Excerpt from "Steam Power", discussed here.

Universal Hem Rules

- 2. Using and Creating Steam Powered Items -

"Though many steam powered machines are believed otherworldly and magical by the ignorant masses, the workings of all steam machines are based on surprisingly mundane principles."

- HE Margany V. Ortems

Please keep in mind that only additions and exceptions to the standard PF rules in the PRD are mentioned, meaning the standard rules always apply to every aspect not specifically described here.

2.1 Boilers and Engines

Steam power primarily involves two conversions of energy, each conversion associated with a main category of steam items: **boilers** which heat water to produce pressurized steam, and **engines** which transform the pressure into mechanical movement, often via a piston pushed back and forth by the steam. Many of the devices presented here also recycle the exhaust steam, using a condenser to transform it back to water which eventually returns to the boiler to be heated again.

A boiler is often designed to provide steam for several engines that may have very different functions, and therefore boilers and engines are usually made and sold as separate items. The numerous forms of steam engines, such as powered armor additions and steam weapons, use the same general item categories as the equivalent non-powered items found in the PRD.

2.2 Pressure Points and Pool

The numerous technical factors and physical relationships which affect the power a steam boiler and engine is capable of producing are represented by *Pressure Points* (PrP) and *Pressure Pool* (Pool) values.

A **PrP** is a hypothetical unit of the pressure which is produced by a boiler and spent by a connected engine. The number of PrP a boiler has at any given moment is its **Pool**, the maximum value of the boiler's Pool and its PrP regain rate dependent on the boiler's size, type and installed accessories.

2.3 Continuous Benefits and Pool

An engine does not spend the PrP in a boiler's Pool simply by being connected and enabled, only when the user activates the engine's special function, as detailed in its description. Still, an engine will not provide any benefits unless it is enabled and connected to a boiler with a sufficient Pool value at any given moment, the value required dependent on the engine in question and listed in its description. Unless the requirement is listed as minor, an engine's Pool requirement stacks with the requirements of any other engines connected to the same boiler.

An engine with a minor Pool requirement needs a very small amount of pressure, providing its continuous benefits as long as the boiler has at least 1 PrP in its Pool, without increasing the boiler's required Pool like other engines do.

If the boiler's Pool drop to a value below the minimum total required, none of the connected engines have sufficient pressure, and all of them are disabled until the boiler's Pool is sufficient to power all connected engines again.

2.4 Enabling and Disabling Engines

As a 1 round action, a character with at least 1 rank in Knowledge (engineering) may connect or disconnect an engine to a boiler adapted to the engine's size. Certain weapons are powered by compressed air instead of steam, and therefore also require a connected and enabled compressor in order to function.

Regardless of the engine connected, a character must also take either a swift or a move action (her choice) to open or close valves to the connection in order to enable or disable the engine, at which point the boiler's total minimum required Pool value also may increase or decrease. Even though an engine may have no Pool requirement at all, it still needs to be connected and enabled before its special function can be activated. Likewise, an engine needs to be disabled before it can be disconnected.

2.5 Regaining PrP

As long as a boiler has a working heat source and water in its tank, it regains a set number of PrP at the beginning of the user's turn, up to its maximum Pool value. The number of PrP regained depends on the boiler's size, type and installed accessories, detailed in the item descriptions. Any PrP regained which exceeds the maximum Pool of the boiler are lost.

2.6 Size Categories and Pressure Points

The PrP a steam boiler provides are dependent on the boiler's size category relative the size category of connected engines. When the size of the boiler matches the size of the connected engines, the boiler's listed Pool and PrP regain rate remain unchanged, while the values are doubled if the boiler powers engines one size category smaller, and they are halved if it powers engines one size category larger. For example, a medium sized boiler pack has a maximum Pool of 4 PrP for connected medium sized engines, 8 PrP for connected small sized engines, or 2 PrP for large sized engines. Unless otherwise noted, all PrP mentioned in the item descriptions and elsewhere in this document refer to medium sized items.

As per the standard rules for item sizes, the cost of a small sized boiler (or any other steam item) is the same while its weight is half that of a medium sized one, and both the cost and weight of a large sized boiler is twice that of a medium sized one.

2.7 Steamcraft - Creating Steam Items

Like many other extraordinary devices such as clockwork items, exotic weapons and siege engines, steam items are difficult to craft, but their creation depend just as much on theoretical knowledge as on practical craftsmanship. Instead of using a separate Craft skill, a character attempting to craft a steam item makes a Craft check using her choice of Craft skill used for creating metal items (such as Craft (armor), Craft (clockwork), Craft (jewelry) or any other at the GM's discretion), but she only counts as many of her ranks in the chosen Craft skill as she also has ranks in Knowledge (engineering). Certain items require that a specific Craft skill is used when making a check to create the item, noted in parenthesis as normal. Steamcraft is otherwise treated in the same manner as any existing Craft skill, the term indicating that these special crafting rules apply when mentioned elsewhere in this document.

Complete steam items are too complex to be created or assembled through magic means, regardless of caster levels or skill ranks, but individual parts (see blue box) can be created using the appropriate spell and Craft skill check. It is also difficult to craft or properly repair steam items without an engineer's toolset or a mechanical workshop, and a character using improvised tools takes a -5 penalty to Craft checks instead of the the normal -2. The mechanical workshop and engineer's toolset are detailed in chapter 7. Associated Items.

Steam Item Parts

Parts of a steam item can be crafted separately, each part corresponding to 10% of the complete item in costs and weight, and having the same Steamcraft check DC as that of the entire item.

Installing or replacing a single part requires 30 minutes of work and a successful Steamcraft check with a DC equal to creating the item -5. Besides the loss of time, there are no penalties for failing checks made to install or replace parts and a character may make as many attempts as she likes. Parts can also be used to quickly repair a damaged steam item, each replaced part restoring 10% of the item's maximum Hit Points.

Parts can sometimes be found for sale in larger cities, but they are typically more rare than complete items.



- 3. Boilers and Accessories -

3.1 Boilers and Boiler Accessories Table

Steam Boiler Types	Cost in gp	Weight	Maximum Pool / Pool regain (S)	Maximum Pool / Pool regain (M)	Notable Features
Boiler Pack	600	10 lbs.	2 / 1 PrP/round	4 / 2 PrP/round	Basic portable boiler
Auxiliary Armor Boiler ^A	5,000	5 lbs.	see text	3 / 2 PrP/round	Used by itself or with other boiler, part of armor
Boiler Pack, Adamantine	7.200	12 lbs.	4 / 2 PrP/round	8 / 4 PrP/round	Superior portable boiler
Steam Boiler Accessories					
Compressor	400	+3 lbs.	-	-	Allows boiler to power compressed air weapons
Boiler Integration ^A	500	-4 lbs.	-	-	Makes a boiler pack become a part of medium or heavy armor
Heat Exchanger	1,200	+3 lbs.	see text	+1 / -	Decreases ACP and water loss, required for superheater
Superheater ^{A, W}	1,800	+2 lbs.	see text	- / +1 PrP/round	Improves Dex to AC, weapon range, and PrP regain
Flash Boiler	2,800	-2 lbs.	see text	+1 / +1 PrP/round	General performance

A, W - Additional properties listed in (A) 4.3 Powered Armor, Shield and Extras Table and/or (W) 5.3 Melee Weapon Extras Table

3.2 Heat Bricks

Intense heat radiates from this small cube, seemingly made of opaque grey glass.

Steam boilers are heated by these small extremely hot bricks. A heat brick is usually sold installed, the price of the brick included in the item's listed price. The costs listed here are used when crafting boilers or replacing a depleted brick one year after the item was purchased.

200 gp (large 1 cubic inch), **140 gp** (small 1/2 cubic inch), superheated versions cost three times as much

3.3 Boilers - Item Descriptions

Auxiliary Armor Boiler

The perfected mithral components of this boiler are bolted directly to armor, spread out to distribute its weight.

This boiler is attached to medium or heavy armor (as if using boiler integration accessory), allowing two boilers to be used as if they were one. The boiler can be used on its own, or as an accessory to a main boiler also attached to the armor (using the boiler integration accessory). As an accessory, the main boiler gains the auxiliary boiler's maximum Pool and regain as bonuses.

An auxiliary boiler can only power engines of its own size, using the maximum Pool and regain values of a medium boiler as if already adjusted for size.

Attaching the boiler to armor requires 1 day of work and a

[&]quot;The boiler forms the heart of a steam powered machine, heating water to feed its engines with hot steam."

⁻ HE Margany V. Ortems

DC 15 Steamcraft check, but the work is usually a service provided by the seller and included in the price.

No accessories can be installed in an auxiliary boiler and its water tank allows for five days of operation, but its function is otherwise identical to a boiler pack.

Maximum Pool 3, 2 PrP regained/round

5,000 gp; 5 lbs. (incl. 1 lbs. water) (mithral only) Steamcraft DC 25, 2,400 gp (plus large heat brick) Hardness 15, 10 Hit Points

Boiler Pack

Hissing and smoking hot tubes and pipes in steel, cast iron and brass make up this odd-looking device.

A boiler pack is carried like a backpack, including everything needed to power portable engines: a water-tube boiler, a condensator and a water tank. These hardened metal components are tightly secured to a sturdy frame partially clad in clay and tough hide to keep the heat away from the user. The water tank holds two pints of water, enough for 24 hours of operation before the tank needs to be refilled. A boiler pack can also give off heat comparable to that of a small camp fire, allowing the boiler to be used for cooking and warmth without smoke or light.

A creature can use a boiler pack one size category smaller than that of the creature's own size, without incurring any penalties beyond the boiler's decreased capacity. However, such a boiler pack must be adapted before the user can connect engines of a size matching its own. Adapting for larger sized engines requires 8 hours of work and a Steamcraft DC 20 skill check. Boiler packs cannot be made smaller than small or to simultaneously power engines of different sizes.

A small boiler pack is heated by a small heat brick, and a large one by two large heat bricks (affecting the cost of crafting). The unwieldy nature of a boiler pack also means a creature cannot use more than one boiler pack at a time, regardless of sizes. A medium boiler pack is roughly 14 inches high, 10 inches wide and 8 inches deep, independent of installed boiler accessories.

Maximum Pool 4, 2 PrP regained/round

600 gp; 10 lbs. (incl. 2 lbs. water) Steamcraft DC 18, 200 gp (plus large heat brick) Hardness 10, 12 Hit Points

Boiler Pack, Adamantine

This small engine pumps air into a pressure chamber, powering devices such as liquid guns.

Several of this superior boiler pack's components are made in adamantine, allowing for the pressure generated by a superheated brick and a water tank that lasts for five days.

The function of an adamantine boiler pack is otherwise identical to a regular boiler pack.

Maximum Pool 6, 3 PrP regained/round

7,200 gp; 12 lbs. (incl. 2 lbs. water) (adamantine only) Steamcraft DC 25, 3,300 gp (plus large superheated brick)

Hardness 20, 16 Hit Points

3.4 Boiler Accessories - Item Descriptions

Unless otherwise noted, only one accessory of each type can be installed in a single boiler.

Compressor

This small engine pumps air into a pressure chamber, powering devices such as liquid guns.

Though technically a small engine, a compressor counts as a boiler accessory as it forms an integral part of the boiler it is installed in and requires no PrP.

Benefits: Items using compressed air can use the PrP produced by the boiler.

Installation: 1 hour of work, DC 10 Steamcraft

200 gp; 2 lbs.

Steamcraft DC 18, 100 gp

Flash Boiler

This bundle of fine mithral pipes replaces the standard water-tube boiler, turning water into steam "in a flash" while also increasing pressure.

Benefits: A flash boiler provides the following benefits to the boiler:

- Maximum Pool increases by +1
- Pool regain increases by +1 PrP/round
- Weight is reduced by 2 lbs.

Special: A flash boiler in small size can only be installed in a boiler made to power small sized engines, reducing the boiler's weight by 1 lbs.

Installation: 2 hours of work, DC 20 Steamcraft **2,800 gp; 2 lbs. uninstalled** (mithral only) Steamcraft DC 25, 1,400 gp

Heat Exchanger

This multi-finned device in mithral cools the exhaust steam of the connected devices before returning it to the boiler's condensator.

Benefits: Up to two heat exchangers can be installed in a boiler, each one providing the following benefits:

- Decreases the boiler's loss of water, the tank lasts for five additional days
- The boiler's maximum Pool increases by +1
- Allows for one superheater to be installed
- The armor check penalty of enabled heavy powered armor or powered shield, or an increased penalty caused by powered armor additions in a combined set, decreases by -1 in total (to a maximum value of 0)

Special: A heat exchanger cannot be made in sizes smaller than medium, but when installed in a small boiler, one medium sized heat exchanger provides the same benefits two small heat exchangers would.

Installation: 1 hour of work, DC 15 Steamcraft **1,200 gp; 2 lbs.** (mithral, medium size or larger only) Steamcraft DC 20, 600 gp

Superheater

By further heating the steam, this miniature boiler in adamantine increases pressure regain speed and reduces resistance caused by water droplets inside engines.

Benefits: One superheater provides the following benefits:

- The boiler's Pool regains +1 PrP/round
- For every 20 feet of normal range, the first range increment of ranged weapons increases by +5 feet

Two superheaters also provide the following benefits:

- The boiler's Pool regains +1 PrP/round
- The maximum Dexterity bonus to AC of enabled heavy powered armor or powered shield, or a reduced bonus caused by powered armor additions in a combined set, improves by +1

Special: A boiler needs to be equipped with one heat exchanger per superheater installed.

Special: A superheater cannot be made in sizes smaller than medium, but when installed in a small boiler, one medium sized superheater provides the same benefits two small superheaters would.

Installation: 1 hour of work, DC 15 Steamcraft **1,800 gp; 2 lbs.** (adamantine, medium size or larger only)

Steamcraft DC 22, 690 gp (plus small superheated brick)



The "Motörhead locomotive" may look like an unintended side-effect of releasing a horny balor in a train museum, but it's obviously steam powered. Which proves beyond doubt that steam power rocks. Hard. Ask Lemmy.

Stenm Powered Armor

- 4. Armor Suits, Additions, Shields and Extras -

"Several portable steam engines are actually parts or suits of armor, allowing the wearer to carry enormous weights, move with astounding speed or even take to the air. In this chapter, I will name the most important of these "worn" inventions. Be it the famous Gorilla Jacket or the mighty Dreadnaught armors, I shall also fully explain the workings of these fantastic devices, sometimes quoting their original inventors."

- HE Margany V. Ortems

4.1 Powered Armor Additions Table and Rules

Light Powered Armor Addition ¹	Cost in gp	Space	Armor bonus	Max Dex	Check penalty	Arcane spell failure chance	Weight	Pool req. / activation
Ballistic Boots	500	feet	-	0 (-2)	-1 (-3) ²	-	- (+10) lbs.	- / 1 PrP
Gadget Gloves	800	hands	-	-	- (-1)	+10%	+3 lbs.	minor / 1 PrP
Terrain Runners	1,400	legs	+1	-1 (-2)	-1 (-2) ²	-	- (+10) lbs.	minor / 1-2 PrP
Bull Band	1,500	head	+1	-1 (-3)	-1 (-3) ²	-	+5 lbs.	minor / 1 PrP
Gorilla Jacket	2,300	body	+1	- (-3)	-2 (-3) ²	+15% (+25%)	+7 (+15) lbs.	+1 / 1 PrP
Pugilist Pistons ^w	2,600	hands	+1	- (-1)	-1 (-2)	+20% (+30%)	+4 lbs.	+1 / 1-4 PrP
Medium Powered Armor Addition								
Jet Pack	15,000	-	-	see text	see text	-	+15 lbs.	0-4 / 1-4 PrP
Turbine Boots	2,000	feet	+1	-1 (-3)	-2 (-3)	-	- (+15) lbs.	+1 / 1-2 PrP
Iron Grip Gauntlets	3,000	hands	+1	- (-2)	-2 (-3)	+25% (+40%)	+6 lbs.	+1-2 / 1-2 PrP
Actuator Greaves	3,500	legs	+2	-1 (-4)	-2 (-4)	-	+5 (+20) lbs.	+1 / 1-3 PrP
Steam Skeleton	4,000	body	+3	-2 (-5)	-3 (-5)	+15% (+30%)	+5 (+30) lbs.	+2 / 1-2 PrP

Light powered armor additions can be used by a monk who has the AC Bonus class feature and wears no other armor. Such a monk may wear one light addition for every three monk levels, without affecting the AC Bonus feature or having to attach the additions to a suit of armor.

Powered additions are steam engines attached to regular suits of armor, granting benefits typically related to body movements, and often also providing an additional armor bonus to AC. Additions count as light or medium armor, affecting which suits of armor the addition can be attached to and the category of the resulting combined

The table lists the available powered armor additions with the following exceptions and additions to the standard armor tables and rules:

 A character with no ranks in Knowledge (engineering) takes a -1 penalty to Dexterity per light armor addition worn.

² While the addition is enabled, the armor check penalty only applies to Dexterity checks and Dexterity-based skill checks

W Additional properties listed in 5.1 Powered Melee Weapons Table

set (further detailed in "Combining and Attaching Additions" below).

- A character with less than 5 ranks in Knowledge (engineering) takes a -2 penalty to Dexterity per medium armor addition worn.
- "Space" is the part of the wearer's body the addition occupies. No two additions worn can occupy the same space (see also "Combining and Attaching Additions").
- Any armor bonus a powered addition provides, as well as the listed decreased maximum Dexterity bonus and increased armor check penalty, arcane spell failure chance and weight, alters the corresponding values of the suit of armor the addition is combined with (the values stack).
- "Pool req. / activation" is the armor addition's Pool requirement and the PrP spent when the wearer activates its special function.
- The values in parenthesis are the greater restrictions and weight of a disabled or broken powered armor addition. The weight given in parenthesis is also the actual weight.

A powered armor addition is always of masterwork quality, the related costs and benefits already included in the values listed in the table.

Combining and Attaching Additions

A set of armor combining a light powered armor addition with a light suit of armor counts as medium armor, and a set combining a light addition with a medium suit counts as heavy armor. Likewise, a set combining a medium addition with a light suit counts as heavy armor. Medium additions can normally not be attached to suits heavier than light, and light additions not to suits heavier than medium (see also "Additions in Special Materials").

A combined set can include more than one addition, provided the set counts as heavy armor or lighter and no two additions occupy the same space (space has no bearing on magic item slots or other mechanics). An addition cannot be enchanted as armor, but the combined set can be enchanted as normal, and a suit retains its enchantments if an addition is attached or removed.

Attaching or removing an addition to a suit of armor requires 2 hours of work and a Steamcraft check, the DC equal to the steam addition's Craft DC -10.

Additions in Special Materials

An addition is restricting primarily because of its mechanized parts, and the values for decreased maximum Dexterity bonus and increased armor check penalty and arcane failure chance therefore remain the same, regardless of the material it is made of.

In general, a combined set of armor is considered to be of the material the suit is made of and uses the properties of that material. This does not apply to weight, which is calculated according to the material of the suit and each addition separately, or to a change of armor categories caused by a special material.

If an addition, suit or both are made of a metal which makes armor count as a lighter category, such as mithral, the number of possible set combinations are increased, as shown with the resulting categories of the possible armor set combinations in the table below. A combined set is treated as a suit of armor for the purpose of determining the resulting category of attaching more than one powered armor addition.

	Mithral light suit	Light or mithral medium suit	Medium or mithral heavy suit	Heavy suit
Mithral light addition	Light set	Light set	Medium set	Heavy set
Light or mithral medium addition	Light set	Medium set	Heavy set	n/a
Medium addition	Medium set	Heavy set	n/a	n/a

4.2 Armor Additions - Item Descriptions

Actuator Greaves

These articulated metal frames are strapped to your legs, improving your speed and maneuverability.

Continuous: +1 Pool requirement, your base speed increases by +5 feet.

Activation: 1-3 PrP spent as part of a charge, run or withdraw action, each spent PrP grants:

- One 45 degrees change of move direction
- A +10 feet bonus to speed (in addition to the continuous bonus)
- A +2 dodge bonus against attacks of opportunity provoked by the movement
- A +1 bonus to combat maneuver checks made as part of a charge

3,500 gp, medium powered armor addition

Powered additions can only be made of metal, and the added cost of an addition in a special material is half that of a normal suit of armor of the corresponding category.

Steamcraft DC 25, 1,750 gp

Ballistic Boots

Several pistons are attached to the sides of these sturdy boots, greatly increasing your ability to jump.

Continuous: no Pool requirement, you gain a +2 circumstance bonus to Acrobatics checks made to jump. **Activation:** 1 PrP spent as part of an Acrobatics check made to jump, the DC is halved and the jump distance may exceed your maximum movement by 20 feet.

Bull Band Synergy:

Activation - Leaping Charge - if you activate both items as part of a charge and still have jumping distance left at the end of the movement, the bull band's bonus increases to +6, and you count as if one size category larger for the purpose of determining whether a target can be affected by the bull rush.

500 gp, light powered armor addition Steamcraft DC 15, 250 gp

Bull Band

The three pistons of this device are attached to the neck of your armor and support a broad metal headband, allowing you to make powerful head-first charges.

Continuous: minor Pool requirement, you gain a +1 circumstance bonus to bull rush combat maneuver checks.

Activation: 1 PrP spent as part of a bull rush combat maneuver, increasing the circumstance bonus to the combat maneuver check to +4.

Ballistic Boots Synergy:

• Activation - Leaping Charge - see the ballistic boots item description.

Steam Horns Synergies:

- Continuous you gain the powerful charge special attack; the steam horn's gore damage dice are doubled when you use them to make a gore attack at the end of a charge.
- Activation Bull Charge activating both the steam horns' extra gore attack and the bull band at the end of a charge allows you to make both the gore attack and a bull rush. You make the gore attack just before the bull rush check.

1,500 gp, light powered armor addition Steamcraft DC 20, 750 gp



"The Muspel is a short range steam engine weapon of unrivaled versatility, each of its three barrels able to cover an area or pinpoint a target with several different types of substances or projectiles. The barrels and intricate construction makes it an unusually heavy and expensive weapon, but also absolutely terrifying in the hands of a competent wielder. Its name, which literally means "world destroyer", is remarkably suitable.

In the illustration above, note the three globules on the top of the weapon which holds alchemical liquid ammunition, the dial on the side for changing between the many pressure and ammunition settings, and the connection sockets on its belly, each one providing a barrel with steam or compressed air."

- HE Margany V. Ortems

Gadget Gloves

Compartments at the back of the hands and clever attachments to the fingers of these odd gloves provide you with several small steam powered tools of high quality.

Continuous: minor Pool requirement, the gloves count as a set of masterwork thieves' tools and a set of masterwork Artisan's tools, the Craft skill decided at the time of the gloves' creation. The tools grant you a +2 circumstance bonus to the associated skill checks.

Activation: 1 PrP spent as part of an associated skill check that requires between one full-round action and ten rounds of activity, increasing the circumstance bonus to +4. 1 additional PrP may be spent to quicken the activity; two or more rounds of activity are reduced to half the number of rounds, a single 1-round action to a full-round action, and a single full-round action to a standard action.

800 gp, light powered armor addition Steamcraft DC 18, 400 gp

Gorilla Jacket

This complex scaffolding of articulated bars, wires and small pistons surrounds your upper body and arms, giving you steam powered strength and speed when grappling.

Continuous: +1 Pool requirement, you gain a +2 bonus to strength checks, strength-based skill checks, grapple combat maneuver checks, and to your combat maneuver defense against grapple attempts.

Activation: 1 PrP spent as an immediate action when an opponent you have grappled makes an attack, or casts a spell or uses a spell-like ability with a somatic or verbal component. As a part of the action, you can make a grapple combat maneuver check against the grappled opponent, and if successful, you prevent the opponent's triggering action from being completed. This immediate grapple check do not gain the normal +5 bonus for

subsequent checks, and a success has no other effect.

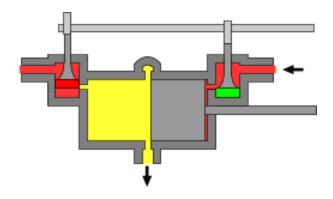
Iron Grip Gauntlets Synergies:

- Continuous while two-weapon fighting, once per round you can add your full strength modifier to the damage roll of your off-hand weapon instead of 1/2 your strength modifier.
- Activation Twin Strike when taking a full-round or standard action which includes a single weapon attack (such as the attack action, a charge or spring attack) while two- weapon fighting, 1 PrP spent by each item as part of the action allows you to make one main hand attack and one off-hand attack. Both attacks receive any temporary bonuses that normally would apply to the replaced single attack (such as that of the Vital Strike feat), except if explicitly limited to one attack per round or turn.

Pugilist Pistons Synergy:

- Continuous once per round, you may add the grab ability to an unarmed strike hit that also gains the pugilist pistons' continuous bonus.
- Activation Power Jab when you hit an opponent with two or more unarmed strikes that gain the pugilist pistons' continuous bonus during the same turn, 1 PrP spent by each item grants you a free additional such unarmed strike against the same opponent.

2,300 gp, light powered armor addition Steamcraft DC 20, 1,150 gp



The workings of an advanced continuous uniflow engine.