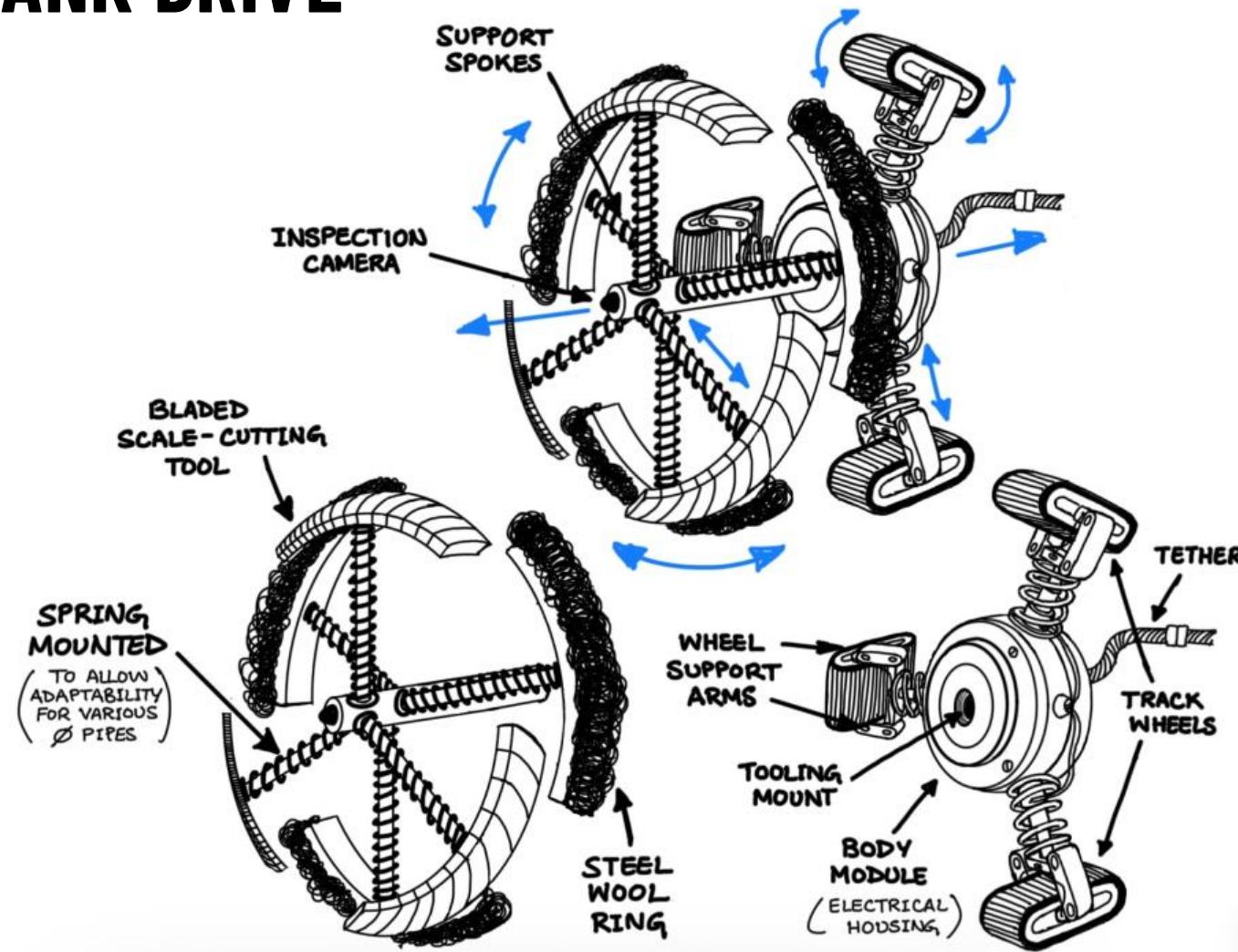
FOUR-BAR LINKAGE TANK DRIVE



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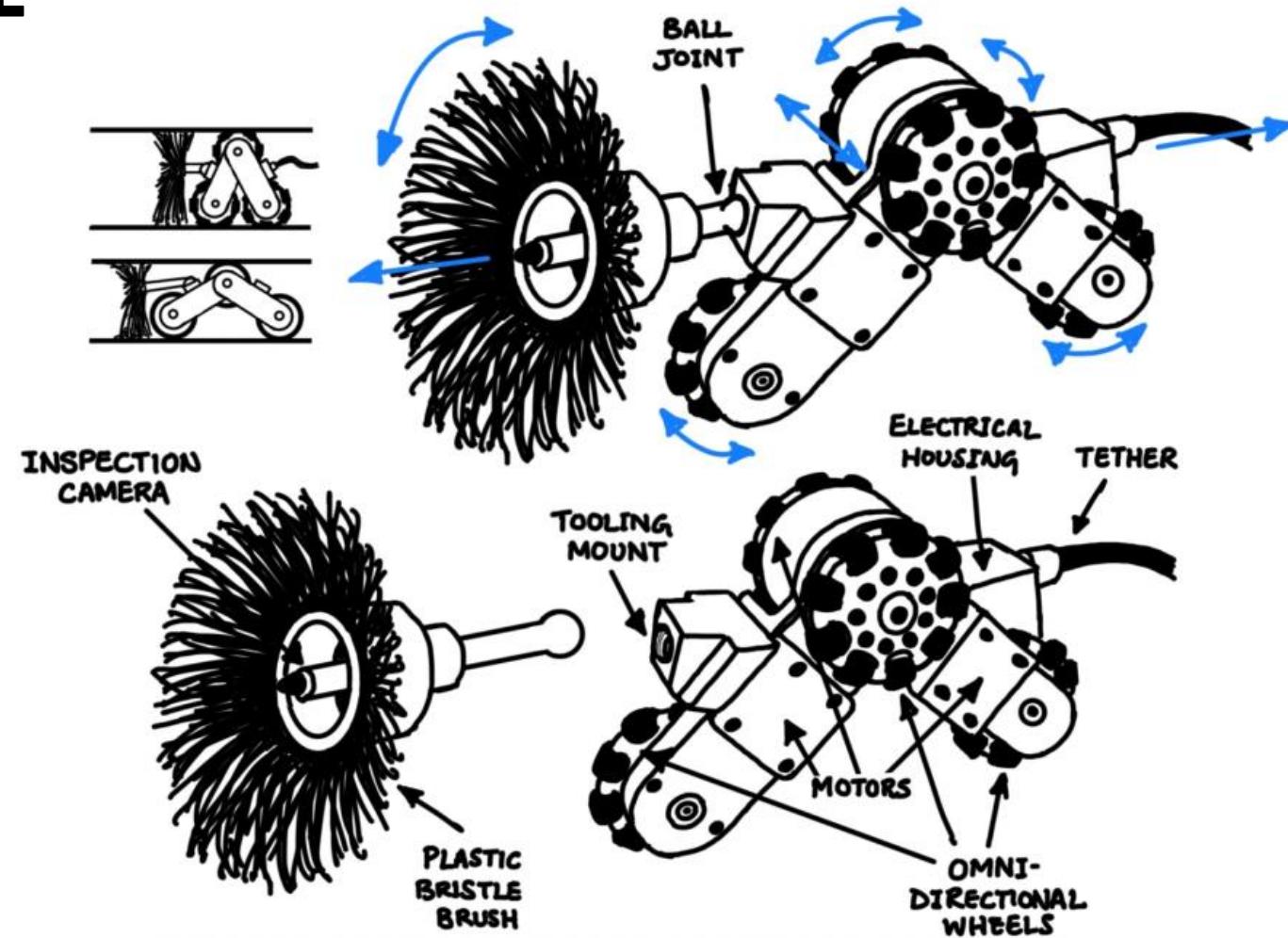
SPRING LOADED TANK DRIVE



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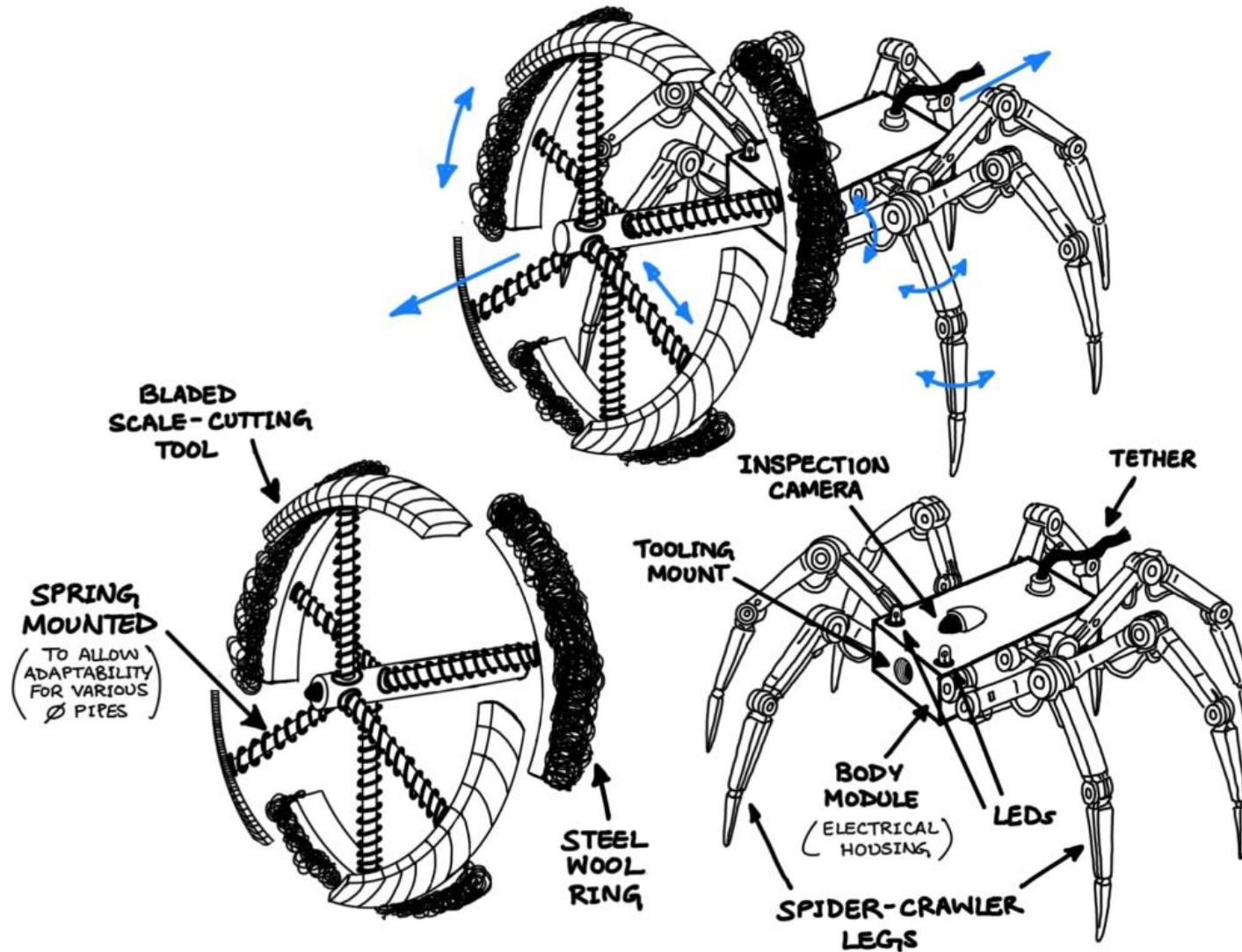
V-SPLAY DRIVE



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SPIDER

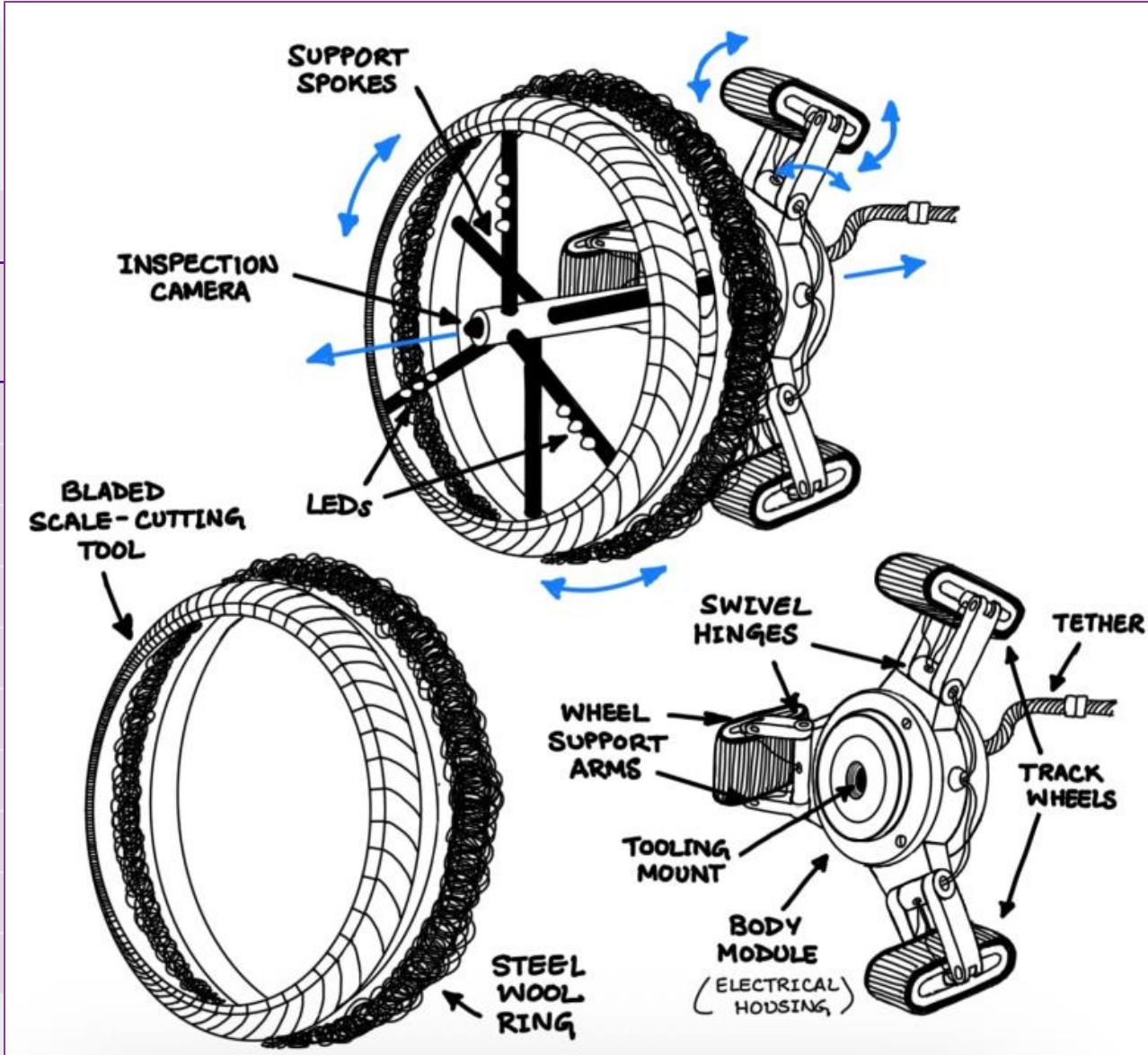


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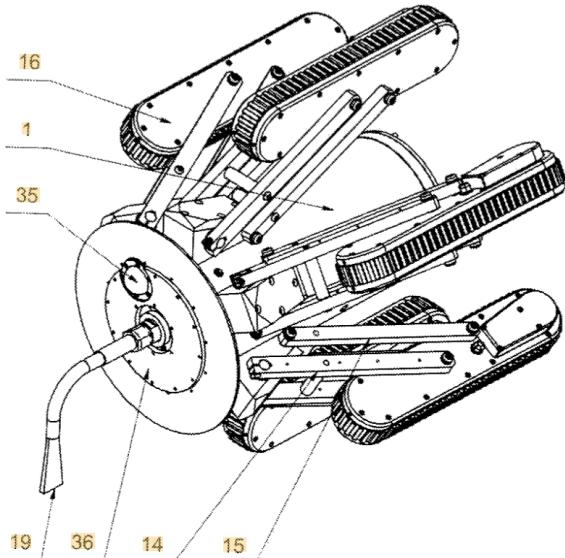
DESIGN MATRIX

Criteria	Priority	Linkage Tank Tread	
		Rating	Weighted Score
Size	1 (x11)	3	33
Mobility	2 (x9)	4	36
Waterproofing	3 (x7)	3	21
Durability	4 (x6)	4	24
Cost	5 (x5)	3	15
Speed	6 (x4)	2	8
Manufacturability	7 (x3)	2	6
Mass	8 (x2)	1	2
Precision	9 (x1)	4	4
TOTAL			149



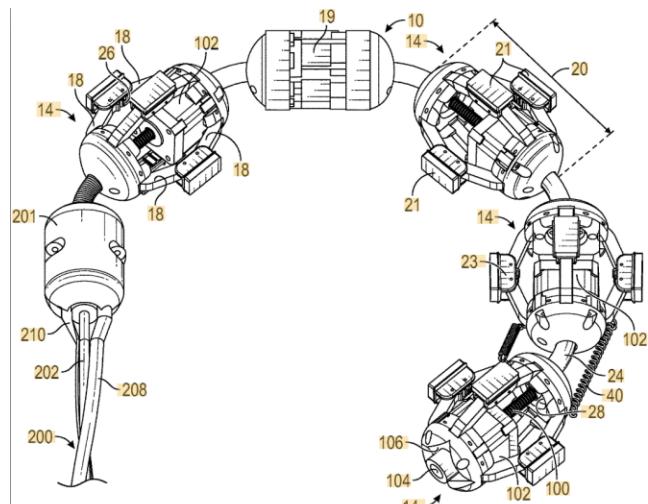
PATENT RESERACH

Jetty Robot 6
[US9101967B2]



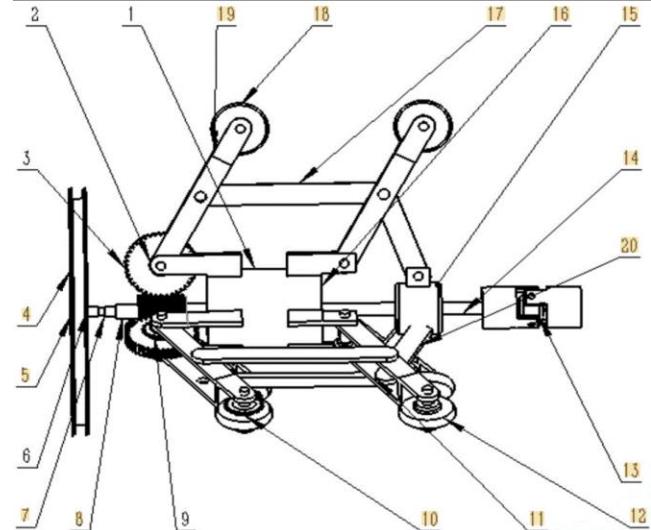
- Self-centering
 - Constant-force expansion
 - Operator-guided bend control
 - Auto-reverse
 - Unique radial drive system

Modular Robotic Crawler [US11781698B2]



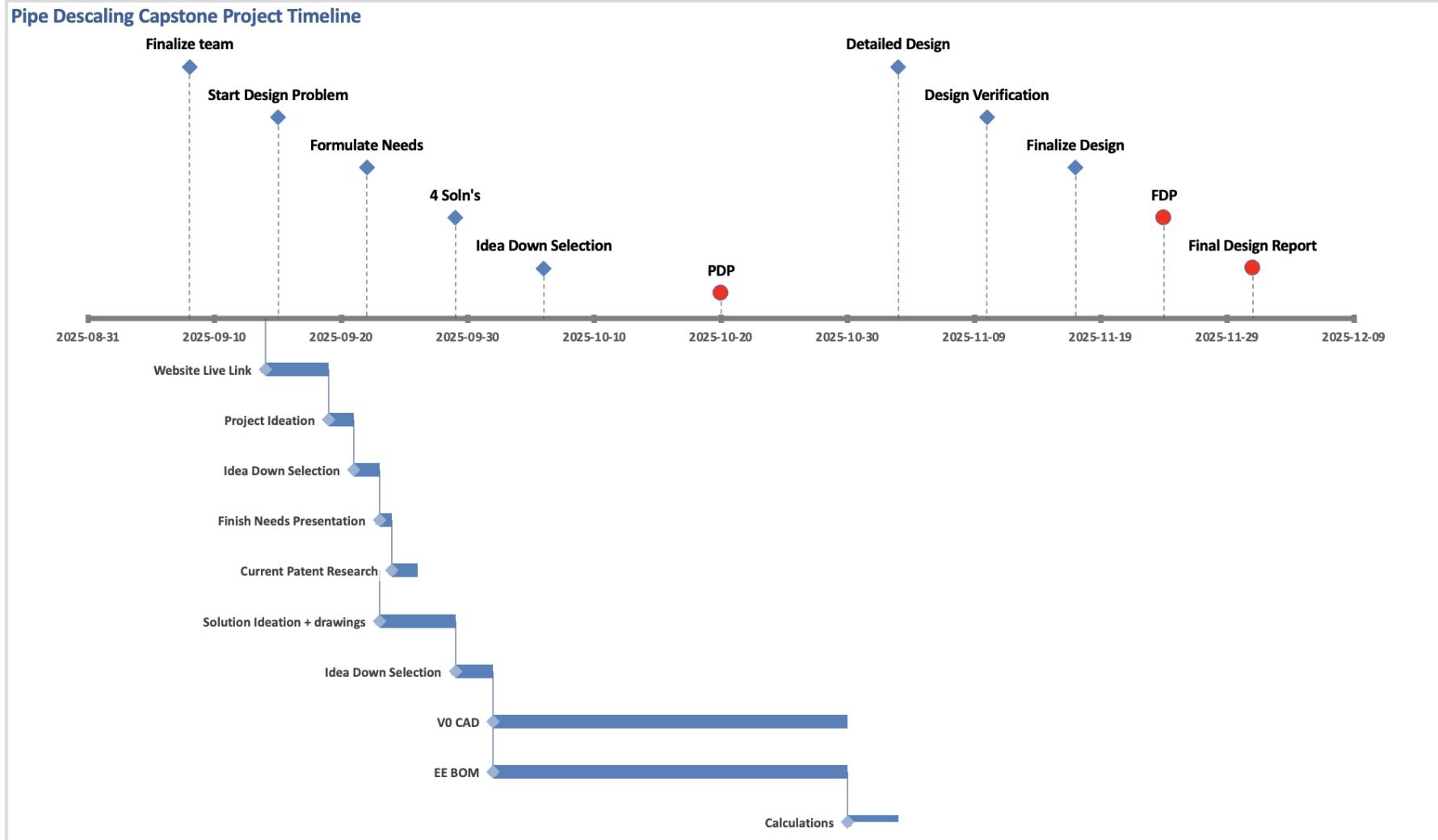
- Hybrid extension mechanism
 - Multi-segment architecture
 - Designed for small diameter pipes

Adaptable Pipe Cleaning Robot [CN107649470B]



- Synchronized radial actuation
 - Modularity/Hot-swap features
 - Sensor feedback loop

PROJECT TIMELINE



QUESTIONS?

