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Research article

Hegel on the Steam-Engine

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Abstract

Hegel did not witness the unveiling of the granite bowl in Berlin's city center, which was crafted and polished using steam engine technology. His comprehension of the steam engine significantly impacted the evolution of scholarly thought in Europe around 1800. While Hegel's works did not explicitly delve into the "steam engine" as a complete concept, his examination of its parts, "steam" and "machine," was very thorough. In natural philosophy, Hegel meticulously detailed steam as an individual physical element, from the ancient Greek theory of four elements to modern meteorology. While he discussed the relationship between steam, air pressure, and heat, he did not address the perspective of the steam engine in technical applications. Instead, he continuously engaged in reflection at the scientific level of the relation between physical elements and individual objects, arising from the dynamic interaction between concepts and real-world objects within the framework of dialectics. Therefore, Hegel's understanding of the steam engine embodies his concept of "pre-scientific hermeneutics," involving continuous reflection of concepts and reality through empirical validation. He thus drew on contemporary meteorological research to demonstrate the dialectical relationship between physical elements and individual bodies, as well as the laws of motion that constitute meteorological elements such as air and water. However, in a complex and variable climate, these motions could be transient and incidental. And so, in his exploration of the scientific principles of the "steam engine," Hegel did not delve into the transformation of these principles into technology or the resulting revolution in social productivity and the accompanying societal ramifications.

Keywords: Steam; Machine; Atmospheric pressure; Heat; Dialectics

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Научная статья

Гегель о паровом двигателе

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Аннотация
Гегель не был свидетелем открытия гранитной чаши в центре Берлина, которая была изготовлена и отполирована с использованием технологии парового двигателя. Однако его понимание парового двигателя существенно повлияло на эволюцию научной мысли в Европе около 1800 года. Хотя в работах Гегеля не рассматривалась явно “паровая машина” как целостная концепция, его исследование ее частей, “пара” и “машины”, было очень тщательным. В натурфилософии Гегель подробно описал пар как отдельный физический элемент, от древнегреческой теории четырех элементов до современной метеорологии. Хотя он обсуждал взаимосвязь между паром, давлением воздуха и теплом, он не затрагивал перспективу парового двигателя в технических приложениях. Вместо этого он постоянно углублялся в рефлексию на научном уровне об отношениях между физическими элементами и отдельными объектами, вытекающими из динамичного взаимодействия между концепциями и реальными объектами в рамках диалектики. Поэтому гегелевское понимания парового двигателя воплощает его концепцию “донаучной герменевтики”, предполагающую постоянное отражение концепций и реальности посредством эмпирической проверки. Таким образом, он использовал современные метеорологические исследования, чтобы продемонстрировать диалектические отношения между физическими элементами и отдельными телами, а также законы движения, составляющие метеорологические элементы, такие как воздух и вода. Однако в сложном и изменчивом климате эти движения могут быть преходящими и случайными. Итак, в своем исследовании научных принципов “парового двигателя” Гегель не вникал в трансформацию этих принципов в технологию или в возникшую в результате революцию в общественной производительности и сопутствующие социальные последствия.

Ключевые слова: Пар; Механизм; Атмосферное давление; Тепло; Диалектика

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INTRODUCTION

In the Winter Palace of Saint Petersburg, resides a unique piece of artistry. It is an oval bowl crafted from jade, known as the "Tsar of Bowls" (Kolesar, 2006). This jade bowl, made from Revnev jade (Russian: Ревневская яшма / Revnevskaja jaschma), dates back to the period between 1820 and 1843. The creation of this artifact relied entirely on manual labor, including years of painstaking polishing and refining, and its transportation required the effort of 720 barge haulers. This stands in stark contrast to the "Granite Bowl" located near Humboldt University in Berlin, crafted during the same period, which was processed using steam engine technology, symbolizing the technological advancements of the era. The production and transportation processes of both bowls not only reflect the level of technological productivity of the time but also mirror the cultural and technological shifts of the era. It is within this context that the philosophy of Hegel unfolds, his theories intricately linked to the technological innovations of the era, particularly the steam engine.

STEAM ENGINE POLISHED "GRANITE BOWL"

In Berlin's "Lustgarten," an impressive historical relic prominently stands in front of the Altes Museum: a massive granite bowl, weighing 75 tons and measuring 22 feet (6.9 meters) in diameter. This exemplary piece of early 19th-century Prussian craftsmanship (Einholz, 1997), was meticulously crafted between 1827 and 1828 by numerous artisans, with the assistance of engineering tools such as capstans. The granite boulder, once cut, was transported to Berlin via the Spree River. Over the following years, this bowl underwent precise polishing and finishing, aided by a ten-horsepower steam engine (fig. 1). This process not only showcased the technological advancements of the time but also reflected the unique cultural ethos of the region, leading the people of Berlin to humorously nickname it "Berlin's Largest Soup Bowl" (Suppenschüssel). Even Johann Wolfgang von Goethe, the literary giant of that era, bestowed a special name on this piece – the "Granite Basin" (Granitbecken) (Goethe, 1828), further emphasizing its emblematic status in the social and cultural milieu of the period.

I would suggest three primary reasons for Prussia's keen interest in using artificial stone to create landmarks within urban landscapes in the 19th century. Firstly, following the French Revolution, Classicism emerged as the dominant artistic style in Europe. German architect Karl-Friedrich Schinkel, a representative of German Classicism, utilized Greek temple architectural elements to shape the entire cityscape of Berlin, the capital of the Prussian monarchy. In this context, the granite bowls served as "imperial signifiers" in the urban landscape of that era (Einholz, 1997). Secondly, there is the association between granite and the Biedermeier style. In German, "Biedermeier" conveys the idea of an "upright and simple" citizenry, representing an artistic style that emerged from a self-aware citizenry. The aesthetic orientation of this style, as seen in its portrayal of family themes, clear design, and choice of building materials, also mirrored the optimism of the middle class in the industrial era toward technological progress.

Lastly, the victory of the feudal nobility over Napoleon led to a cautious critical attitude among the intellectual class, prompting German philosophers to turn inward and embrace Romanticism. This position valued the inner world, emotions, passion, and mysticism, endeavoring to construct philosophical systems within the realm of personal life. Against the backdrop of the Carlsbad Decrees and the political conditions in Prussia at the time, Hegel's legal philosophy, though somewhat conservative in form, had already been integrated as the objective spirit in his *Encyclopedia* (1817, in manuscript form, Hegel, 1974).

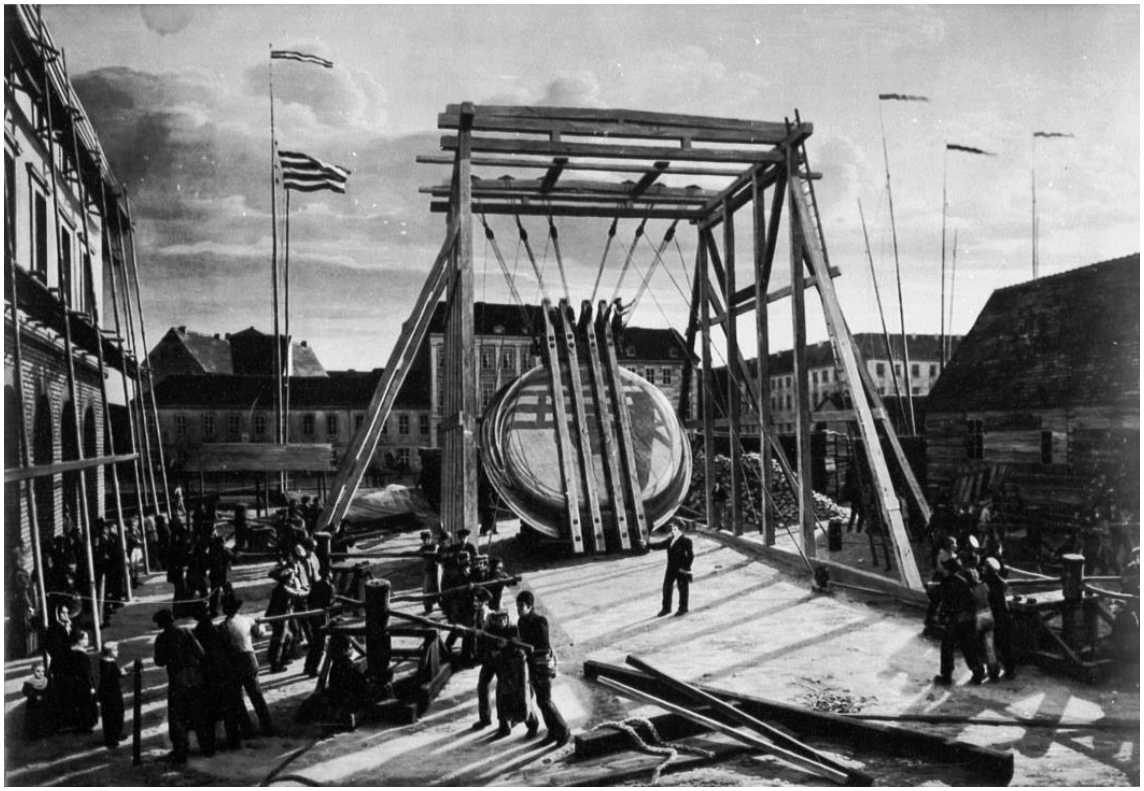

Figure 1. *Aufrichtung der Granitschale im Packhof zu Berlin* (Erection of the Granite Bowl in the Berlin Packhof). This is one of three paintings by Johann Erdmann Hummel which documented the polishing, erection, and final display of the granite bowl, highlighting how 19th century Berlin is literally mirrored in the industrially manufactured bowl. (The original painting from 1831 was destroyed in 1945. This pre-1940s photograph is in the public domain at commons.wikipedia.org.)

In his publication On the English Reform Bill (Über die englische Reform bill) in 1831, Hegel explicitly mentioned the “steam engine” for the first and only time. He stated: “The English mob committed an act of extreme folly, specifically targeting a certain entity for special interests – the destruction of the steam engine” (Hegel, 1970d, p. 553). Despite seldom mentioning the steam engine in his writings, its use and impact in the

reality of that time, particularly in Berlin where Hegel resided, were significant. This reveals an important historical fact: Despite Hegel's works not delving deeply into the steam engine, this technology had become an indispensable part of industrial and everyday life in the 19th century, exerting a profound influence on Hegel's era.

Geographically, during Hegel's time in Berlin from 1828 to 1831, his residence at Am Kupfergraben 4a was near the iconic granite bowl, with Humboldt University, where he taught, just separated by a river. Unfortunately, Hegel succumbed to cholera on November 14, 1831, the same day the granite bowl was unveiled in front of the Altes Museum (Einholz, 1997). As a result, it is probable that he only heard about the transportation, processing, polishing, and finishing of the granite bowl, and never witnessed its completion. This presents an interesting phenomenon: Despite living in an era of rapid technological advancement, Hegel, as a philosopher, may have kept a certain distance from the assimilation of technology with official narratives. This leads to the question: At what point in Hegel's philosophical texts did the steam engine, a pivotal achievement of the Industrial Revolution, become a part of effective knowledge in the realm of typical philosophical thinking? To address this, one must delve into Hegel's philosophical writings to examine how he addressed the issues of "steam" and "machinery."

HEGEL ON STEAM

In Hegel's *Encyclopedia of the Philosophical Sciences: Part One* he classifies the science of philosophy into three main groups: I. Logic, which centers on the science of the idea in itself and for itself, which is essentially the form of pure thought. II. Philosophy of Nature, which examines the science of the idea in otherness or externality, linking concepts with the corresponding realms of objects in the real world. III. Philosophy of Spirit, exploring the idea of returning to the self from otherness (Hegel, 1970b, p.63). This division highlights Hegel's view of the Philosophy of Nature as a dynamic developmental process based on the latest scientific research findings of his time. He stresses that philosophical science must be consistent with natural experience. Also, its genesis and development are predicated upon and conditioned by empirical physics. Furthermore, Hegel points out the limitations of traditional physics from the perspective of the Philosophy of Nature, emphasizing that concepts within this domain are directly related to their corresponding realms of objects within a certain scope in the real world.

In his *Encyclopedia of Philosophical Sciences: Part Two*, which was published in 1830, Hegel categorized the philosophy of nature into three distinct domains: Mechanics, Physics, and Organic Physics. From his Jena period onwards, Hegel dedicated years to extensive research in the field of natural philosophy. The fundamental concept of Hegel's natural philosophy is articulated in section 281 of *Encyclopedia of Philosophical Sciences: Part Two*: "Individual bodies contain various specific determinations of the totality of elements as their subordinate links. These determinations exist directly in a

free, self-determined form within the bodies; hence, they constitute the universal, physical elements of individual bodies" (Hegel, 1970c, p.158). Here, with the term "physical elements" Hegel primarily refers to air, fire, water, and earth. Unlike the concept of elements in Mendeleev's periodic table, Hegel's "physical elements" primarily relate to differences in the number of basic states of matter, rather than qualitative differences. Therefore, the differences between air, fire, water, and earth lies mainly in the differences in states of matter aggregation: fire symbolizes energy (referencing Plato's *Timaeus* and Heraclitus), water represents the properties of liquids (referencing Thales), air signifies the form of the atmosphere (referencing Anaximenes), and earth denotes the solid state. Pirmin Stekeler suggests that the differences among these four elements are "conceptual-logical" (Stekeler, 2023).

In subsequent discussions, Hegel mentioned that "physical elements are a kind of actuality, not yet dissipated into abstract chemical entities" (Hegel, 1970c, p. 159). To understand the concept of "matter dissipated into abstract chemical entities" (zur chemischen Abstraktion verflüchtigte Materie), it is first important to recognize that among the four elements – air, fire, water, and earth – gas is primarily associated with the property of dissipation (volatilization). Secondly, "abstract chemistry" refers to the transformation of matter (Verwandlung), following the principle of equivalent exchange. Hegel points out: "The predominant concept in Empedocles' philosophy, and one that first appeared in his philosophy, is that of combination or synthesis. As a combination, it presents for the first time the unity of opposing entities" (Hegel, 1970e, p.346). The "synthesis" (Synthese) or "combination" (Vermischung) that Hegel discusses here refers to this kind of material transformation. The most direct manifestation of this transformation (Verwandlung) is not air, fire, or earth, but water. Water can exist in three states: liquid, solid, and gaseous.

I understand Hegel's analysis in section 282 of the *Encyclopedia of Philosophical Sciences* regarding air as a form of negative universality. In section 283 concerning fire's negating and destructive qualities, it becomes evident why he shifts his focus to water in section 284: "This neutral entity [...] lacks incessant activity in itself, but is entirely the possibility of process, of solubility; moreover, it can assume the form of gas and solid, states beyond its unique condition, beyond its indeterminacy. Such an element is water" (Hegel, 1970c, p. 167). Hegel presents two comparisons here: Firstly, there is the comparison of air and water, both exhibiting elastic characteristics and apparent solubility. Thus, distinguishing between air and water in terms of solubility at a speculative level poses a challenge, necessitating further differentiation through modern natural scientific research. Secondly, there is the comparison of fire and water which are opposites in their processual attributes – fire represents movement and destructiveness, while water symbolizes stillness and the ability to dissolve other substances. Arguably, the solubility of air and water becomes the central theme of Hegel's philosophical discourse after section 284.

Indeed, within section 286 of the *Encyclopedia of Philosophical Sciences*, titled "The Process of the Elements," Hegel articulates a nuanced concept: "Despite contradicting their unity, different elements and their mutual differences are unified within individual identity" (Hegel, 1970c, p. 170). This individual identity establishes a dialectical relation between physical life on earth and meteorological processes. Although intricate, the essence of this statement lies in investigating the relationship between physical elements and individual entities, which is further illustrated in "meteorological processes" (meteorologischen Prozeß). Hegel's discourse encompasses two significant semantic layers. Firstly, it reveals the intricacy of interactions among elements and how these interactions become manifest in broader natural phenomena. Secondly, it highlights the central role of individual identity in these interactions, particularly in maintaining unity amidst diversity. Together, these meanings form Hegel's distinctive perspective on comprehending the natural world.

As previously stated, the terminological concept utilized in argumentation is directly correlated with its corresponding sphere of real-world objects. Within this framework, the concept denotes tangible elements, whereas individual entities constitute the realm of real-world objects. Hegel defines the interplay between these two as a "dialectical relationship." Within this encompassing dialectic, "individual bodies" (individuelle Körper) may exist in varying stages of development, within specific contexts and environments. Hegel observes, "When air and water are subjected to conditions distinct from those of the entire earth, their manifestations in free, elemental connections differ entirely from their manifestations in individualized connections with individual bodies" (Hegel, 1970c, p.172). Therefore, when attempting to comprehend the diverse "individual bodies" originating from "physical elements" (Physikalische Elemente), consideration must be given to their developmental stages, specific contexts, and environments. Here, Hegel's dialectical relationship emerges as the conundrum of reconciling the universality of physical elements with the particularity of individual objects. In the parlance of contemporary social sciences, this pertains to examining the relationship between multiple independent variables and dependent variables.

Secondly, by the 18th century, meteorology had advanced beyond its previous status as a component of astrology and basic pneumatics as proposed by Aristotle. It had established itself as an independent branch of applied physics (Wolf, 1952). Hegel viewed meteorological processes as large-scale chemical processes in nature. He expressed that, "Meteorological processes are the manifestation of individual genesis, where individuality dominates various free qualities that seek separation, bringing them back to a point of concrete unity" (Hegel, 1970c, p. 186). In other words, meteorology during Hegel's time represented the study of the atmosphere as a comprehensive mechanical, physical, and chemical process. If this meteorological knowledge fails to integrate with the specific conditions of empirical objects, it remains merely abstract and lifeless knowledge at the level of understanding. Hegel utilized a wide range of contemporary meteorological research, including studies on humidity, in an attempt to demonstrate,

within the framework of his natural philosophy, the dialectical relationship between physical elements and individual bodies, as well as the laws of motion that constitute meteorological elements such as air and water. However, in a complex and variable climate, these motions could be transient and incidental.

In his *The Jena System*, Hegel discusses the presence of water as humidity (steam) in the air: “The water that turns into the air is different, it contends against the earth” (Hegel, 1986, p. 66). He presents two different viewpoints regarding water dissolved in air: On the one hand, he believes that water can dissolve in the air and condense back into the liquid state through temperature changes; on the other hand, he cites the research of de Lüc and Lichtenberg, who attempted to prove through empirical evidence that air neither dissolves water nor contains dissolved water (compare Lichtenberg & Kries, 1800). During Hegel's time, theories of water vapor primarily consisted of two explanatory models. One is the theory of “elastic” air proposed by Saussure, the other was advocated by de Lüc and Lichtenberg, suggesting that steam is independent and mechanically mixed with air. These theories offer distinct interpretations from the perspectives of chemical dissolution and mechanical mixture, playing different roles in explaining the formation of rain.

Saussure and de Lüc reached different conclusions regarding water evaporation and condensation through their invention and manufacture of instruments. Saussure investigated humidity changes with temperature by enclosing elastic steam, dissolved in air, in an airtight shell (Wolf, 1952), while de Lüc conducted quantitative studies on atmospheric temperature, air pressure, altitude, and humidity. De Lüc critiqued the hypotheses of Leibniz and Bernoulli, emphasizing the non-fixed relationship between fluctuations in atmospheric pressure and the amount of steam in the atmosphere (de Lüc, 1797). Despite using organic media to manufacture hygrometers, de Lüc could not establish an absolute proportional relationship between changes in mass and size of a substance and changes in humidity in the air. Studies like these laid a crucial foundation for the development of meteorology and physics, reflecting the progress in scientific technology of that time.

During Hegel's time, numerous hypotheses regarding the formation of rain were put forth in the field of meteorology, along with extensive observational efforts using various instruments. However, Hegel stressed that the concepts people used, and the physical elements abstracted from them are fundamentally a “process” (Prozess). In his perspective, the earth and climate serve as the tangible bearers of these physical elements. People often mistake physical elements and their processes for individualized objects as they tend to grasp the forms of existence, states of motion, and variables from paradigms or theorems rooted in thought. For instance, in natural science research, there is a tendency to start from physical laws, such as Newtonian mechanics, in order to analyze specific phenomena encountered in experience. Yet, Hegel believed that while physical laws might hold on a subjective level, they require further verification when faced with objective natural objects. This standpoint sharply contrasts with Kant's dualism (the

division between the thing-in-itself and the phenomenon) as upheld in the *Critique of Pure Reason*. Hegel, however, strived to establish a close dialectical relationship between the pure forms of logic and empirical objects in natural philosophy. This close connection is achieved and completed through reflective thinking. In this process of reflection, concepts (the terminological concepts used in argumentation) establish a dialectical relationship with their corresponding realms in the real world, demonstrating Hegel's profound understanding of the relationship between entities and processes, and how he integrates philosophical thought with concrete findings in natural science, proposing a new perspective on truth in the realm of natural philosophy.

HEGEL ON THE STEAM-ENGINE

Hegel's travels in September and October of 1822 took him through Netherlands and Belgium, where he discovered that the steamboat journey from The Hague to London only took 24 hours (Jaeschke, 2016). Although Hegel had only sparingly referenced the concept of the "steam engine" in his writings, in *The Jena System III* he extensively explored the relationship between steam and power, drawing on Dalton's law of evaporation.

Dalton's law of evaporation emphasizes that the rate at which water evaporates from a surface is directly proportional to the disparity between the saturated water vapor pressure and the actual water vapor pressure in the air on the surface. It is inversely proportional to the air pressure above the surface and directly associated with the wind speed above the surface. In essence, Dalton established the relationship between the rate of evaporation from a surface and the various factors on which the evaporation depends (such as wind, air temperature, and humidity), formulating it as a linear function. Within this framework, assuming that steam and air mix in the same container space, this involves the issue of mutual pressure and the movement distance of particles between steam, as an elastic fluid, and air. In a marginal note in *The Jena System III* (Hegel, 1976, p. 65), Hegel cites Dalton's original text. As stated by the editors of Hegel's collected works, this citation comes from the 1803 volume 13 of *Annals of Physics*, published in Halle, titled "Further Discussion of a New Theory on the Nature of Mixed Gases" (Weitere Erörterung einer neuen Theorie über die Beschaffenheit gemischter Gasarten).

First, the section quoted by Hegel mainly explains: "The space occupied by a certain gas is inversely proportional to the pressure it is under. The absolute distance between these particle centers must vary according to different circumstances and is difficult to ascertain; however, in certain cases, it is possible to express their relative distances in different elastic fluids" (Hegel, 1976, p.329).

Second, Hegel highlights in *The Jena System III* the latent energy of vapor as an elastic fluid: "Potential steam, elastic fluid, condenses at a certain temperature, producing more heat than an equal amount of water at the same temperature" (Hegel, 1976, p.67). The actual contact of dissimilar particles in mixed elastic fluids results in interactions between them, akin to the resistance observed in inelastic bodies, creating a polarity-like resistance

between air particles and steam molecules. Hegel observes significant energy released during the process of steam molecules condensing and transforming into water, describing this energy as “free and sensitive.” Furthermore, Hegel references Gren's remarks on Mr. Watt in “Outlines of a Theory of Nature” (Grundriß der Naturlehre), to support the assertion that the thermal content in steam significantly surpasses that in boiling water. Hegel indicates that if the steam is enclosed in a non-evaporating container, its temperature may rise up to 943 degrees (Gren, 1800). With Gren's support, Hegel identifies a physical law in the phenomenon of steam expanding, releasing energy, reducing temperature, and condensing into water: When the cohesive form of a body changes, its energy shifts towards the thermal substance. This law applies to various evaporation phenomena, including the volatilization of mercury and oxidizer reactions. Hegel's examination of this specialized individual physicality emphasizes investigating the relationships of pure quantities of bodies (such as specific gravity) and their cohesive forms, exploring how they ultimately transform into heat or other forms of energy mediums.

Finally, Hegel discovers his exploration of individual physicality within the conceptual framework of “the process of the earth” (der Prozess der Erde). He observes: “The process of the earth is constantly stimulated by the universal self of the earth, which is the activity of light, representing the original relationship between the earth and the sun. Consequently, the process of the earth undergoes further differentiation based on its position relative to the sun, a position that dictates climate and seasons, among other factors” (Hegel, 1970c, p. 178). According to Hegel, the process of the earth will ultimately disintegrate and become a natural existence devoid of self-consciousness. However, within this process lies a crucial phase: the emergence of human life and the actuality of spirit. Human life and spirit can represent the process of the earth within the logic of “being for itself” (Fürsichsein). Therefore, despite Hegel not disclosing the scientific mechanisms behind natural phenomena such as the formation of rain (he only clarifies the cyclical transformation of water and its philosophical implications), his thought shifts from the natural world to the spiritual and rational structure of humans, returning once again to the system of speculative philosophy. This serves as the crux of Hegel's philosophy, demonstrating how he integrates natural scientific phenomena with human spirit and rationality to deeply contemplate and interpret the natural world within his philosophical framework. This approach reflects Hegel's effort to connect the natural sciences with human spirituality and rationality, thereby providing profound insights into the philosophical interpretation of natural processes.

Regrettably, in his exploration of the scientific principles of the “steam engine,” Hegel confined himself to citations and investigation without delving into the transformation of these principles into technology or the resulting revolution in social productivity and the accompanying societal ramifications. In *The Jena System*, Hegel examined the connection between labor and tools, viewing tools as dynamic entities that could only modify nature through human labor. In contrast, machines represented a further conceptual advancement of tools, bringing about not only catastrophic consequences for the natural world but also

deceiving it. Hegel labeled this extreme development of machinery as "the cunning of reason," leading to the alienation of human instincts from nature, enabling nature to exhaust itself (Hegel, 1976, p. 207). In his later work, *Principles of the Philosophy of Law*, Hegel elaborated on the relationship between the division of labor and machine production, noting: "Furthermore, the abstraction of production leads to increasingly mechanized labor, until ultimately, humans can step aside, replaced by machines" (Hegel, 1970a, p. 353). As time progressed, Hegel in his Berlin period recognized the positive impact of machinery on the general welfare of the state, social classes, and division of labor. However, due to cholera, he passed away on the day of the unveiling ceremony of the granite bowl, thus missing the opportunity to firsthand witness the national significance symbolized by the era of the steam engine. The absence is immense for aesthetics, law, and other philosophical considerations in real philosophy, which according to Hegel incessantly progresses and evolves based on the principle of concept and reality.

CONCLUSION

I suggest that Hegel's examination of the steam engine reflects the foundational methodological approach in his philosophical thought. This approach involves establishing a dialectical relationship between concepts (terminological concepts used in argumentation) and their corresponding domains in the real world. These concepts stem from the pure forms of thought in logic; however, the merging of logical concepts with the tangible objects of real philosophy necessitates ongoing reflection for adjustment and refinement. This could partially elucidate why Hegel didn't delve deeply into the technical aspects of the steam engine and its resulting social impacts: His focus was more on the transformation of dialectical relationships among physical elements in natural philosophy and the delineation between specialized individual physicality and the earth's processes. Furthermore, I contend that Hegel's noticeable reduction in lectures and writings on natural philosophy during his time in Heidelberg and Berlin may be ascribed to the challenge of identifying concept-reality correspondences that align with his dialectical trichotomy amidst the significant shifts in scientific research and technological innovation during the early 19th century.

Since the Jena period, Hegel has consistently emphasized the significance of natural science in his philosophy, in addition to being actively involved in the Mineralogical Association and the Physical Society. The substantial incorporation of natural science materials is notably conspicuous in *The Jena System III*. This is undoubtedly influenced by the intellectually stimulating academic environment at the University of Jena. While Hegel initially showed interest in Watt's steam research in his *The Jena System*, this interest did not continue in his later philosophical work. This could be due to geographic limitations, his academic focus on philosophy, or the incomplete industrialization in the Prussian Kingdom where he lived. Regardless of the reason, Hegel's understanding of the steam engine as a machine went beyond the traditional European perspective, which viewed machines as anthropomorphized and ontologized clockwork mechanisms. His perspective

laid the groundwork for the Young Hegelian school and Marx, marking a significant development in the industrialization of machinery.

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