Perpetual motion of the second kind

Jacob Tripler Wainwright

PERPETUAL MOTION

OF THE

SECOND KIND

WAINWRIGHT

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OR

Heat from the Atmosphere a Substitute for Fuel.

BY

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1905

PREFACE.

All important advancements in science have originated as heresy.

This collection of heretical monographs is merely a contribution to science and has proved to be invulnerabla to all attempts by physicists to identify a paradox therewith. Furthermore, thorough explanation and publication can not be identified with charlatanism. In fact, the matter is presented with a sense of duty and to promote education.

The author would also recommend to the attention of savants the recently published very able and heretical observations on this subject by Henri Poincarré, Professor of Mathematical Physics, at the Sorbonne, Paris; and Member of the Institute of France.

It may here be remarked that, the present science of Thermodynamics must perish because founded on hypothesis, and will be rebuilt upon a foundation of phenomena and fact only. For a masterful exposition of the fundamental assumptions which underlie the second law of Thermodynamics, the reader is referred to the published proceedings of the Meeting at Cardiff in 1891, of the British Association for the Advancement of Science; "Report of a Committee, consisting of Messrs. J. Larmor and G. H. Bryan, on the present state of our knowledge of Thermodynamics, specially with regard to the Second Law."

In that Report, the following statement occurs—"A complete mechanical proof of the Second Law would involve a mechanical definition of temperature applicable to all kinds and states of matter, together with an explanation on dynamical or statistical laws of the principle of degradation of energy in *non-reversible* processes, and we are still far from arriving at a satisfactory solution of these problems."

The fourth or last paper included herein not only presents a solution for this particular last mentioned problem, but is the author's *third* demonstration to *disprove* the Second Law.

J. T. W.

THE FALLACY

OF THE

SECOND LAW OF THERMODYNAMICS

AND THE

Feasibility of Transmuting Terrestrial Heat Into Available Energy.

Read July 2, 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

BY

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1902

THE FALLACY

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The Second Law of Thermodynamics was propounded by Sadi Carnot, in the year 1824. Was mathematically *established* by Professors Clausius and Thompson (Lord Kelvin), independently by each, respectively in the years 1850 and 1851, on the same *peculiar* foundation (on laws which are now obsolete) and at a date when the laws of Boyle, Gay-Lussac, and Watt were considered *sufficiently* accurate and applicable to *all* fluids within *practical* limits of temperature and pressure. And both investi gators were *particular* to explain that the mathematical treatment and conclusions therefrom were based upon this *assumption*, which was only approximately correct at best, and applied only to limits of pressure and temperature that were then considered practicable; (Memoirs by Carnot, Clausius, and Thompson) (Translation by Professor Magie, of Princeton University; Harper & Bros., Publishers, New York, 1899).

Subsequently (in the year 1881), Professor Amagat demonstrated that the laws of Boyle and Gay-Lussac are *very far* from being true when the fluid's condition is near the *critical-point.* Also, recent progress in the art of liquefying gases at low temperatures has demonstrated that *practical* limits of temperature and pressure have *increased* to such an extent that the critical-point of many gases is readily attained. Consequently the Boyle and Gay-Lussac law must be abandoned, and Amagat's principle must be substituted. Thus the Thompson and Clausius *assumption* is no longer applicable, and their demonstration is destroyed.

Amagat's demonstration of the impotency of the Boyle and Gay-Lussac law has been universally accepted, but the effect of his demonstration upon the *establishment* of the Second Law of Thermodynamics has not before been observed.

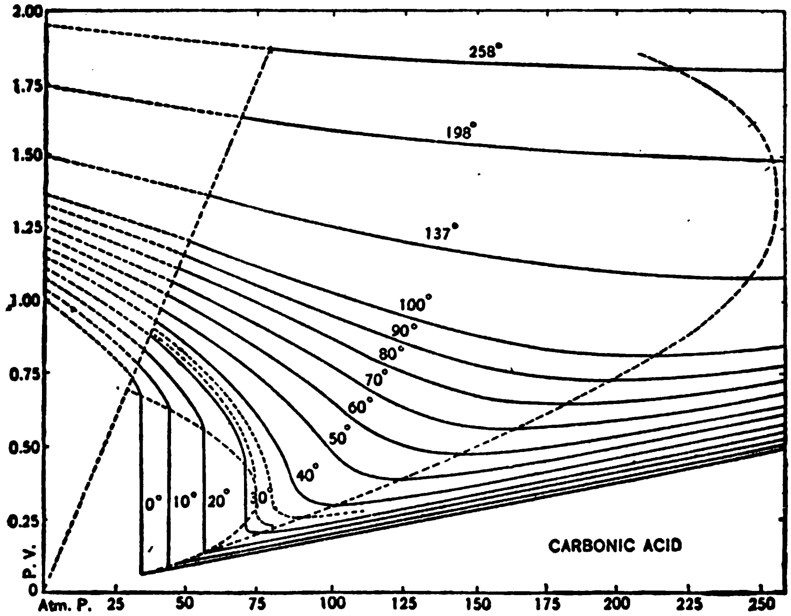


Fig. 6.

Figure 6 is an exact reproduction of a diagram of isothermals relating to carbon-dioxide, made by Amagat (Annales de Chimie et de Physique, 6e Serie, t. xxix. 1893) (Translation by Professor Barus, of Brown University; Harper & Bros. publishers, New York, 1899) and is the result of actual research. The abscissas represent the pressures in atmospheres, while the ordi nates represent the corresponding values of the product resulting from multiplying the pressure by the corresponding volume, otherwise designated as *pv*.

The lowest isothermal shown by Amagat corresponds to the temperature of zero (274 degrees absolute) on the Centigrade-thermometer. Above the critical–pressure, and within the limits of his diagram, this isothermal is practically a straight line which, if prolonged, passes through the origin of ordinates. This shows that, within these limits of pressure, this particular isothermal has *constant volume* for all degrees of pressure. Consequently, at or near this particular *finite* temperature, and within these limits of pressure, this particular fluid (carbon-dioxide) becomes *practically* incompressible or inert, as regards the influence of pressure alone. Thus, this *important* phenomenon is placed beyond dispute.

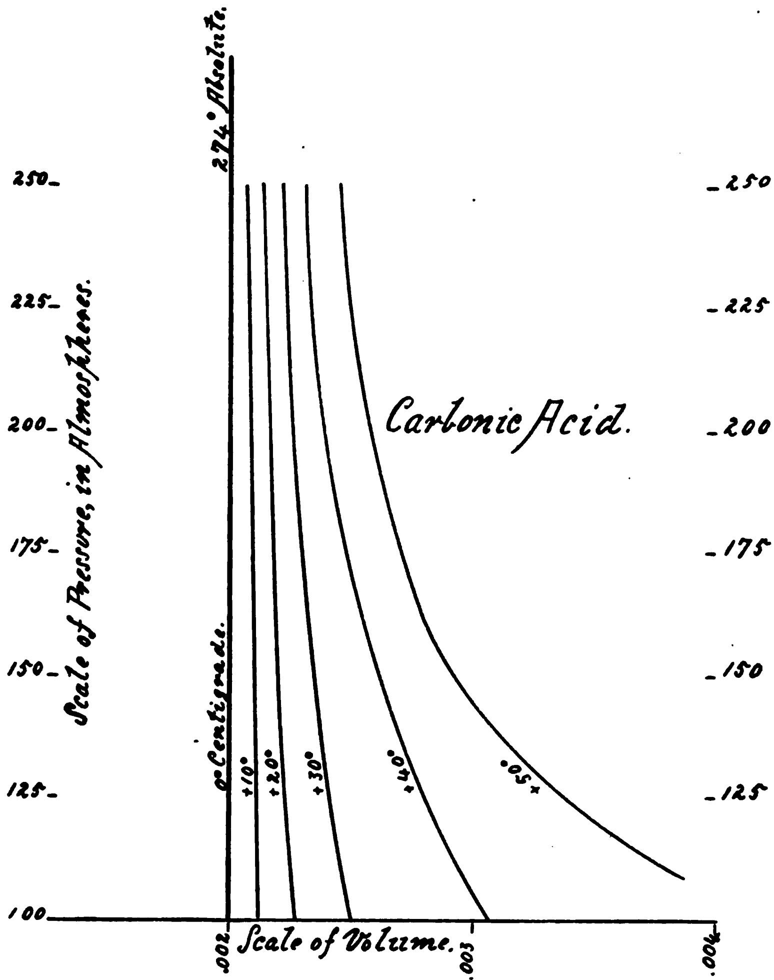


Fig. 7.

This phenomenon does not result as an erratic change in the condition of the fluid, but is the result of a series of gradual and well known changes, and consequently is susceptible to isodiabatic treatment. For the purpose of showing this matter in a more familiar way, I have constructed the diagram of isothermals shown by Figure 7, from matter shown in Figure 6. In Figure 7, the ordinates represent the pressures in atmospheres, while the abscissas represent the corresponding volumes.

The Second Law of Thermodynamics has been defined in many different ways; all of which are merely mathematical deductions from the fundamental law which defines, "*Difference of*

Entropy between any two Isodiabatics" as a particular thermal property of a substance, which *remains constant for all temperatures.*

Also, "Difference of Entropy between two Isodiabatics" may be defined as the quantity of latent-heat or heat absorbed (or given up) at constant temperature, ratioed or divided by the corresponding absolute-temperature, and comprised between limits defined by the two particular isodiabatics considered.

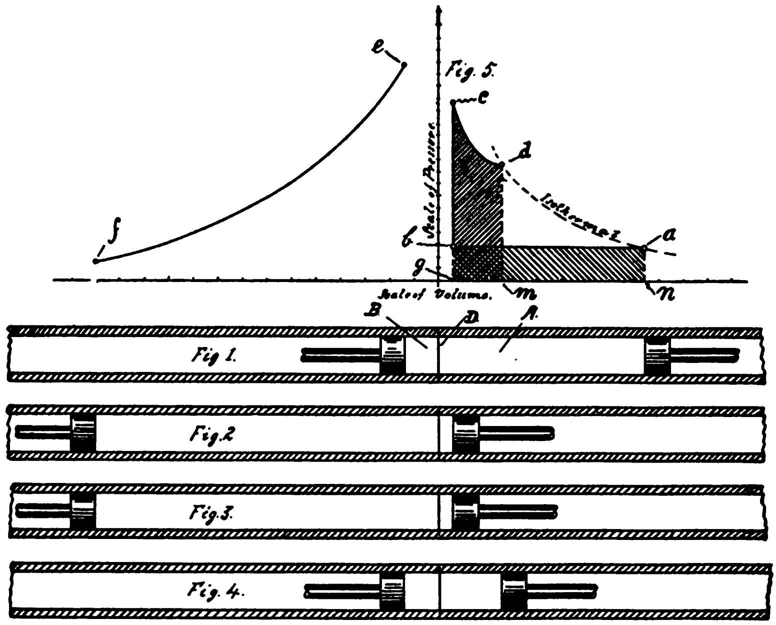
Again, thermodynamic changes or lines are said to be isodiabatic to each other, when they are identical as regards temperature changes and transfer of heat.

Referring to Figure 7, it will be observed that such "Difference of Entropy," measured on any isothermal whose temperature is appreciably greater than 274 degrees of absolute-temperature, will consist of a finite quantity of latent heat ratioed or divided by a finite absolute-temperature, and consequently there results a *finite* value. Whereas, if measured on the isothermal corresponding to 274 degrees of absolute-temperature; by reason of the *practically incompressible* or inert condition acquired by the fluid at or near this particular temperature, it will consist of an *infinitely small* quantity of latent-heat ratioed or divided by the *very finite* temperature of 274 degrees, and consequently there results a value which is *zero.* Thus, in a simple manner; free from all questions of quantitative analysis, and unknown and doubtful matter; the Second Law of Thermodynamics is disproved, as regards its application to carbon-dioxide, because this law requires *one finite* value for all temperatures.

From the relation between Entropy and the Second Law of Thermodynamics, it will be observed that, at pressure greater than the critical-pressure, such law does not permit the inert condition (which is identical with the disappearance of that property by which latent-heat can be developed), until the fluid has been cooled to an extent corresponding to *zero* of absolute-temperature. Amagat, by his research work on other gases, has conclusively demonstrated that the properties of carbon-dioxide are typical for all fluids. Consequently all gases can on different routes or lines which are isodiabetic to each other, become inert at some *finite* absolute-temperature, and therefore the Second Law of Thermodynamics is fallacious for *all* fluids.

After having disposed of the Second Law of Thermodynamics, my next object is to establish the principle that it is possible, in a *perfect* thermodynamic engine, to change or transform the pressure condition or tension of the working fluid; without transferring heat to, or from an external medium; without transferring dynamic energy to, or from an external source; and without resulting a changed temperature.

My principle indirectly conflicts with the Second Law of thermodynamics, as will appear hereinafter.



Figures 1, 2, 3, and 4 show successive operations of an *ideal* type of transforming engine.

A and B are insulated cylinders; each closed by its respective piston; and separated one from the other by the diaphram D capable of a perfect conduction of heat.

The cylinder A contains the gas to be treated or transformed as regards its tension, the gas in the cylinder B is merely a working fluid. By reason of the diaphram D, these separated gases always have a common temperature.

Figure 5 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Figure 1 shows the beginning of the operation. Starting with the gas in the cylinder A, in the condition at *a* on the diagram; and with the gas in the cylinder B, in the condition shown at *e*; each gas having the same temperature but differing as regards pressure and density.

The first operation consists in densifying the gas in cylinder A, through a falling range of temperature; and at constant pressure somewhat above, or at the critical pressure; until the *inert* condition is reached. At the same time the gas in cylinder B is expanded at a sufficient rate to maintain the above mentioned constant pressure in cylinder A by reason of a transfer of heat through the diaphram D. Figure 2 shows the position of the pistons at the close of this operation, and the points *b* and *f* on the diagram show the respective condition of these separated gases after having thus passed through the series of conditions shown respectively by the lines *a-b* and *e-f*. By reason of Amagat's principle, the gas in cylinder A has now acquired an incompressible condition, as regards the influence of pressure alone.

The second operation consists in applying an increased pressure on the fluid in cylinder A, while the condition of the gas in the cylinder B is maintained without change. Figure 3 shows the unchanged position of the pistons at the close of this operation, and the points *c* and *f* on the diagram show the respective condition of the separated gases after the gas in cylinder A has thus passed through the series of conditions shown by the line *b-c*, while the condition of the gas in cylinder B remains unchanged.

The third operation consists in densifying the gas in the cylinder B, through a series ef conditions *exactly* the reverse of that by which it was expanded; at the same time, the gas in cylinder A is expanded through a range of increasing temperatures and a series of pressures suited to maintain the gas in cylinder B through its return series of conditions, or in other words, expanded on the line *c-d* which is isodiabatic to the line *a-b*. Figure 4 shows the position of the pistons at the close of this operation, and the points *d* and *e* on the diagram show the respective condition of the separated gases after having thus passed through the series of conditions shown respectively by the lines *c-d* and *f-e*.

These three operations cause the transformation of the gas in cylinder A, from the condition of tension shown at *a*, to the increased tension shown at *d*; also cause both gases to return to their initial condition as regards temperature. Whereas, the gas in cylinder B is caused to depart from and return to its initial condition in all respects; depart and return through one range or path of conditions; and consequently without a transfer of heat through the diaphram D, in an aggregate sense, or in other words, the heat transferred from cylinder A is returned to it again.

Since this change has been effected by a return to the initial condition of temperature, and *without* an aggregate transfer of heat through the diaphram D; it necessarily results that, in an aggregate sense, neither heat nor dynamic energy has been transferred to, or from *either* cylinder.

The isothermal *a-d* can be chosen at sufficient temperature to insure that, within the limits of the diagram, it is *practically* governed by the law of Boyle and Gay-Lussac. In such case, the return of the treated gas to its initial temperature means a return to its initial condition as regards conserved energy; and consequently, in order not to conflict with the first law of Thermodynamics, the area *a-b-g-n* which represents the external work accompanying the compression, must be equal to the area *c-d-m-g* which represents the external work accompanying the expansion; from which it results that, the point *d* must be at a higher pressure than the point *a*.

After having demonstrated the truth of my principle, my next object is to show how such principle can be applied as a means for dispensing with a refrigerating medium, in the operation of a perfect heat engine.

Again referring to Figures 1 to 5 inclusive; a modification of the apparatus may readily be conceived, by which the transformed fluid at the condition corresponding with the point *d*, may be transferred to another cylinder capable of effecting an isothermal-expansion from the condition at *d* to the condition at *a* by means of heat received from an external source, and then returning the fluid to the transforming engine to there be transformed to its initial condition at *d* in the manner just described.

Such operation constitutes a cycle which may be successively repeated. And it will be observed that; such cycle absorbs heat from an external source, at a constant temperature; converts *all* of this heat into available dynamic energy; and does not discharge any heat to an external source.

Thus, is presented the long sought feasibility of converting Terrestrial Heat into Available Energy.

REPLY, IN DISCUSSION OF

THE FALLACY

OF THE

SECOND LAW OF THERMODYNAMICS

AND THE CONSEQUENT

Feasibility of Secondary Perpetual Motion

In reply to criticism of
Paper read July 2 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

BY

JACOB T. WAINWRIGHT
CIVIL ENGINEER

CHICAGO
1903

REPLY, IN DISCUSSION OF

THE FALLACY

OF THE

Second Law of Thermodynamics

AND THE

Consequent Feasibility of Secondary Perpetual Motion.

The "second law" of thermodynamics is supposed to define the possibilities of a heat engine operated by the manipulation of matter.

The possibilities of such an engine are necessarily dependent upon *properties* of matter. Consequently, in order to *properly* investigate the validity of such law, it becomes necessary to determine what specific properties of matter this law requires; then to determine if such properties are possessed by *all* matter, in *all* conditions.

This is the only *certain* method. Consequently, I have ignored all methods having an hypothetical nature; among which may be classed the various methods based on molecular *theories*, etc., all of which are very interesting but have no value as regards *certainty*.

By determining the particular properties of matter which are necessary to uphold the "second law," and then invoking a *known phenomenon* which shows that *all* matter does not *always* possess such properties, I have effected a simple and *certain* refutation of this law.

Thus, it is shown that criticism of my paper, in order to be relevant, must be restricted *strictly* to a refutation of the assertions which I have herein set forth in the preceding paragraph.

A *theory* associated with a great name does not constitute a *fact.* This truth applies particularly to the well-known treatments by Clausius, Szily, von Helmholtz, Rankine, Boltzman, Maxwell, and some other writers on "Relation between a Kinetic Theory of Gases and the 'Second Law' of Thermodynamics," all of which are based on *postulations* of comparatively simple conception embracing merely *supposed* molecular forces and motion. Determination of the complex action *within* the molecules and consequent influence on external conditions has not been attempted by any writer on "Kinetic Theory of Gases."

"True Science" may be defined as knowledge of *facts.* Whereas, "Hypothetical Science" is devoid of established fact, is fickle and ever changing, is useful only in a tentative way, is usually labeled—"Pure Science," and is taken whole and swallowed as gospel truth only by those who fail in distinguishing fact from fiction.

In conclusion; it may be safely said that the actions of Nature are not simple, but on the contrary, are *infinitely* complex; and that the human mind will never be able to formulate a *law* of Nature, which will hold true for *all* matter, for all conditions within finite limits.

ANOTHER DEMONSTRATION

TO DISPROVE THE

SECOND LAW OF THERMODYNAMICS

AND THEREBY PROVE THE

Feasibility of
Secondary Perpetual Motion

An addendum to
Paper read July 2, 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

Read December 31, 1903, at the
Saint Louis Meeting.

BY

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CIVIL ENGINEER

CHICAGO

1903

ANOTHER DEMONSTRATION

TO DISPROVE THE

Second Law of Thermodynamics

AND THEREBY PROVE THE

Feasibility of Secondary Perpetual Motion.

At the 1902 meeting, at Pittsburgh, I presented to the members of the "Physical Section" a demonstration having substantially this same title. That particular demonstration was based upon a phenomenon disclosed by the published research work of Emile Hillaire Amagat, of Paris, Professor at the Ecole Polytechnique, and member of the Academie des Sciences Français. The particular phenomenon invoked was that;—"At or about an absolute temperature of 274 degrees Centigrade, and at pressures above the critical-pressure, carbon-dioxide becomes practically incompressible or inert, as regards the influence of pressure alone."

The demonstration was confronted by the suggestion that Amagat's work should be thoroughly verified before it could be accepted as evidence to effect a so important revolution in Physical and Chemical Science.

In order to overcome such difficulty, I have devised the following novel demonstration, and have succeeded in presenting the subject in a simple manner free from all questions of quantitative analysis and unverified matter.

I have taken up the subject where Clerk Maxwell abandoned it as hopeless, because he thought it impossible to invent a material or real device to manipulate a gas so as to perform a function which would eliminate the necessity of the coöperation of his celebrated imaginary "sorting demons" and an hypothetical treatment involving a kinetic theory of gases. In fact, I manipulate and transform the pressure condition of a practically perfect gas; and dispense with all postulations, except the "first law" of conservation of energy, which is properly a postulation in a strict sense but has been thoroughly verified as it relates to the various phenomena which contribute to this demonstration.

Maxwell questioned the validity of the "second law," but failed in his attempts to devise a material or real cycle to effect a refutation; and as a last resource, invoked his demon and kinetic theory combination, and therewith effected merely a grotesque and valueless demonstration of thermodynamic possibilities.

I have solved this particular problem by devising a working medium consisting of a combination of a gas and solid matter; the solid matter being arranged so as to constitute a complete heat engine in itself and having the *peculiar* property of transmuting heat into work by reason of *either* a rise or a fall in temperature. In this manner is produced a working medium which taken as a whole is not amenable to the "second law."

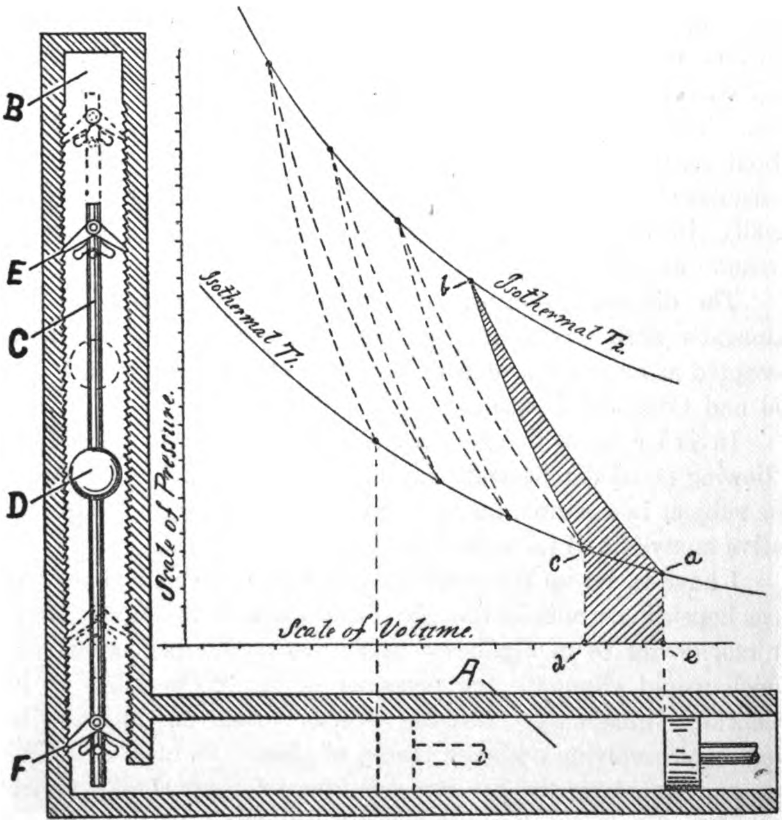

Figure 1.

Figure 1 shows an *ideal* type of transforming engine.

A is an insulated cylinder closed by a piston. This insulated cylinder connects with the insulated chamber *B*, here shown in elevation, and containing the aforementioned peculiar heat engine which is indicated by *C*.

This engine *C* consists of a long metal rod in a vertical position and weighted at its center by the solid sphere or mass of metal *D*. This rod *C* is provided at each end with a pawl device, shown respectively at *B* and *F*, and operating in a ratchet device extending vertically on the sides of the chamber *B*. These pawls are arranged so as to permit a free and unrestrained upward motion along the ratchet, but prevent a downward motion.

Corresponding with and above the cylinder *A*, is a Clapeyron diagram showing thc successive operations in the cylinder.

Operating with a practically perfect working gas, or in other words, a gas amenable to the laws of Boyle and Gay-Lussac. This working gas fills the cylinder *A*, and also with the aforemen tioned rod engine fills the chamber *B*. A common pressure prevails throughout the entire working gas.

Starting with the gas in the cylinder *A*, in the condition at *a* on the isothermal line T_1 in the diagram, with the piston at the corresponding position *e*, and the rod engine *C* suspended from the upper pawl *E*.

The first operation consists in compressing the gas through a rising range of temperature and at rising pressure until the upper isothermal line T_2 is reached at *b*. During this operation, the rise in temperature throughont the rod *C* has caused same to *expand* from the lower pawl *F*, lift the weight *D* to a certain extent, and cause the upper pawl *E* to climb upward along the ratchet. In accord with the "first law" of conservation of energy, this work of lifting represents an equivalent amount of heat energy taken from the entire working medium.

The second operation consists in expanding the gas through a falling range of temperature and at falling pressure until the initial temperature is again acquired on the lower isothermal line at *c*, and the piston has moved to the corresponding position at *d*. During this operation the fall in temperature throughout the rod *C* has caused same to *contract* towards the upper pawl and *again* lift the weight *D* to a certain extent, and cause the lower pawl to climb upward along the ratchet. Again, in accord with the "first law" of conservation of energy, this work of lifting represents an equivalent amount of heat energy taken from the entire working medium.

Since the entire working medium has now returned to its initial condition as regards temperature, the working gas has necessarily returned to its initial condition as regards conserved energy. Also, the rod engine in the chamber B has necessarily returned to its initial condition as regards conserved heat energy, but has acquired a certain amount of potential energy due to its change in elevation, which, by reason of the force of gravitation, can be readily converted into dynamic energy.

By reason of the "first law" of conservation of energy, this available potential energy is an exact equivalent of the external work applied to the piston of cylinder A, and is represented on the diagram by the area *e-a-b-c-d-e*. Consequently the working gas has been compressed from the pressure condition at a to the higher pressure condition at c on the same isothermal, without an expenditure of energy in an aggregate sense, and without an interchange of heat with an external source.

Successive repetitions of this cycle merely cause the rod engine to climb higher, as shown by dotted lines, and the working gas to become more compressed, as shown by the successional movement of the cycle along the isothermal.

From a mathematical point of view, it will be observed that I have now succeeded in refuting the "second law" of thermodynamics, by two distinct treatments applied respectively to a consideration of the two opposite and extreme limits of condition which a gas can acquire. Consequently, the same truth must necessarily hold true for all intermediate conditions, and complicated demonstrations based on quantitative analysis are in this simple manner made unnecessary.

Thus, is presented a material advancement in Science, from that state identified with Maxwell's "demoniacal dream."

A PERPETUAL MOTION

OF THE

SECOND KIND

An Addendum to

Papers read July 2, 1902, and December 31, 1903, respectively at the Pittsburg and St. Louis Meetings of the "Physical Section" of the American Association for the Advancement of Science.

BY

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CHICAGO

1904

ABSTRACT.

This particular demonstration is based upon an elaboration on the phenomenon of "Free Expansion of Gases and Vapors"; and not only destroys the theory that "the second law of thermodynamics" holds true for perfect-gases, but incidentally destroys the doctrine of "irreversible-processes," and a new law to replace "the second law of energetics" is presented.

A PERPETUAL MOTION
OF THE
SECOND KIND

At the 1902 and 1903 meetings, respectively at Pittsburg and St. Louis, I presented to the members of the "Physical Section" demonstrations to prove that "the second law of thermodynamics" is fallacious, and establish the feasibility of "perpetual motion of the second kind."

These demonstrations have proved to be invulnerable to all attempts to identify fallacious reasoning therewith. But the extreme heretical nature of the proposition, taken in connection with other conditions, seems to require a demonstration which is less dependent upon reasoning and more dependent upon visual perception; n other words, an accurate measurable or quantitative analysis seems to be the only means for effecting a covincing demonstration of this important principle or truth.

After considering that our knowledge of thermal properties of matter is so limited that a complete treatment of specific-heat is at the present time impossible, except for a perfect-gas, and consequently places a perfect-gas as the only available working medium which affords an absolutely correct and reliable *quantitative* analysis of thermodynamic operations. Also, considering that the treatments by such eminent minds as Thompson (Lord Kelvin), Clausius, Maxwell, Rankine and others determine that a *perfect-gas* working medium *cannot* be manipulated so as to conflict with "the second law of thermodynamics." It is with much gratification that I find myself able to make direct contradiction to their teaching regarding this particular and specific principle relating to perfect-gases which is now universally believed to be *established* on a *true* mathematical foundation.

It may here be remarked that the above mentioned investigators failed to perceive that their mathematical treatment embraced or covered merely a *particular class* of physical processes.

Heretofore, I did not attempt to question the validity of the "second law" in connection with a working medium in which the change of state applies to perfect-gas solely. Consequently, this attack is somewhat more bold.

In this, also in my previous papers, I have entirely dispensed with postulations, excepting "the first law of conservation of energy," and have based the several demonstrations on hitherto unperceived functional properties of some well known phenomenon.

The demonstration in my first mentioned paper is based upon an important phenomenon disclosed by the research work of Amagat, which he published in the year 1893. In my second paper, the demonstration is based on a common phenomenon that was first observed and recorded at a date which is lost in antiquity. In this paper the demonstration is based upon an elaboration on the particular phenomenon which was first observed and published by Gay-Lussac in the year 1806; was rediscovered and formulated into tangible shape by Joule in the year 1845; was invoked by Kelvin in the year 1848 in his celebrated treatment to establish an absolute scale of temperature, and was cited by both Gay-Lussac and Joule as a convincing argument in favor of the theory of immateriality of heat.

This phenomenon is commonly known as Joule's Law for Free Expansion of Gases and Vapors, and is thus aptly formulated by Rankine: "When the expansion of a gas takes effect, not by enlarging the vessel in which it is contained, and so performing work on external bodies, but by propelling the gas itself from a space in which it is at a higher pressure into a space in which it is at a lower pressure, a portion of the energy is employed wholly in agitating the particles of the gas, and when the agitation so produced has entirely subsided through the mutual friction of those particles, an equivalent quantity of heat is developed, which neutralizes the previous cooling, wholly if the gas is perfect, partially if it is imperfect." In other words, for a perfect gas, there results an unchanged temperature.

An important conclusion which follows this phenomenon is that: "Internal-energy of a given quantity of *perfect-gas* depends only on its temperature, and not on its pressure and volume."

From what precedes, it will be observed that this phenomenon has been more prolific than any other physical manifestation, in the matter of disclosing important truths to contribute to the advancement of the science of thermodynamics.

I have perceived that an elaboration based on this phenomenon affords a simple and *certain* means for refuting "the second law of thermodynamics."

Excepting myself, writers have always defined the "second law" in terms of the possibilities of a heat engine, all of which definitions are of a more or less specific nature. Whereas, the definition, as set forth in my first mentioned paper, is in terms of properties of matter, is *generic* in nature, and is as follows: "Difference of entropy between any two Isodiabatics is a particular thermal property of a substance, which remains constant for all temperatures." Thus the properties of matter which are necessary to uphold the "second law" are tersely and completely set forth.

From this definition, also from other sources, it will be perceived that *transformation* of entropy condition is a direct refutation of the "second law," and is not affected by the positive or negative nature of the transformation. In other words, transformation to a condition of greater entropy conflicts with the law as properly defined, as does a transformation to a condition of less entropy. The mere *transformation* constitutes the refutation.

The sense in which the word "transformation" is herein used means a change without functional compensation.

The prevailing conception of the "second law" consists in numerous formulations, usually of a negative kind, each having a respective specific nature, and constructed so as to prohibit a transformation from a greater to a less condition of entropy, and at the same time dodge the question of a reversed transformation, because the reversed transformation is a fact, and the other transformation is *assumed* to be impossible. This necessity to provide for an *exception* is the cause of the unsatisfactory and comparatively chaotic condition of the "second law," in a constructive sense. A properly constructed law is never hampered with exceptions, and is never formulated in a negative manner in order to dodge a comprehensive statement to cover *all* phenomena.

In thermodynamic operations, "free-expansion" of a perfect-gas effects a transformation of the entropy condition in an aggregate sense, is well known, is readily perceived, and is incidentally shown hereinafter. This change is always from a less to a greater degree of entropy condition, and consequently is identified with so-called "degraded energy."

This *operation* is irreversible, and caused Clausius to make the following well known observation: "The entropy of the universe tends toward a maximum." This observation, taken in consideration with a conception of the *infinite* time which constituted the "Heretofore," indicates that, by this time, all energy would have become unavailable, a condition which we know does not exist. Furthermore, it is the particular object of this paper to show that, although this operation is not reversible, the enthropy transformation which the operation produces *can be* reversed by applying means controlled by other phenomena, and thereby prove that "degraded-energy" is a myth.

"Perpetual motion of the second kind" requires not only a transformation of entropy condition, but it is essential that this transformation shall be from a greater to a less degree of condition. In other words, shall be the reverse of that as manifested by the phenomenon of "free expansion of gases and vapors," and consequently conflicts with the second law."

From a mathematical point of view, it will be perceived that:

1st. A combination of physical influences or elements held in equilibrium by functional conditions constitutes a "physical system."

2d. All physical effects are identified with a change in one or more of the functional elements, and are independent of the manner of change.

3d. The *operation* of effecting changes in the functional elements of a system is reversible when the equilibrium has been continuously maintained, and is irreversible when the equilibrium has not been continuously maintained.

4th. The *effect* of an operation *can always be reversed,* and when produced by an operation which is made irreversible by the unrestrained or unbalanced action of some particular element or elements, can be reversed by another irreversible operation made irreversible by the unrestrained action of another element or elements having an *opposing* action to the first mentioned element or elements.

I wish to emphasize these four related statements, and contribute same to Physical Science, particularly as new principles or laws upon which to *rebuild* thermodynamics and other sciences which have been builded on "the second law of energetics."

These truths when properly understood suggest means for readily reversing *all* processes. The process is reversed—this does not necessarily mean that the operation is reversed—the entropy transformation and other essential effects are reversed.

The thermodynamic system of a *perfect-gas* is an extremely simple physical-system, consisting of the three functional elements (temperature, pressure, and volume), held in equilibrium in accord with the laws of Boyle and Gay-Lussac. From which it will be perceived that, in this system, temperature and pressure *oppose* each other in their functional action. Also, it will be perceived that changes not in accord with the laws of

Boyle and Gay-Lussac can be effected only by destroying the system for the time being; in other words, destroying the equilibrium.

From the above explanation of the properties of a perfect-gas, taken in connection with the afore-mentioned statement or law No. 4, it will be perceived that the problem of producing a transformation of entropy condition the reverse of that identified with the phenomenon of "free expansion," consists merely in devising a similar operation, but in which the temperature and pressure are given interchanged parts; in other words, with unchanged aggregate or total volume condition an operation having a drop or unrestrained fall in temperature and a maintained unchanged pressure. This is simple, and is the gist of the whole matter presented in this paper.

Having thus presented the rationale of the subject, I will now take up the demonstration.

In a simple manner I will first describe the phenomenon of "free-expansion" and the resulting *transformation* of the entropy condition from a less to a greater degree of condition.

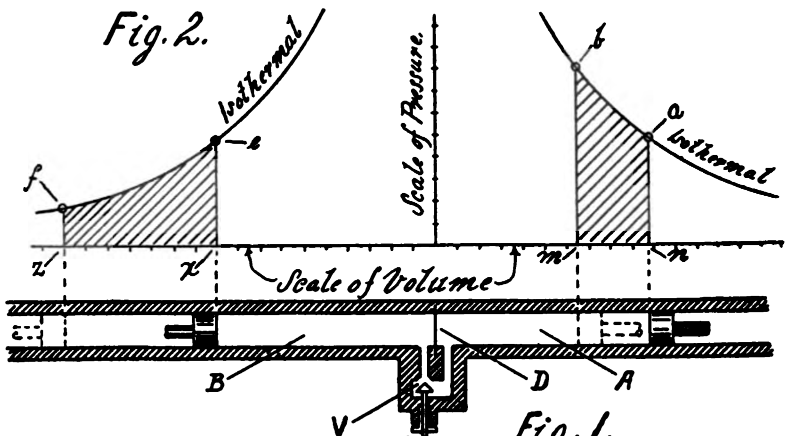

Figure 1 shows an *ideal* type of transforming engine. A and B are insulated cylinders, each closed by its respective piston, and separated one from the other by the diaphragm D, capable of a perfect conduction of heat. V is a stop-cock or valve, is also insulated and controls the flow of gas from one cylinder to the other. By reason of the diaphragm D, the gases in each cylinder always have a common temperature.

Figure 2 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Starting with a *perfect-gas* in each cylinder and the valve V closed, these gases having identically the same composition, volume, pressure, and temperature, which condition is shown respectively at *a* and *e* on the diagram.

The first operation consists in densifying the gas in the cylinder A, through a rising range of pressure and at constant temperature. At the same time the gas in cylinder B is expanded at a sufficient rate to maintain constant temperature in the cylinders by reason of a transfer of heat through the diaphragm D. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points *b* and *f* on the diagram show the respective conditions of these separated gases after having thus passed through the series of conditions shown respectively by the isothermal paths *a-b* and *e-f*. By reason of the compensating action in accord with "the first law of conservation of energy," since the temperature has been maintained unchanged, the area *a-b-m-n-a*, which represents the external work to produce compression, must be equal to the area *e-f-z-x-e*, which represents the external work resulting from expansion, from which it results that the aggregate or total volume of the two gases is now greater than at the beginning of the operation. Also, it will be perceived that, whereas the aggregate entropy condition of these cylinders has not been changed, their respective entropy conditions are now changed an equal amount, but in opposite degree or nature.

The second operation consists in opening the value V and thereby causing the phenomenon of "free expansion." By this means a condition common to both gases is effected without transferring dynamic energy to or from an external source and without resulting a changed temperature, but this return of both gases to a common

Boyle-Lussac can be effected only by destroying the system for the time being; in other words, destroying the equilibrium.

Such a result constitutes a *transformation* of entropy condition, and from a less to greater degree of condition. Consequently, so-called degradation of energy is identified therewith.

Also in a simple manner I will now show how another phenomenon effects results which are exactly the reverse of those just described. In other words, will show how to *reverse the transformation* just described.

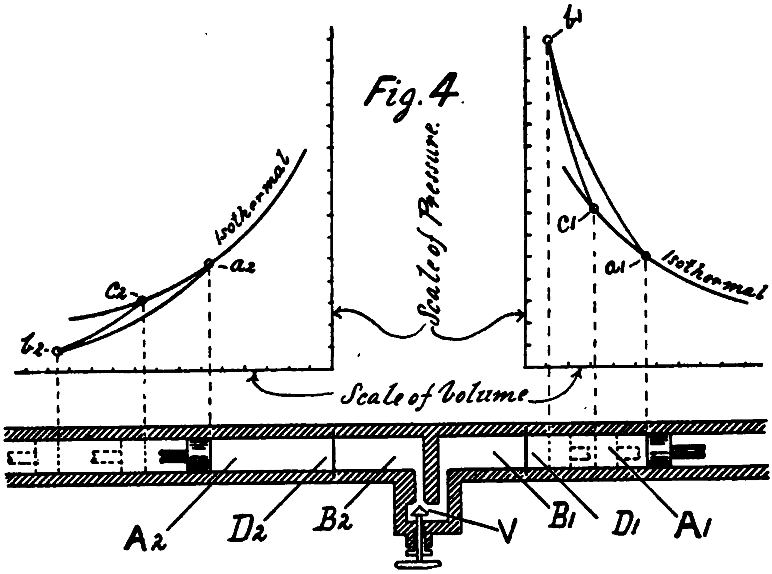

Fig. 3.

Figure 3 shows another *ideal* type of transforming engine. A_1 and A_2 are insulated cylinders, each closed by its respective piston, and each separated from respective insulated adjacent chambers B_1 and B_2 by the diaphragms D_1 and D_2, capable of a perfect conduction of heat. V is a stop-cock or valve, is also insulated and controls the flow of gas from one of these chambers to the other. By reason of these diaphragms the gases in a cylinder and its adjacent chamber always have a common temperature.

Figure 4 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Starting with a *perfect-gas* in the two cylinders and two chambers; for the purpose of simplifying the quantitative computations, each one of the four have identically the same composition, volume, pressure, and temperature; with the valve V slightly open, and thus permit a common pressure in the two chambers and at the same time maintain a thermal insulation between the chambers B_1 and B_2. The conditions in the two cylinders are shown respectively at a_1 and a_2 on the diagram.

The first operation consists in densifying the gas in the cylinder A, through a rising range of pressure and temperature. At the same time the gas in cylinder A_2 is expanded through a falling range of pressure and temperature, at a sufficient rate to maintain *constant pressure* in the chambers B_1 and B_2, all by reason of a transfer of heat through the diaphragms D_1 and D_2. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points b_1 and b_2 on the diagram show the respective conditions of these separated gases after having thus passed through the series of conditions shown respectively by the paths a_1-b_1 and a_2-b_2. This operation effects a reduced temperature in chamber B_2, and an increased temperature in chamber B_1, which causes an overflow of heated gas from chamber B_1, through the valve V, and into the cooled chamber B_2, where an *unrestrained* drop in temperature results with an *unchanged pressure,* and thus effects the desired *transformation* as planned. Also, as regards this operation, it will be perceived that since the common pressure and respective volume for the chambers B_1 and B_2 are maintained unchanged, it results that the internal energy in each chamber is maintained unchanged; consequently, heat, which is conducted through the diaphragm D_1, cannot be retained in these two chambers as specific-heat, latent-heat, nor for transformation into dynamic energy, but necessarily passes through and out by way of the diaphragm D_2; therefore, in this manner, all heat which departs from the cylinder A_1 passes immediately into the cylinder A_2, and in order to maintain the unchanged pressure and consequently unchanged internal energy in the chambers B_1 and B_2, it necessitates that the cylinder A_2 does not receive any heat other than that discharged from the cylinder A_1.

The second operation consists in closing the valve V; then reversed motions are given to the respective pistons of cylinders A_1 and A_2, until each cylinder and adjacent chamber acquire the initial temperature. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points c_1 and c_2 on the diagram show the respective conditions of these separated gases after having passed through the series of conditions shown respectively by the paths b_1-c_1 and b_2-c_2. It will be perceived that the gas contained in the chambers B_1 and B_2 has now undergone a change (as regards the initial and final condition) which is exactly the reverse of that manifested by the phenomenon of "free-expansion." Also, it will be perceived that the whole system has returned to the initial temperature condition, and consequently to the initial condition as regards internal or total conserved energy; therefore it will be perceived that also this operation does not effect a changed aggregate internal energy in the chambers B_1 and B_2.

The device shown in Figure 3 is merely ideal, and is intended to aid in a mental conception of a process. The process only is to be considered.

The device shown is crude and devoid of refinements, particularly as regards the valve V or other suitable device to maintain a thermal insulation between the Chambers B_1 and B_2 and at the same time permit an unrestrained passage of gas from one of these chambers to the other.

The initial conditions have been chosen so as to cause a simple process which can be readily analyzed quantitatively by an ordinary mathematician having an elementary knowledge of thermodynamics. Clapeyron's method of illustrating has been presented because it conveniently shows the method of operation; however, his

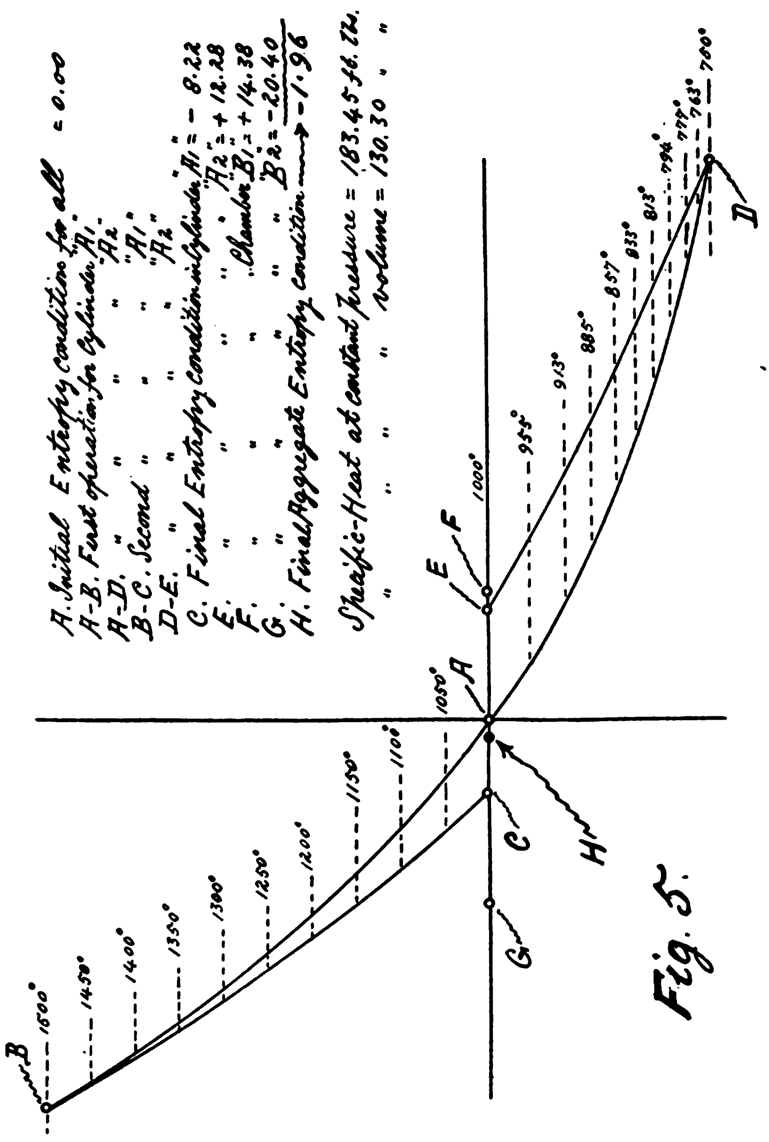

Fig. 5.

type of diagram is not the most convenient for quantitative treatment; consequently, I now present the same matter in the entropy-temperature diagram shown in the following Figure 5.

Figure 5 is accurately drawn to scale, the vertical scale representing temperature, and the horizontal scale representing entropy. The notes explain the diagram, and it will be perceived that the initial temperature is taken at 1000 degrees, and the limit for the upper range of temperature is at 1500 degrees. Also, it will be perceived that the final entropy condition, taken in an aggregate sense, shows a very *considerable* transformation in a *negative* direction from the aggregate initial condition, and thus settles the entire subject matter.

In order to avoid prolixity, all quantitative computations have been omitted from this particular paper. Also, for the same reason, an explanation of the relation between the transformation of entropy condition just demonstrated and "perpetual motion of the second kind" is omitted because the matter is well understood by all physicists; in fact, a favorite way of formulating "the second law of thermodynamics" is a negation of this transformation.

In conclusion, it may be remarked that "the doctrine of degraded energy" has been an important factor in retarding the advancement of Physical Science, and its destruction means rapid and extended progress. Consequently, it is hoped that the matter presented in this paper will be appreciated at an early date.

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PERPETUAL MOTION

OF THE

SECOND KIND

WAINWRIGHT

PERPETUAL MOTION

OF THE

SECOND KIND

OR

Heat from the Atmosphere a Substitute for Fuel.

BY

JACOB T. WAINWRIGHT

CIVIL ENGINEER

CHICAGO

1905

PREFACE.

All important advancements in science have originated as heresy.

This collection of heretical monographs is merely a contribution to science and has proved to be invulnerabla to all attempts by physicists to identify a paradox therewith. Furthermore, thorough explanation and publication can not be identified with charlatanism. In fact, the matter is presented with a sense of duty and to promote education.

The author would also recommend to the attention of savants the recently published very able and heretical observations on this subject by Henri Poincarré, Professor of Mathematical Physics, at the Sorbonne, Paris; and Member of the Institute of France.

It may here be remarked that, the present science of Thermodynamics must perish because founded on hypothesis, and will be rebuilt upon a foundation of phenomena and fact only. For a masterful exposition of the fundamental assumptions which underlie the second law of Thermodynamics, the reader is referred to the published proceedings of the Meeting at Cardiff in 1891, of the British Association for the Advancement of Science; "Report of a Committee, consisting of Messrs. J. Larmor and G. H. Bryan, on the present state of our knowledge of Thermodynamics, specially with regard to the Second Law."

In that Report, the following statement occurs—"A complete mechanical proof of the Second Law would involve a mechanical definition of temperature applicable to all kinds and states of matter, together with an explanation on dynamical or statistical laws of the principle of degradation of energy in *non-reversible* processes, and we are still far from arriving at a satisfactory solution of these problems."

The fourth or last paper included herein not only presents a solution for this particular last mentioned problem, but is the author's *third* demonstration to *disprove* the Second Law.

J. T. W.

THE FALLACY

OF THE

SECOND LAW OF THERMODYNAMICS

AND THE

Feasibility of Transmuting Terrestrial Heat Into Available Energy.

Read July 2, 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

BY
JACOB T. WAINWRIGHT
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CHICAGO
1902

THE FALLACY

OF THE

Second Law of Thermodynamics

AND THE

Feasibility of Transmuting Terrestrial Heat Into Available Energy

The Second Law of Thermodynamics was propounded by Sadi Carnot, in the year 1824. Was mathematically *established* by Professors Clausius and Thompson (Lord Kelvin), independently by each, respectively in the years 1850 and 1851, on the same *peculiar* foundation (on laws which are now obsolete) and at a date when the laws of Boyle, Gay-Lussac, and Watt were considered *sufficiently* accurate and applicable to *all* fluids within *practical* limits of temperature and pressure. And both investigators were *particular* to explain that the mathematical treatment and conclusions therefrom were based upon this *assumption*, which was only approximately correct at best, and applied only to limits of pressure and temperature that were then considered practicable; (Memoirs by Carnot, Clausius, and Thompson) (Translation by Professor Magie, of Princeton University; Harper & Bros., Publishers, New York, 1899).

Subsequently (in the year 1881), Professor Amagat demonstrated that the laws of Boyle and Gay-Lussac are *very far* from being true when the fluid's condition is near the *critical-point*. Also, recent progress in the art of liquefying gases at low temperatures has demonstrated that *practical* limits of temperature and pressure have *increased* to such an extent that the critical-point of many gases is readily attained. Consequently the Boyle and Gay-Lussac law must be abandoned, and Amagat's principle must be substituted. Thus the Thompson and Clausius *assumption* is no longer applicable, and their demonstration is destroyed.

Amagat's demonstration of the impotency of the Boyle and Gay-Lussac law has been universally accepted, but the effect of his demonstration upon the *establishment* of the Second Law of Thermodynamics has not before been observed.

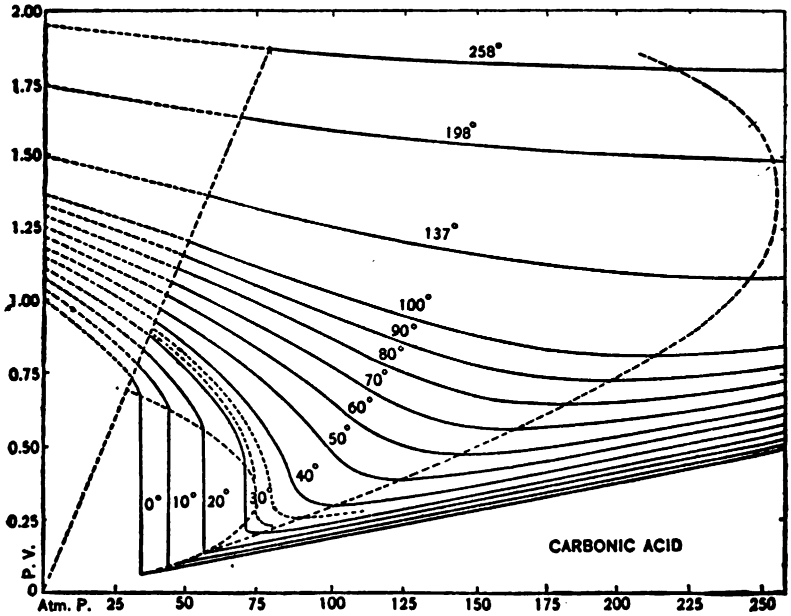


Fig. 6.

Figure 6 is an exact reproduction of a diagram of isothermals relating to carbon-dioxide, made by Amagat (Annales de Chimie et de Physique, 6e Serie, t. xxix. 1893) (Translation by Professor Barus, of Brown University; Harper & Bros. publishers, New York, 1899) and is the result of actual research. The abscissas represent the pressures in atmospheres, while the ordi nates represent the corresponding values of the product resulting from multiplying the pressure by the corresponding volume, otherwise designated as *pv*.

The lowest isothermal shown by Amagat corresponds to the temperature of zero (274 degrees absolute) on the Centigrade-thermometer. Above the critical–pressure, and within the limits of his diagram, this isothermal is practically a straight line which, if prolonged, passes through the origin of ordinates. This shows that, within these limits of pressure, this particular isothermal has *constant volume* for all degrees of pressure. Consequently, at or near this particular *finite* temperature, and within these limits of pressure, this particular fluid (carbon-dioxide) becomes *practically* incompressible or inert, as regards the influence of pressure alone. Thus, this *important* phenomenon is placed beyond dispute.

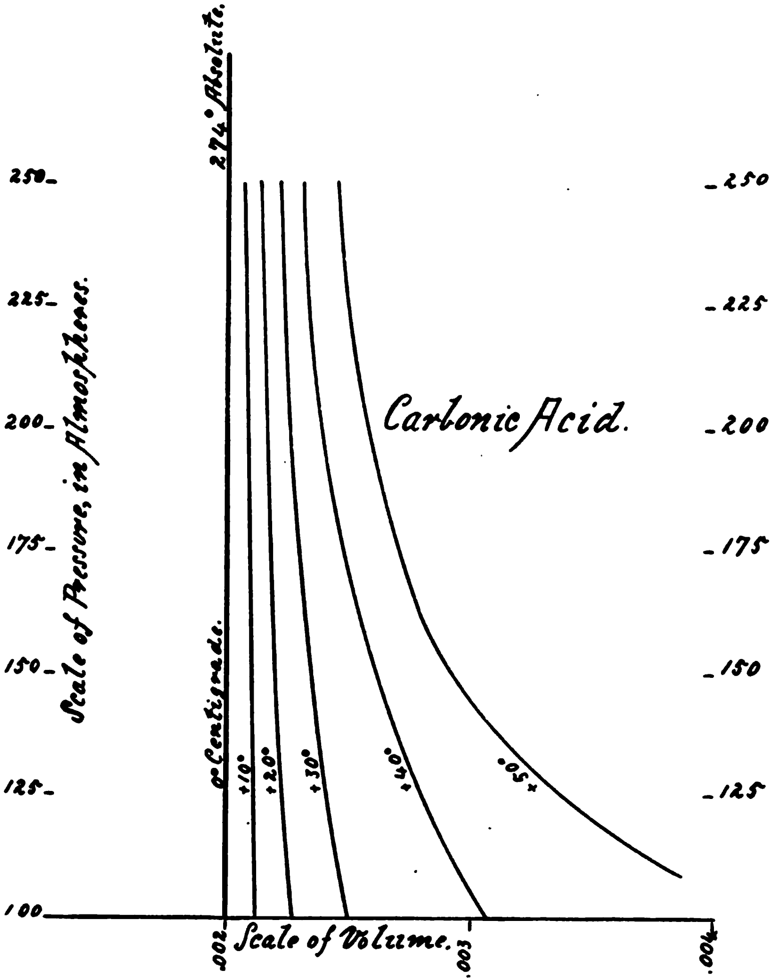


Fig. 7.

This phenomenon does not result as an erratic change in the condition of the fluid, but is the result of a series of gradual and well known changes, and consequently is susceptible to isodiabatic treatment. For the purpose of showing this matter in a more familiar way, I have constructed the diagram of isothermals shown by Figure 7, from matter shown in Figure 6. In Figure 7, the ordinates represent the pressures in atmospheres, while the abscissas represent the corresponding volumes.

The Second Law of Thermodynamics has been defined in many different ways; all of which are merely mathematical deductions from the fundamental law which defines, "*Difference of*

Entropy between any two Isodiabatics" as a particular thermal property of a substance, which *remains constant for all temperatures.*

Also, "Difference of Entropy between two Isodiabatics" may be defined as the quantity of latent-heat or heat absorbed (or given up) at constant temperature, ratioed or divided by the corresponding absolute-temperature, and comprised between limits defined by the two particular isodiabatics considered.

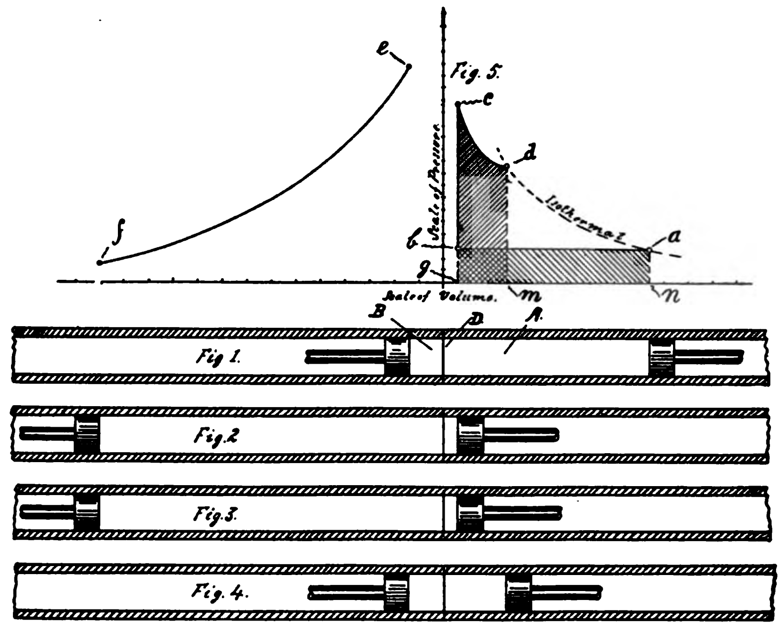
Again, thermodynamic changes or lines are said to be isodiabatic to each other, when they are identical as regards temperature changes and transfer of heat.

Referring to Figure 7, it will be observed that such "Difference of Entropy," measured on any isothermal whose temperature is appreciably greater than 274 degrees of absolute-temperature, will consist of a finite quantity of latent heat ratioed or divided by a finite absolute-temperature, and consequently there results a *finite* value. Whereas, if measured on the isothermal corresponding to 274 degrees of absolute-temperature; by reason of the *practically incompressible* or inert condition acquired by the fluid at or near this particular temperature, it will consist of an *infinitely small* quantity of latent-heat ratioed or divided by the *very finite* temperature of 274 degrees, and consequently there results a value which is *zero.* Thus, in a simple manner; free from all questions of quantitative analysis, and unknown and doubtful matter; the Second Law of Thermodynamics is disproved, as regards its application to carbon-dioxide, because this law requires *one finite* value for all temperatures.

From the relation between Entropy and the Second Law of Thermodynamics, it will be observed that, at pressure greater than the critical-pressure, such law does not permit the inert condition (which is identical with the disappearance of that property by which latent-heat can be developed), until the fluid has been cooled to an extent corresponding to *zero* of absolute-temperature. Amagat, by his research work on other gases, has conclusively demonstrated that the properties of carbon-dioxide are typical for all fluids. Consequently all gases can on different routes or lines which are isodiabetic to each other, become inert at some *finite* absolute-temperature, and therefore the Second Law of Thermodynamics is fallacious for *all* fluids.

After having disposed of the Second Law of Thermodynamics, my next object is to establish the principle that it is possible, in a *perfect* thermodynamic engine, to change or transform the pressure condition or tension of the working fluid; without transferring heat to, or from an external medium; without transferring dynamic energy to, or from an external source; and without resulting a changed temperature.

My principle indirectly conflicts with the Second Law of thermodynamics, as will appear hereinafter.



Figures 1, 2, 3, and 4 show successive operations of an *ideal* type of transforming engine.

A and B are insulated cylinders; each closed by its respective piston; and separated one from the other by the diaphram D capable of a perfect conduction of heat.

The cylinder A contains the gas to be treated or transformed as regards its tension, the gas in the cylinder B is merely a working fluid. By reason of the diaphram D, these separated gases always have a common temperature.

Figure 5 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Figure 1 shows the beginning of the operation. Starting with the gas in the cylinder A, in the condition at *a* on the diagram; and with the gas in the cylinder B, in the condition shown at *e*; each gas having the same temperature but differing as regards pressure and density.

The first operation consists in densifying the gas in cylinder A, through a falling range of temperature; and at constant pressure somewhat above, or at the critical pressure; until the *inert* condition is reached. At the same time the gas in cylinder B is expanded at a sufficient rate to maintain the above mentioned constant pressure in cylinder A by reason of a transfer of heat through the diaphram D. Figure 2 shows the position of the pistons at the close of this operation, and the points *b* and *f* on the diagram show the respective condition of these separated gases after having thus passed through the series of conditions shown respectively by the lines *a-b* and *e-f*. By reason of Amagat's principle, the gas in cylinder A has now acquired an incompressible condition, as regards the influence of pressure alone.

The second operation consists in applying an increased pressure on the fluid in cylinder A, while the condition of the gas in the cylinder B is maintained without change. Figure 3 shows the unchanged position of the pistons at the close of this operation, and the points *c* and *f* on the diagram show the respective condition of the separated gases after the gas in cylinder A has thus passed through the series of conditions shown by the line *b-c*, while the condition of the gas in cylinder B remains unchanged.

The third operation consists in densifying the gas in the cylinder B, through a series ef conditions *exactly* the reverse of that by which it was expanded; at the same time, the gas in cylinder A is expanded through a range of increasing temperatures and a series of pressures suited to maintain the gas in cylinder B through its return series of conditions, or in other words, expanded on the line *c-d* which is isodiabatic to the line *a-b*. Figure 4 shows the position of the pistons at the close of this operation, and the points *d* and *e* on the diagram show the respective condition of the separated gases after having thus passed through the series of conditions shown respectively by the lines *c-d* and *f-e*.

These three operations cause the transformation of the gas in cylinder A, from the condition of tension shown at *a*, to the increased tension shown at *d;* also cause both gases to return to their initial condition as regards temperature. Whereas, the gas in cylinder B is caused to depart from and return to its initial condition in all respects; depart and return through one range or path of conditions; and consequently without a transfer of heat through the diaphram D, in an aggregate sense, or in other words, the heat transferred from cylinder A is returned to it again.

Since this change has been effected by a return to the initial condition of temperature, and *without* an aggregate transfer of heat through the diaphram D; it necessarily results that, in an aggregate sense, neither heat nor dynamic energy has been transferred to, or from *either* cylinder.

The isothermal *a-d* can be chosen at sufficient temperature to insure that, within the limits of the diagram, it is *practically* governed by the law of Boyle and Gay-Lussac. In such case, the return of the treated gas to its initial temperature means a return to its initial condition as regards conserved energy; and consequently, in order not to conflict with the first law of Thermodynamics, the area *a-b-g-n* which represents the external work accompanying the compression, must be equal to the area *c-d-m-g* which represents the external work accompanying the expansion; from which it results that, the point *d* must be at a higher pressure than the point *a*.

After having demonstrated the truth of my principle, my next object is to show how such principle can be applied as a means for dispensing with a refrigerating medium, in the operation of a perfect heat engine.

Again referring to Figures 1 to 5 inclusive; a modification of the apparatus may readily be conceived, by which the transformed fluid at the condition corresponding with the point *d*, may be transferred to another cylinder capable of effecting an isothermal-expansion from the condition at *d* to the condition at *a* by means of heat received from an external source, and then returning the fluid to the transforming engine to there be transformed to its initial condition at *d* in the manner just described.

Such operation constitutes a cycle which may be successively repeated. And it will be observed that; such cycle absorbs heat from an external source, at a constant temperature; converts *all* of this heat into available dynamic energy; and does not discharge any heat to an external source.

Thus, is presented the long sought feasibility of converting Terrestrial Heat into Available Energy.

REPLY, IN DISCUSSION OF

THE FALLACY

OF THE

SECOND LAW OF THERMODYNAMICS

AND THE CONSEQUENT

Feasibility of Secondary Perpetual Motion

In reply to criticism of
Paper read July 2 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

BY

JACOB T. WAINWRIGHT
CIVIL ENGINEER

CHICAGO
1903

REPLY, IN DISCUSSION OF

THE FALLACY

OF THE

Second Law of Thermodynamics

AND THE

Consequent Feasibility of Secondary Perpetual Motion.

The "second law" of thermodynamics is supposed to define the possibilities of a heat engine operated by the manipulation of matter.

The possibilities of such an engine are necessarily dependent upon *properties* of matter. Consequently, in order to *properly* investigate the validity of such law, it becomes necessary to determine what specific properties of matter this law requires; then to determine if such properties are possessed by *all* matter, in *all* conditions.

This is the only *certain* method. Consequently, I have ignored all methods having an hypothetical nature; among which may be classed the various methods based on molecular *theories*, etc., all of which are very interesting but have no value as regards *certainty*.

By determining the particular properties of matter which are necessary to uphold the "second law," and then invoking a *known phenomenon* which shows that *all* matter does not *always* possess such properties, I have effected a simple and *certain* refutation of this law.

Thus, it is shown that criticism of my paper, in order to be relevant, must be restricted *strictly* to a refutation of the assertions which I have herein set forth in the preceding paragraph.

A *theory* associated with a great name does not constitute a *fact*. This truth applies particularly to the well-known treatments by Clausius, Szily, von Helmholtz, Rankine, Boltzman, Maxwell, and some other writers on "Relation between a Kinetic Theory of Gases and the 'Second Law' of Thermodynamics," all of which are based on *postulations* of comparatively simple conception embracing merely *supposed* molecular forces and motion. Determination of the complex action *within* the molecules and consequent influence on external conditions has not been attempted by any writer on "Kinetic Theory of Gases."

"True Science" may be defined as knowledge of *facts*. Whereas, "Hypothetical Science" is devoid of established fact, is fickle and ever changing, is useful only in a tentative way, is usually labeled—"Pure Science," and is taken whole and swallowed as gospel truth only by those who fail in distinguishing fact from fiction.

In conclusion; it may be safely said that the actions of Nature are not simple, but on the contrary, are *infinitely* complex; and that the human mind will never be able to formulate a *law* of Nature, which will hold true for *all* matter, for all conditions within finite limits.

ANOTHER DEMONSTRATION

TO DISPROVE THE

SECOND LAW OF THERMODYNAMICS

AND THEREBY PROVE THE

Feasibility of Secondary Perpetual Motion

An addendum to
Paper read July 2, 1902, at the Pittsburg Meeting of the "Physical Section" of the American Association for the Advancement of Science.

Read December 31, 1903, at the Saint Louis Meeting.

BY

JACOB T. WAINWRIGHT
CIVIL ENGINEER

CHICAGO
1903

ANOTHER DEMONSTRATION

TO DISPROVE THE

Second Law of Thermodynamics

AND THEREBY PROVE THE

Feasibility of Secondary Perpetual Motion.

At the 1902 meeting, at Pittsburgh, I presented to the members of the "Physical Section" a demonstration having substantially this same title. That particular demonstration was based upon a phenomenon disclosed by the published research work of Emile Hillaire Amagat, of Paris, Professor at the Ecole Polytechnique, and member of the Academie des Sciences Français. The particular phenomenon invoked was that;—"At or about an absolute temperature of 274 degrees Centigrade, and at pressures above the critical-pressure, carbon-dioxide becomes practically incompressible or inert, as regards the influence of pressure alone."

The demonstration was confronted by the suggestion that Amagat's work should be thoroughly verified before it could be accepted as evidence to effect a so important revolution in Physical and Chemical Science.

In order to overcome such difficulty, I have devised the following novel demonstration, and have succeeded in presenting the subject in a simple manner free from all questions of quantitative analysis and unverified matter.

I have taken up the subject where Clerk Maxwell abandoned it as hopeless, because he thought it impossible to invent a material or real device to manipulate a gas so as to perform a function which would eliminate the necessity of the coöperation of his celebrated imaginary "sorting demons" and an hypothetical treatment involving a kinetic theory of gases. In fact, I manipulate and transform the pressure condition of a practically perfect gas; and dispense with all postulations, except the "first law" of conservation of energy, which is properly a postulation in a strict sense but has been thoroughly verified as it relates to the various phenomena which contribute to this demonstration.

Maxwell questioned the validity of the "second law," but failed in his attempts to devise a material or real cycle to effect a refutation; and as a last resource, invoked his demon and kinetic theory combination, and therewith effected merely a grotesque and valueless demonstration of thermodynamic possibilities.

I have solved this particular problem by devising a working medium consisting of a combination of a gas and solid matter; the solid matter being arranged so as to constitute a complete heat engine in itself and having the *peculiar* property of transmuting heat into work by reason of *either* a rise or a fall in temperature. In this manner is produced a working medium which taken as a whole is not amenable to the "second law."

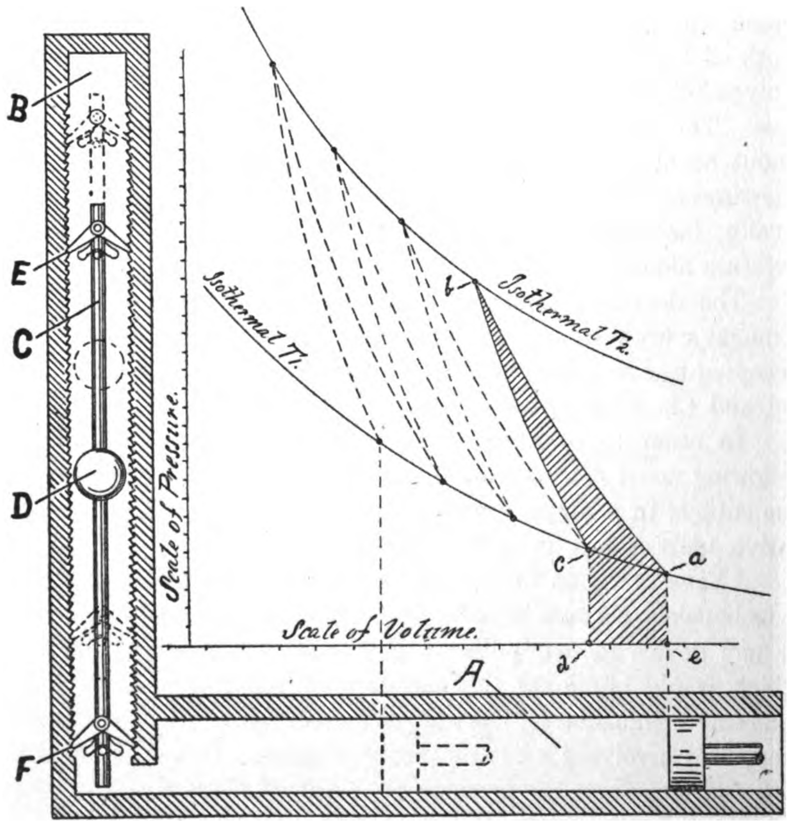


Figure 1.

Figure 1 shows an *ideal* type of transforming engine.

A is an insulated cylinder closed by a piston. This insulated cylinder connects with the insulated chamber *B*, here shown in elevation, and containing the aforementioned peculiar heat engine which is indicated by *C*.

This engine *C* consists of a long metal rod in a vertical position and weighted at its center by the solid sphere or mass of metal *D*. This rod *C* is provided at each end with a pawl device, shown respectively at *B* and *F*, and operating in a ratchet device extending vertically on the sides of the chamber *B*. These pawls are arranged so as to permit a free and unrestrained upward motion along the ratchet, but prevent a downward motion.

Corresponding with and above the cylinder *A*, is a Clapeyron diagram showing thc successive operations in the cylinder.

Operating with a practically perfect working gas, or in other words, a gas amenable to the laws of Boyle and Gay-Lussac. This working gas fills the cylinder *A*, and also with the aforemen tioned rod engine fills the chamber *B*. A common pressure prevails throughout the entire working gas.

Starting with the gas in the cylinder *A*, in the condition at *a* on the isothermal line T_1 in the diagram, with the piston at the corresponding position *e*, and the rod engine *C* suspended from the upper pawl *E*.

The first operation consists in compressing the gas through a rising range of temperature and at rising pressure until the upper isothermal line T_2 is reached at *b*. During this operation, the rise in temperature throughont the rod *C* has caused same to *expand* from the lower pawl *F*, lift the weight *D* to a certain extent, and cause the upper pawl *E* to climb upward along the ratchet. In accord with the "first law" of conservation of energy, this work of lifting represents an equivalent amount of heat energy taken from the entire working medium.

The second operation consists in expanding the gas through a falling range of temperature and at falling pressure until the initial temperature is again acquired on the lower isothermal line at *c*, and the piston has moved to the corresponding position at *d*. During this operation the fall in temperature throughout the rod *C* has caused same to *contract* towards the upper pawl and *again* lift the weight *D* to a certain extent, and cause the lower pawl to climb upward along the ratchet. Again, in accord with the "first law" of conservation of energy, this work of lifting represents an equivalent amount of heat energy taken from the entire working medium.

Since the entire working medium has now returned to its initial condition as regards temperature, the working gas has necessarily returned to its initial condition as regards conserved energy. Also, the rod engine in the chamber B has necessarily returned to its initial condition as regards conserved heat energy, but has acquired a certain amount of potential energy due to its change in elevation, which, by reason of the force of gravitation, can be readily converted into dynamic energy.

By reason of the "first law" of conservation of energy, this available potential energy is an exact equivalent of the external work applied to the piston of cylinder A, and is represented on the diagram by the area e-a-b-c-d-e. Consequently the working gas has been compressed from the pressure condition at a to the higher pressure condition at c on the same isothermal, without an expenditure of energy in an aggregate sense, and without an interchange of heat with an external source.

Successive repetitions of this cycle merely cause the rod engine to climb higher, as shown by dotted lines, and the working gas to become more compressed, as shown by the successional movement of the cycle along the isothermal.

From a mathematical point of view, it will be observed that I have now succeeded in refuting the "second law" of thermodynamics, by two distinct treatments applied respectively to a consideration of the two opposite and extreme limits of condition which a gas can acquire. Consequently, the same truth must necessarily hold true for all intermediate conditions, and complicated demonstrations based on quantitative analysis are in this simple manner made unnecessary.

Thus, is presented a material advancement in Science, from that state identified with Maxwell's "demoniacal dream."

A PERPETUAL MOTION

OF THE

SECOND KIND

An Addendum to

Papers read July 2, 1902, and December 31, 1903, respectively at the Pittsburg and St. Louis Meetings of the "Physical Section" of the American Association for the Advancement of Science.

BY

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1904

ABSTRACT.

This particular demonstration is based upon an elaboration on the phenomenon of "Free Expansion of Gases and Vapors"; and not only destroys the theory that "the second law of thermodynamics" holds true for perfect-gases, but incidentally destroys the doctrine of "ir-reversible-processes," and a new law to replace "the second law of energetics" is presented.

A PERPETUAL MOTION
OF THE
SECOND KIND

At the 1902 and 1903 meetings, respectively at Pittsburg and St. Louis, I presented to the members of the "Physical Section" demonstrations to prove that "the second law of thermodynamics" is fallacious, and establish the feasibility of "perpetual motion of the second kind."

These demonstrations have proved to be invulnerable to all attempts to identify fallacious reasoning therewith. But the extreme heretical nature of the proposition, taken in connection with other conditions, seems to require a demonstration which is less dependent upon reasoning and more dependent upon visual perception; n other words, an accurate measurable or quantitative analysis seems to be the only means for effecting a covincing demonstration of this important principle or truth.

After considering that our knowledge of thermal properties of matter is so limited that a complete treatment of specific-heat is at the present time impossible, except for a perfect-gas, and consequently places a perfect-gas as the only available working medium which affords an absolutely correct and reliable *quantitative* analysis of thermodynamic operations. Also, considering that the treatments by such eminent minds as Thompson (Lord Kelvin), Clausius, Maxwell, Rankine and others determine that a *perfect-gas* working medium *cannot* be manipulated so as to conflict with "the second law of thermodynamics." It is with much gratification that I find myself able to make direct contradiction to their teaching regarding this particular and specific principle relating to perfect-gases which is now universally believed to be *established* on a *true* mathematical foundation.

It may here be remarked that the above mentioned investigators failed to perceive that their mathematical treatment embraced or covered merely a *particular class* of physical processes.

Heretofore, I did not attempt to question the validity of the "second law" in connection with a working medium in which the change of state applies to perfect-gas solely. Consequently, this attack is somewhat more bold.

In this, also in my previous papers, I have entirely dispensed with postulations, excepting "the first law of conservation of energy," and have based the several demonstrations on hitherto unperceived functional properties of some well known phenomenon.

The demonstration in my first mentioned paper is based upon an important phenomenon disclosed by the research work of Amagat, which he published in the year 1893. In my second paper, the demonstration is based on a common phenomenon that was first observed and recorded at a date which is lost in antiquity. In this paper the demonstration is based upon an elaboration on the particular phenomenon which was first observed and published by Gay-Lussac in the year 1806; was rediscovered and formulated into tangible shape by Joule in the year 1845; was invoked by Kelvin in the year 1848 in his celebrated treatment to establish an absolute scale of temperature, and was cited by both Gay-Lussac and Joule as a convincing argument in favor of the theory of immateriality of heat.

This phenomenon is commonly known as Joule's Law for Free Expansion of Gases and Vapors, and is thus aptly formulated by Rankine: "When the expansion of a gas takes effect, not by enlarging the vessel in which it is contained, and so performing work on external bodies, but by propelling the gas itself from a space in which it is at a higher pressure into a space in which it is at a lower pressure, a portion of the energy is employed wholly in agitating the particles of the gas, and when the agitation so produced has entirely subsided through the mutual friction of those particles, an equivalent quantity of heat is developed, which neutralizes the previous cooling, wholly if the gas is perfect, partially if it is imperfect." In other words, for a perfect gas, there results an unchanged temperature.

An important conclusion which follows this phenomenon is that: "Internal energy of a given quantity of *perfect-gas* depends only on its temperature, and not on its pressure and volume."

From what precedes, it will be observed that this phenomenon has been more prolific than any other physical manifestation, in the matter of disclosing important truths to contribute to the advancement of the science of thermodynamics.

I have perceived that an elaboration based on this phenomenon affords a simple and *certain* means for refuting "the second law of thermodynamics."

Excepting myself, writers have always defined the "second law" in terms of the possibilities of a heat engine, all of which definitions are of a more or less specific nature. Whereas, the definition, as set forth in my first mentioned paper, is in terms of properties of matter, is *generic* in nature, and is as follows: "Difference of entropy between any two Isodiabatics is a particular thermal property of a substance, which remains constant for all temperatures." Thus the properties of matter which are necessary to uphold the "second law" are tersely and completely set forth.

From this definition, also from other sources, it will be perceived that *transformation* of entropy condition is a direct refutation of the "second law," and is not affected by the positive or negative nature of the transformation. In other words, transformation to a condition of greater entropy conflicts with the law as properly defined, as does a transformation to a condition of less entropy. The mere *transformation* constitutes the refutation.

The sense in which the word "transformation" is herein used means a change without functional compensation.

The prevailing conception of the "second law" consists in numerous formulations, usually of a negative kind, each having a respective specific nature, and constructed so as to prohibit a transformation from a greater to a less condition of entropy, and at the same time dodge the question of a reversed transformation, because the reversed transformation is a fact, and the other transformation is *assumed* to be impossible. This necessity to provide for an *exception* is the cause of the unsatisfactory and comparatively chaotic condition of the "second law," in a constructive sense. A properly constructed law is never hampered with exceptions, and is never formulated in a negative manner in order to dodge a comprehensive statement to cover *all* phenomena.

In thermodynamic operations, "free-expansion" of a perfect-gas effects a transformation of the entropy condition in an aggregate sense, is well known, is readily perceived, and is incidentally shown hereinafter. This change is always from a less to a greater degree of entropy condition, and consequently is identified with so-called "degraded energy."

This *operation* is irreversible, and caused Clausius to make the following well known observation: "The entropy of the universe tends toward a maximum." This observation, taken in consideration with a conception of the *infinite* time which constituted the "Heretofore," indicates that, by this time, all energy would have become unavailable, a condition which we know does not exist. Furthermore, it is the particular object of this paper to show that, although this operation is not reversible, the enthropy transformation which the operation produces *can be* reversed by applying means controlled by other phenomena, and thereby prove that "degraded-energy" is a myth.

"Perpetual motion of the second kind" requires not only a transformation of entropy condition, but it is essential that this transformation shall be from a greater to a less degree of condition. In other words, shall be the reverse of that as manifested by the phenomenon of "free expansion of gases and vapors," and consequently conflicts with the second law."

From a mathematical point of view, it will be perceived that:

1st. A combination of physical influences or elements held in equilibrium by functional conditions constitutes a "physical system."

2d. All physical effects are identified with a change in one or more of the functional elements, and are independent of the manner of change.

3d. The *operation* of effecting changes in the functional elements of a system is reversible when the equilibrium has been continuously maintained, and is irreversible when the equilibrium has not been continuously maintained.

4th. The *effect* of an operation *can always be reversed,* and when produced by an operation which is made irreversible by the unrestrained or unbalanced action of some particular element or elements, can be reversed by another irreversible operation made irreversible by the unrestrained action of another element or elements having an *opposing* action to the first mentioned element or elements.

I wish to emphasize these four related statements, and contribute same to Physical Science, particularly as new principles or laws upon which to *rebuild* thermodynamics and other sciences which have been builded on "the second law of energetics."

These truths when properly understood suggest means for readily reversing *all* processes. The process is reversed—this does not necessarily mean that the operation is reversed—the entropy transformation and other essential effects are reversed.

The thermodynamic system of a *perfect-gas* is an extremely simple physical-system, consisting of the three functional elements (temperature, pressure, and volume), held in equilibrium in accord with the laws of Boyle and Gay-Lussac. From which it will be perceived that, in this system, temperature and pressure *oppose* each other in their functional action. Also, it will be perceived that changes not in accord with the laws of

Boyle and Gay-Lussac can be effected only by destroying the system for the time being; in other words, destroying the equilibrium.

From the above explanation of the properties of a perfect-gas, taken in connection with the afore-mentioned statement or law No. 4, it will be perceived that the problem of producing a transformation of entropy condition the reverse of that identified with the phenomenon of "free expansion," consists merely in devising a similar operation, but in which the temperature and pressure are given interchanged parts; in other words, with unchanged aggregate or total volume condition an operation having a drop or unrestrained fall in temperature and a maintained unchanged pressure. This is simple, and is the gist of the whole matter presented in this paper.

Having thus presented the rationale of the subject, I will now take up the demonstration.

In a simple manner I will first describe the phenomenon of "free-expansion" and the resulting *transformation* of the entropy condition from a less to a greater degree of condition.

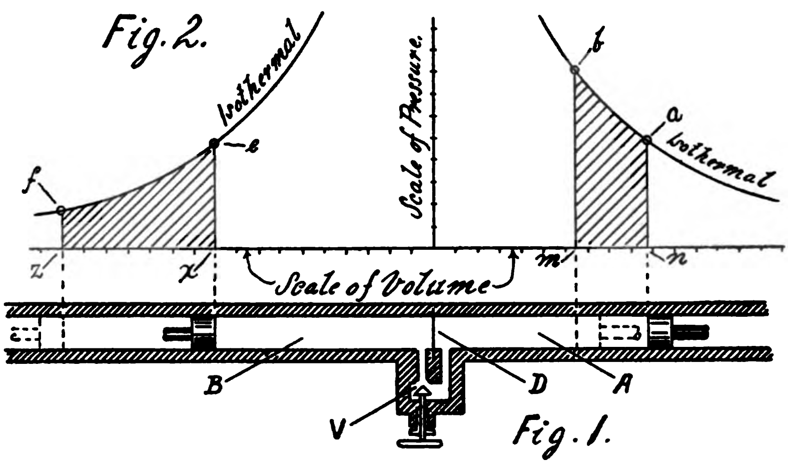

Figure 1 shows an *ideal* type of transforming engine. A and B are insulated cylinders, each closed by its respective piston, and separated one from the other by the diaphragm D, capable of a perfect conduction of heat. V is a stop-cock or valve, is also insulated and controls the flow of gas from one cylinder to the other. By reason of the diaphragm D, the gases in each cylinder always have a common temperature.

Figure 2 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Starting with a *perfect-gas* in each cylinder and the valve V closed, these gases having identically the same composition, volume, pressure, and temperature, which condition is shown respectively at *a* and *e* on the diagram.

The first operation consists in densifying the gas in the cylinder A, through a rising range of pressure and at constant temperature. At the same time the gas in cylinder B is expanded at a sufficient rate to maintain constant temperature in the cylinders by reason of a transfer of heat through the diaphragm D. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points *b* and *f* on the diagram show the respective conditions of these separated gases after having thus passed through the series of conditions shown respectively by the isothermal paths *a-b* and *e-f*. By reason of the compensating action in accord with "the first law of conservation of energy," since the temperature has been maintained unchanged, the area *a-b-m-n-a,* which represents the external work to produce compression, must be equal to the area *e-f-z-x-e,* which represents the external work resulting from expansion, from which it results that the aggregate or total volume of the two gases is now greater than at the beginning of the operation. Also, it will be perceived that, whereas the aggregate entropy condition of these cylinders has not been changed, their respective entropy conditions are now changed an equal amount, but in opposite degree or nature.

The second operation consists in opening the value V and thereby causing the phenomenon of "free expansion." By this means a condition common to both gases is effected without transferring dynamic energy to or from an external source and without resulting a changed temperature, but this return of both gases to a common condition is at *increased* volume and consequent lowered pressure.

Such a result constitutes a *transformation* of entropy condition, and from a less to greater degree of condition. Consequently, so-called degradation of energy is identified therewith.

Also in a simple manner I will now show how another phenomenon effects results which are exactly the reverse of those just described. In other words, will show how to *reverse the transformation* just described.

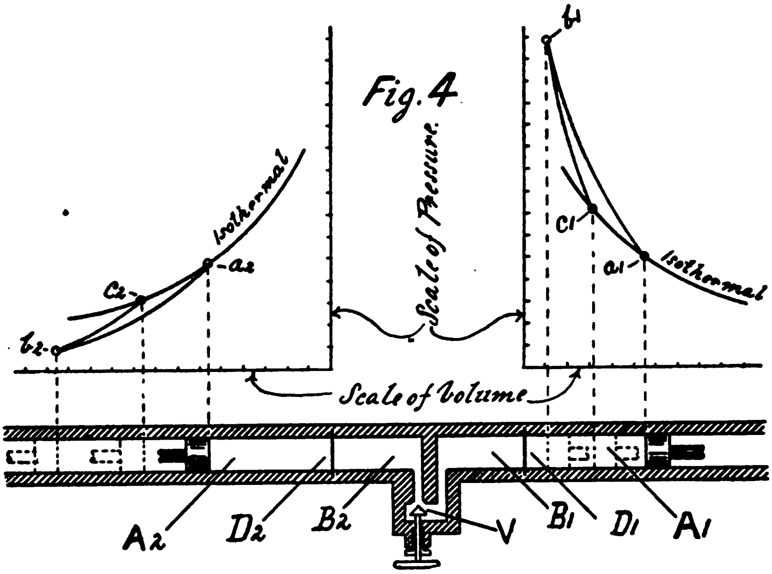

Fig. 3.

Figure 3 shows another *ideal* type of transforming engine. A_1 and A_2 are insulated cylinders, each closed by its respective piston, and each separated from respective insulated adjacent chambers B_1 and B_2 by the diaphragms D_1 and D_2, capable of a perfect conduction of heat. V is a stop-cock or valve, is also insulated and controls the flow of gas from one of these chambers to the other. By reason of these diaphragms the gases in a cylinder and its adjacent chamber always have a common temperature.

Figure 4 is a Clapeyron diagram showing the successive operations in the respective cylinders.

Starting with a *perfect-gas* in the two cylinders and two chambers; for the purpose of simplifying the quantitative computations, each one of the four have identically the same composition, volume, pressure, and temperature; with the valve V slightly open, and thus permit a common pressure in the two chambers and at the same time maintain a thermal insulation between the chambers B_1 and B_2. The conditions in the two cylinders are shown respectively at a_1 and a_2 on the diagram.

The first operation consists in densifying the gas in the cylinder A, through a rising range of pressure and temperature. At the same time the gas in cylinder A_2 is expanded through a falling range of pressure and temperature, at a sufficient rate to maintain *constant pressure* in the chambers B_1 and B_2, all by reason of a transfer of heat through the diaphragms D_1 and D_2. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points b_1 and b_2 on the diagram show the respective conditions of these separated gases after having thus passed through the series of conditions shown respectively by the paths a_1-b_1 and a_2-b_2. This operation effects a reduced temperature in chamber B_2, and an increased temperature in chamber B_1, which causes an overflow of heated gas from chamber B_1, through the valve V, and into the cooled chamber B_2, where an *unrestrained* drop in temperature results with an *unchanged pressure,* and thus effects the desired *transformation* as planned. Also, as regards this operation, it will be perceived that since the common pressure and respective volume for the chambers B_1 and B_2 are maintained unchanged, it results that the internal energy in each chamber is maintained unchanged; consequently, heat, which is conducted through the diaphragm D_1, cannot be retained in these two chambers as specific-heat, latent-heat, nor for transformation into dynamic energy, but necessarily passes through and out by way of the diaphragm D_2; therefore, in this manner, all heat which departs from the cylinder A_1 passes immediately into the cylinder A_2, and in order to maintain the unchanged pressure and consequently unchanged internal energy in the chambers B_1 and B_2, it necessitates that the cylinder A_2 does not receive any heat other than that discharged from the cylinder A_1.

The second operation consists in closing the valve V; then reversed motions are given to the respective pistons of cylinders A_1 and A_2, until each cylinder and adjacent chamber acquire the initial temperature. Dotted lines show the position of the pistons at the close of this operation, and the corresponding points c_1 and c_2 on the diagram show the respective conditions of these separated gases after having passed through the series of conditions shown respectively by the paths b_1-c_1 and b_2-c_2. It will be perceived that the gas contained in the chambers B_1 and B_2 has now undergone a change (as regards the initial and final condition) which is exactly the reverse of that manifested by the phenomenon of "free-expansion." Also, it will be perceived that the whole system has returned to the initial temperature condition, and consequently to the initial condition as regards internal or total conserved energy; therefore it will be perceived that also this operation does not effect a changed aggregate internal energy in the chambers B_1 and B_2.

The device shown in Figure 3 is merely ideal, and is intended to aid in a mental conception of a process. The process only is to be considered.

The device shown is crude and devoid of refinements, particularly as regards the valve V or other suitable device to maintain a thermal insulation between the Chambers B_1 and B_2 and at the same time permit an unrestrained passage of gas from one of these chambers to the other.

The initial conditions have been chosen so as to cause a simple process which can be readily analyzed quantitatively by an ordinary mathematician having an elementary knowledge of thermodynamics. Clapeyron's method of illustrating has been presented because it conveniently shows the method of operation; however, his

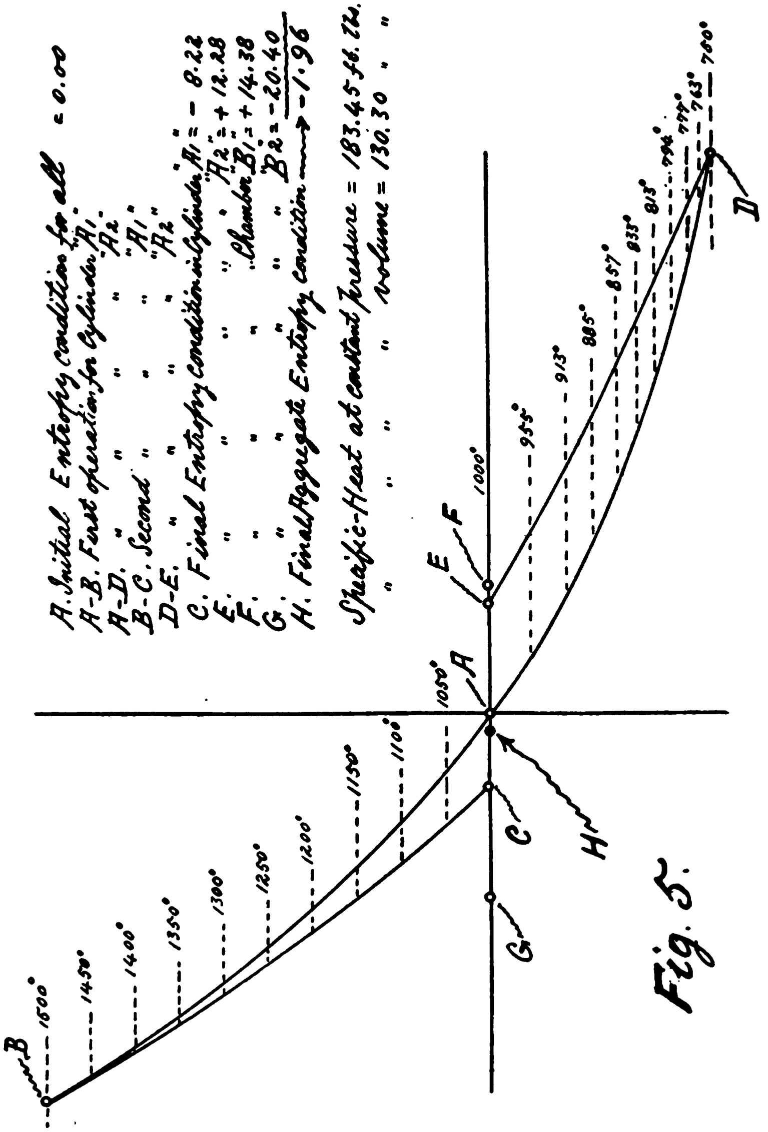

Fig. 5.

type of diagram is not the most convenient for quantitative treatment; consequently, I now present the same matter in the entropy-temperature diagram shown in the following Figure 5.

Figure 5 is accurately drawn to scale, the vertical scale representing temperature, and the horizontal scale representing entropy. The notes explain the diagram, and it will be perceived that the initial temperature is taken at 1000 degrees, and the limit for the upper range of temperature is at 1500 degrees. Also, it will be perceived that the final entropy condition, taken in an aggregate sense, shows a very *considerable* transformation in a *negative* direction from the aggregate initial condition, and thus settles the entire subject matter.

In order to avoid prolixity, all quantitative computations have been omitted from this particular paper. Also, for the same reason, an explanation of the relation between the transformation of entropy condition just demonstrated and "perpetual motion of the second kind" is omitted because the matter is well understood by all physicists; in fact, a favorite way of formulating "the second law of thermodynamics" is a negation of this transformation.

In conclusion, it may be remarked that "the doctrine of degraded energy" has been an important factor in retarding the advancement of Physical Science, and its destruction means rapid and extended progress. Consequently, it is hoped that the matter presented in this paper will be appreciated at an early date.

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