National Archives and Records Administration

NORTHEAST REGION
201 VARICK STREET
NEW YORK, NEW YORK 10014-4811
www.nara.gov/regional

March 10, 2011

Mr. Phillipe Krebs
8 Avenue de la Liberation
LE PLESSIS ROBINSON,
92350
France

Dear Mr. Krebs,

Enclosed you will find a copy of the court records you requested, as well as a receipt for the charge of $181.50 to your Visa card. A total of 242 pages are enclosed, and a citation for the records enclosed appears below. Unfortunately, there is no index to the case records in our holdings, but there are many secondary sources available on the case that may help you find other records of interest.

Thank you for your inquiry to the National Archives at New York. Please take a moment to return the attached customer service form to let us know what you thought of our services.

Sincerely,

Elizabeth E. Pope

Elizabeth Pope
Archivist

RG 21, Records of the District Courts of the United States
U.S. Circuit Court, Southern District of New York
Equity Case 8616 : Electric Vehicle Co. & George B. Selden vs S.A. des Anciens Etablissements Panhard & Levassor and André Messenat
Arthur Constantine Krebs Testimony

A. C. Krebs.
Oct. 31, 1906.

CIRCUIT COURT OF THE UNITED STATES
SOUTHERN DISTRICT OF NEW YORK.

ELECTRIC VEHICLE COMPANY and
GEORGE B. SELDEN,
Complainants.

against

SOCIETE ANONYME DES ANCIENS ETABLISSEMENTS PANHARD ET LEVASSOR
and ANDRE MASSENAT,
Defendants.

Proofs for final hearing on behalf of the Defendants in the above entitled cause taken de bene esse pursuant to due notice before John A. Shields, Esquire, a Standing Examiner, at the office of Coudert Brothers, No. 71 Broadway, New York City, beginning on the 31st day of October, 1906, at 11 o'clock in the forenoon.

Appearances:

Messrs. BETTS, SHEFFIELD & BETTS,
by S. R. Betts, for Complainants,

Messrs. Coudert Brothers,
by John P. Murray, for Defendants.

Thereupon Arthur Constantin Krebs, of the City of Paris, being first duly sworn by the Examiner in behalf of the Defendants to testify to the truth, the whole truth and nothing but the truth did testify as follows:

DIRECT EXAMINATION BY MR. MURRAY:

Q1. Please state what is your name, age, residence and occupation?

A. Arthur Constantin Krebs; 55 years old; residence

2/120

Paris, 19 Ave. d'Ivry; Directeur of the Societe Anonyme des Anciens Etablissements Panhard et Levassor.

Q2. State what has been your mechanical experience; what led you to these studies, and what education have you received on this subject?

Objected to, in so far as it calls for testimony by the witness of work done in foreign countries, as incompetent, irrelevant and immaterial, such work being no defense to this suit on the Selden patent, and evidence of such work being incompetent to invalidate the patent in suit or to affect or limit its scope.

A. In 1870 I entered the army as an officer. In 1877 I was assigned to the engineer corps at the aeronautic station where I studied for six years the construction of derigible balloons. During that period I studied and worked on internal combustion engines. It seemed to me this type of motor might afford a solution of the question of the derigible balloon. Thereafter I occupied myself trying to propel vehicles by means of motors. It is thus that about 1884 I followed with great interest the construction of the small petrol motors of Monsieur Daimler. In 1889 in the shop of Panhard-Levassor was made the first application of this Daimler engine to a vehicle. This firm had also made gas engines of the Otto type and Benz type which they abandoned to give their entire attention to the Daimler motor. Impressed with the satisfactory operation of this small engine, in 1894 I worked at and built a carriage with change-speed [illegible]

clutches. This vehicle pleased Monsieur Levassor very much and I reached an understanding with him to establish their manufacture in the shops of Panhard et Levassor. Upon the death of Mr. Levassor in 1897 I resigned my commission as Major and thereupon became connected with the new company Panhard & Levassor as technical director. From then I have continuously followed and directed the construction of engines and petrol vehicles. It was from that time on that the methods of ignition for motors underwent great modifications. The electric ignition system, which until then had been abandoned as not giving complete reliability, was taken up again when the new small secondary battery afforded means of producing electricity under better conditions. Prior to that direct flame ignition had been preferred, although this did not permit high speed. Then, with the incandescent tube ignition, Monsieur Daimler succeeded in getting 700 revolutions per minute with the little engines that he had specially designed with a view of applying them to automobile vehicles.

Q4. What is your personal experience with carburetters?

Objected to as immaterial and incompetent for the reason that it calls for testimony of use in a foreign country.

A. The first carburetter in use was based on the principle of causing air to pass over surfaces saturated with petroleum distillate in order to produce the combustible gas by vaporization. This arrangement required a constant re-

gulation owing to variable temperature of the air and the degree of volatilization of the fuel. In order that the mixture be explosive, it is necessary that the relation between the weight of air and the weight of fuel be very nearly constant. To accomplish this pumps have been designed with the object of supplying the liquid fuel at the same proportion as the volume of air corresponding to the displacement by the piston in the cylinder. The pump was next replaced by an orifice located in the air induction pipe in such a manner that air and liquid would flow in by orifices having a constant area under the same vacuum. The uniformity of the mixture resulted from this arrangement. Prior to that the power of internal combustion engines was regulated entirely by suppressing completely the suction, and therefore power strokes, when the speed exceeded the predetermined limit. In that way one effected regulation by the system called "hit or miss." This method of control necessitated the inconvenience of a large fly-wheel in order to maintain uniform speed. In a vehicle the engine should be as light as possible. It was therefore desirable to reduce the weight of fly wheel in proportion to the power strokes and the work to be performed. That is to say to reduce the volume of mixture introduced in order to obtain less powerful strokes. It is in view of this that I have made a study of the theory upon which I have constructed the automatic carburetter which affords a means of supplying the motor with a perfect mixture

Q5. Say when you saw for the first time a self-propelled vehicle and what was your personal experience in connection with automobiles?

Same objection as to Q4.

A. In 1867 I saw for the first time the automobile vehicle of Lotz. Thereafter in 1878 the vehicle of Bollee. Since then I have seen first steam vehicles in operation, and since 1891 vehicles of various types propelled by petrol. Since 1894 I have been occupied with the construction of vehicles having explosion engines.

Q6. Will you please describe briefly the vehicle of Lotz of 1867, and the vehicle of Bollee of 1878?

Objected to as calling for incompetent testimony, the witness not having been qualified as one familiar with the so-called Lotz & Bollee vehicles, and as immaterial in that the alleged vehicles, if they existed, were propelled by steam and not by gas engines of any description, and for the further reason that the question calls for testimony of uses of alleged mechanisms in a foreign country, such testimony being incompetent in this suit.

A. The vehicle of Lotz consisted essentially of a steam generator carried on a forecarriage with fifth wheel with a coupling (king bolt) pin and with a trailer consisting of an axle and two wheels, one of which wheels could be connected or disconnected from the axle in order to permit

endless screw gearing with a sector connected by chains to the ends of the front axle. The Bollee vehicle of 1878 was exhibited at the Champ de Mars in Paris, to which place it had been propelled under its own power from Le Mans. One of the distinctive features of this vehicle consisted in the articulation of the front wheels which involved the individual pivoting of each wheel. This is the same arrangement which we find today in the steering mechanism of practically every automobile vehicle. The boiler was vertical and the engine drove the rear wheels by means of chains.

Q7. If you know say what kind of an engine was used on the Lotz vehicle and if you saw it operating and, if so, where and when?

Same objection as to Q6.

A. It was a steam engine and transmitted its power to the wheels by means of gearing. I saw this vehicle running at Lons le Saulnier, in view of a trial made with this machine under the direction of Mr. Lotz when he made a trip for advertising purposes in 1867, if I remember rightly.

Q8. Please state what engine was used on the Bollee vehicle and describe it, and state whether or no you have seen it operating. In case you have, where and when?

Same objection as to Q6.

A. I only saw the Bollee vehicle at the Exposition of 1878. I did not see it operating, but I was impressed with some of the mechanical features of it, among others,

the steering wheels.

Q9. Please state where and when, for the first time you saw a vehicle propelled by a Benz engine?

Objected to as incompetent in that it calls for testimony of use in a foreign country, and as indefinite for the reason that it appears of record that Benz engines were of various kinds and it does not appear to which kind reference is made.

A. I saw a Benz vehicle operated in Paris about 1891 or 1892. The transmission was effected from the engine to a shaft, by means of belts which shaft drove the driving wheels by chains. I never had the opportunity of closely examining a Benz vehicle until 1894.

Q10. Tell whether or no the Benz vehicle had a body, and if so describe it briefly?

Objected to as indefinite, for the reason that it does not appear what particular vehicle is being referred to, and as incompetent for the reason that it calls for testimony of use in a foreign country.

A. It is difficult for me to describe the Benz vehicle which I first saw because I confuse it in my mind with the one which I examined more in detail in 1894.

Q11. Please state what is the relation between the number of revolutions of the crank shaft and the number of revolutions of the wheels in the Benz vehicle?

Same objection as to Q10.

A11. I do not know what relation, but it appears to me that the motor always revolved faster than the wheels.

Q12. State whether or no there was a clutch or a disconnecting device permitting the motor to rotate free, and if so, for what purpose?

Same objection as to Q10.

A12. I am not certain of the means but there was some means permitting the motor to run free. This was operated when the vehicle stood still. The purpose was to permit the motor to be started while the vehicle was at rest.

Q13. Please give all details regarding your mechanical experience as far as you remember, year by year, Describe also as fully as possible the various subjects on which you have been engaged since you began your mechanical work?

Objected to as calling for incompetent testimony in so far as it calls for testimony by the witness of work done in foreign countries.

A13. Previous to 1870 my education had been particularly directed to preparation for L'Ecole Polytechnic; but owing to the war with Germany, and my being in Besancon on the frontier, I was not able to take the entrance examinations, because they did not take place. I entered an artillery regiment and about November, 1870, as sub-lieutenant in an infantry regiment. After the war I was transferred to St. Cyr School, where I remained for one year in order to complete my military education. Since then I have continually been occupied with mechanical matters, and I applied myself

to studies to equip myself as engineer, by my own efforts, keeping myself in close touch with new developments in the mechanical arts.

In view of this, in 1877 I was detailed to the Engineer Corps Staff in order to study and investigate the utility of balloons in warfare. From 1877 to 1885 I cooperated in all of the work on the construction of captive balloons for military purposes and for their use in warfare. This work comprised, in addition to the construction of balloons proper, the study and construction of material for readily producing hydrogen gas, and also of vehicles with steam windlasses for handling balloons, etc. All the mechanical work has been the subject of special study by me, and to accomplish this I constructed and organized a shop located in the Park of Chalais at Meudon, which shop is still in existence. At the same time I collaborated in the study and in the construction of the derigible balloon "La France", the first balloon equipped with a motor which rose in the air and manoeuvered successfully and returned to the starting point. The first ideas entertained for the propulsion of balloons involved the idea of a gas engine but the study of the subject soon showed me that in view of the actual conditions of the construction of these motors they were much too heavy.

It was then that I selected an electric motor operated by a very light battery. Electricity was then undergoing great development and I was therefore led to its study in

378

order to solve the problem of the derigible balloon. It was suggested to the Minister of Marine that this same method of an electric motor be employed for propelling sub-marine which is the propulsion of a floating body capable of ~~xxxxxx~~ diving below the surface of the water. I was then detailed on naval construction service from 1886 to 1890 to collaborate in the construction of the submarine "Gymnote", which has been the model type for the construction of a number of sub-marines for the navy, until it became possible to displace the electric motor by the petrol motor.

About 1890 I was instructed to study for the fire brigade of Paris vehicles for salvage apparatus, and at that time I attempted to follow up the work that was being done to adopt the small petrol engine of Daimler to automobile vehicles. In 1894 I commenced work on a vehicle equipped with a Daimler motor driving the wheels by means of a ~~xxxxx~~ speed changing gear controlled by magnetic clutches. The result of these studies was my securing a patent on the thirteenth of May, 1896, which resulted in my consummating my connection with the firm of Panhard & Levassor. In 1897 upon the death of Mr. Levassor I tendered my resignation as Major and became technical director of the Societe Anonyme des Anciens Etablissements Panhard et Levassor. Since then I devoted all my time to the general management of that firm and the development of engines and mechanical parts of vehicles and especially to the study of carburetters. This study has resulted in giving the petrol motor the flexibility and range of power

3478

requisite for the driving of vehicles. The first difficulty which I met in the working out of a carburetter was the maintenance under all conditions of a constant ratio between the weight of air and fuel. It was after a very precise theoretical study of all the constituent elements which are involved in carburetion that I designed the automatic carburetter as it exists today. The results I desired to accomplish materialized upon the first trial and without it being necessary to modify by experiment the dimensions predetermined for the construction of the apparatus. With this carburetter it is possible to vary either the speed of the engine under constant load, or the power at varying speed, or both the power and the speed at the same time. Immediately after this study I was led to recommend the use of a petrol engine, thus rendered very flexible for driving submarine boats. The construction of 22 boats was started in 1902, driven by 60 horse power engines, which were constructed in our shops. At present I am also constructing petrol engines of the same power for derigible balloons for the War Department, which are still lighter than those for the submarines. I may therefore say that all the work that I have undertaken equipped me especially to be very thoroughly informed on the question of internal combustion motors. I may add that my carburetter, known as the Krebs carburetter, is the only one actually used on all Panhard et Levassor vehicles, and there is great demand for its use on other makes of vehicle.

3 x 60

Q14. Please state when Panhard et Levassor commenced the construction of automobiles and engines for such, and in reply thereto produce, if you have them, letters or documents authenticating these dates and the first actual operation of automobiles of the Societe Panhard et Levassor?

Objected to as irrelevant, immaterial and incompetent, for the reason that it calls for testimony by the witness of work done by the Defendant Company, a foreign corporation, in foreign countries, such work having no bearing on the scope or validity of the patent in suit or on any issues raised by the pleadings herein.

A14. Panhard et Levassor commenced the construction of automobiles/ vehicle engines as early as 1889; at the same time the firm of Peugeot, who was constructing quadricycles, made arrangements with the firm of Panhard et Levassor to purchase their light engines in order to use them on their quadricycles. Up to 1895 these two firms were in intimate relations, as shown by letters from the Peugeot firm from December 30, 1889 to January, 1895. From that time on the Peugeot firm decided to construct their own engines. Among other letters there is one of March 17, 1890, in which Peugeot states the satisfactory result obtained with a Daimler engine, and wishes to know if a so-called 5 horse power engine does not really give more than 5 horse power; in one dated July 30, 1890, it is stated that the operation of a quadricycle equipped with an engine is not satisfactory. 9481

There is also mention of two other vehicles which shortly would be completed, and if the engines operate satisfactorily they are to serve as a type; in another letter, dated October 3, 1890, is mention of the question of the Peugeot firm, constructing petrol vehicles equipped with Daimler engines, the operation of which has been more satisfactory than anything of the kind. In another letter, October 25, 1890, the Peugeot firm placed an order for 20 engines of 2 horse power each, of the same type which had already been delivered. In 1891 the firm Panhard et Levassor made the first vehicle equipped with its Daimler engine, which first vehicle was soon followed by several others, which worked sufficiently well to offer them for sale. A leaflet of testimonials shows that as early as October, 1892, the vehicles sold to various customers had given entire satisfaction. A price list of January, 1892, lists petrol vehicles. In 1894, at the trials of the Petit Journal the Panhard et Levassor carried off the first prizes (2 Panhard and Levassor vehicles, 2 Peugeot vehicles, equipped with Daimler engines furnished by Panhard et Levassor). Paris-Bordeaux-Paris, June, 1895, Carriage No. 5, equipped with Daimler engine, made the run there and back without stop. The Peugeot vehicle equipped with Daimler motor, and another vehicle of the firm Panhard et Levassor, were also among the first.

Q15. Can you produce any of the first catalogues and price lists of the Panhard et Levassor firm?

9-482

~~A15.~~ One of January, 1892, another of October, 1892, and a third of the 1st of December, 1895.

Q16. Can you give a description of the engine embodied in the vehicles of the Panhard et Levassor firm made before 1895?

The question is objected to as calling for testimony of use in a foreign country.

A16. The first engines constructed up to 1893 had one or two cylinders with the connecting rods acting in one plane on the same crank located between two fly wheels. The motors with two cylinders had their cylinders in the same plane and inclined with their axes disposed V shape. The inlet valves were automatic. The exhaust valves were controlled by stems, the movement of which was effected by cams sliding in a spiral groove in one of the fly wheels. The ignition was effected by means of a small platinum tube in communication with the interior of the cylinder and heated externally by the flame of a burner supplied by petrol under pressure of about 30 centimeters of water (3/100 of an atmosphere). The engine operated on the four cycle principle, that is, that the charge drawn in by the piston was compressed by it in the upper part of the cylinder previous to its ignition. The ignition resulting from this very compression which had the effect of driving the gas in the cylinder into the platinum tube. The location of the hot part of the platinum tube was so arranged that the gas driven into it reached the incandescent part at

the moment the piston reached the upper part of its stroke. If ignition took place sooner the engine gave less power; the regulation of the motor consisting in carefully determining the position of the burner in order to properly heat the platinum tube. The engine was provided with a ball governor suppressing the exhaust of the burned gases as soon as the engine ran at too high a speed. The burned gases not being allowed to escape the cylinder remained filled and did not draw in a fresh mixture. Therefore no power stroke took place as long as the governor prevented the exhaust valve opening. In 1894 a new type was substituted in place of the model which has just been described. This consisted of two parallel cylinders in which moved two pistons each acting by their connecting rod on the crank shaft carried in a casing which supported the cylinder, one fly wheel being fastened at the end of the shaft. The inlet valves were still automatic; the exhaust valves were operated by cams mounted on a special shaft located parallel to the crank shaft and operated by the latter by means of a set of gears causing the cam shaft to rotate at one-half the speed of the motor shaft. A ball governor mounted on the cam shaft determined the speed of the motor by preventing the opening of the exhaust valve. This arrangement slightly differing from the one used on the previous engines, produces the same result, that is, the suppression of the in-take until such time as the engine speed slowed down below the normal. This type of motor was constructed until 1897. In both of these engines ignition was effected as I have de-

scribed it above, that is by means of a platinum tube brought to incandescence. The combustible mixture was generated in the same manner in these engines. Carburetion was effected as follows: the inlet valves were connected by a pipe with the tank containing a volatile liquid hydrocarbon. During the suction stroke fresh air was led to the tank by a pipe bringing it in close proximity to the surface of the hydrocarbon whereby it became charged with combustible vapors before it reached the cylinders by the pipe connecting the tank to the inlet valve. The combustible mixture thus generated being too rich, an opening communicating directly with the air, and easily closed by a valve, allowed the introduction into the pipe, connecting the tank to the inlet valve, of a quantity of pure air the amount of which could be easily controlled by the valve. This device, however, required a new setting of the regulating valve whenever the temperature of the tank and of the liquid hydro-carbon varied, or when the hydro-carbon became poorer in volatile parts after having been in the tank for some time. In order to remedy this cause of trouble Mr. Daimler invented in 1893 his atomizing carburetter. This device operates as follows: in the pipe conducting the air to the inlet valve there is located a very small pipe through which liquid hydro-carbon can flow. Owing to the suction caused by the engine a partial vacuum is produced in the inlet pipe which, drawing air on the one hand and the liquid hydro-carbon on the other, causes them to flow simultaneous-

ly through their respective orifices. The liquid flowing through its narrow aperture falls in with a very swift stream of air which causes its atomization. This breaking up of the fuel has the effect of increasing greatly its surface of contact offered to the air, and it transforms itself almost instantly into vapor, this causing a great lowering of the temperature of the air, and mixing with it forms the combustible mixture which is carried into the cylinder. It may be noticed that by means of this device the two fluids are caused to flow through orifices the area of which has been previously determined in order to give the most suitable proportion of weight of fuel and that of air. That ratio is independent of the vacuum which causes the flow of the fluids. It can therefore be understood that in such condition the gaseous mixture remains the same whatever the speed of the engine. The engine will therefore be able to operate in the best possible condition independently of its speed.

Q17. Please describe the means employed for transmitting the power of the motor to the wheels in the Panhard vehicles constructed before 1895?

Same objection as to Q16.

A17. As early as 1890 the transmission of the power of the engine to the driving wheels of the vehicle was accomplished in the following manner generally speaking: the engine shaft was prolonged at one end by a shaft capable of being connected or disconnected to the engine shaft by means of a clutch operated by the foot or hand, by properly dis-

posed levers. The extension of the engine shaft carried a sleeve which could be slid on it. This sleeve carried generally three gear wheels having different diameters and adapted to engage respectively with three gears carried by a third shaft located parallel to the first one. By shifting the sleeve any one of the gears could be brought into mesh with the complementary gear of the third shaft. This operation was accomplished by means of a lever shifted by hand, which caused the sleeve to slide and to stop in any one of the three positions of gear mesh. In order to shift the sleeve it was necessary to disconnect the motor shaft by actuating the clutch. A locking arrangement was provided with the object of preventing the shifting of the sleeve so long as the motor shaft was not disconnected. At one end of the third shaft was mounted a bevel gear inmeshing with a bevel pinion keyed to the balance gear, the axis of the latter being placed parallel to the axle of the driving wheels. On the outer ends of the balance gear shafts were keyed sprockets driving sprockets on the rear wheels by means of chains.

In the first vehicles built up to 1893-1894, the driving axle was driven by a single chain, in which arrangement the balance gear was mounted on the axle instead of the counter-shaft driven by the bevel pinion of the third shaft. The driving wheels were then keyed at the outer ends of the shafts of the differential, which thus constituted the axle.

The slackening of speed of the vehicle or its stopping was accomplished by a drum on the chain shaft, which could be retarded by a brake operated by a foot pedal. In order not to be compelled to stop the engine when the vehicle was stopped, the braking action on the drum could only take place after the motor had been disconnected by operating the brake pedal, effecting at the same time the disconnecting clutch. Thus this unclutching was automatically accomplished when the speed of the carriage was slackened or when it was stopped.

Q18. State whether or not a clutch mechanism or some means of disconnecting the motor from the speed changing gear was in use on the Panhard vehicle before 1895, and if so, what was the object of such device?

Objected to for the same reasons as for Q16, and for the additional reason that the question is leading and suggestive.

A18. Ever since the Panhard Company began to build petrol engines the motor shaft has always been connected to the speed changing mechanism by a clutch. This clutch is necessary to allow the passing from one speed to another, that is, to disengage the gears in mesh and bring into mesh the gears corresponding to the speed wanted. Such an operation can only be performed by reducing in the desired ratio the speed of the two shafts carrying the gear wheels. As the shaft connected to the driving

wheel cannot change its speed, owing to the inertia of the vehicle, it is therefore the speed of the shaft, interposed between the engine shaft and the one just mentioned, which must be modified. As the speed of the engine is regulated by its governor, it may be readily understood that it becomes indispensable to disconnect it from the shaft, which must undergo a change in speed. Moreover, the clutching action must be progressive, that is, it must allow for a certain slip in order to impart without shock to the vehicle the power of the engine. While the clutch is being applied, both the vehicle and the engine modify their speed until they correspond to the gear ratio slected. Clutching mechanisms are well known and are numerous, but in practice, however, the friction cone, leather covered, has been adopted.

Q19. Please state the ratio between the number of revolutions of the crank shaft and of the driving wheels in the Panhard vehicles built previous to 1895?

Objected to as immaterial and incompetent, in calling for testimony of use in a foreign country.

A19. The speed ratio was about as follows: for the first speed 20, for the second speed from 12 to 13 and for the high speed from 6 to 7. That is to say at the first speed the engine was turning about 20 times faster than the driving wheels, at the second speed about 12 times as fast, and at the high speed about 6 times as fast.

Q20. Please specify the location of the engine in the Panhard vehicle built before 1895?

Same objection as to Q19.

A20. In the first 4 or 5 vehicles the engine was located near the middle part of the vehicle between the axles, but almost immediately thereafter it was decided to locate the engine at the front of the vehicle above the axle supporting the steering wheels, the axis of the engine being located longitudinally, that is, at right angle to the axle. In the Peugeot vehicle equipped with Daimler engine furnished by the firm of Panhard & Levassor, the engine was placed at the rear of the vehicle the axis of its shaft being located at right angles to that of the axle.

Q21. Kindly examine this exhibit of the defendant, No. 165, and please say whether you know what it is?

A21. This document is an illustrated catalogue of the firm of Panhard & Levassor describing the petrol engine but more especially the two seated vehicle constructed and offered for sale as early as 1891. The picture shows clearly the forward location of the engine; the driving of the rear axle by means of a chain; the speed changing levers, and the clutch levers that I have just described. The description inserted in the catalogue gives some information regarding the engine, the steering of the vehicle, the possible speeds which may be reached, and finally all information relative to the starting of the engine and the vehicle and their stopping.

Q22. Please say whether or not the defendant's exhibit No. 165 comprising the catalogue of January 1892, the catalogue of October 1892, and the catalogue of December 1, 1895, describing the vehicle sold by Panhard & Levassor at these respective dates?

Objected to as leading and suggestive.

A22. The three documents above mentioned are actually catalogues of the firm of Panhard & Levassor. Those of 1892 describe the same vehicle two seated or four seated. The catalogue of 1891 describes only two seated vehicles but gives the information that a four seated vehicle would be built next year, and states the price of this vehicle. The catalogue of 1895 illustrates a vehicle equipped with a motor developing 4 horse power. In this type of motor the axis of both cylinders are parallel instead of forming a V as said previously in the description given of these different types.

Q23. Kindly state what was the object of printing the catalogues mentioned in the preceding question?

A23. These catalogues were sent to customers who wished information from the firm of Panhard & Levassor concerning these vehicles. They were also distributed to the public at the cycle shows which took place yearly, lately at the Palace of Industry. It was at this show that the first small Daimler motor constructed by Panhard & Levassor appeared first, and the first automobile vehicles were shown afterwards. After every automobile race the vehicles which had

covered the course were also exhibited at the Palais de l'Industrie to be shown to the public, and the catalogues were distributed on such occasions.

Q24. Please state if you know at what date the paper marked "Attestations" was printed, and for what object?

A24. This sheet was printed in 1894 in order to be distributed to the public at the exhibition of vehicles which had taken part in the race "Concours du Petit Journal", 1894.

Q25. Please state how many copies of the paper marked "Attestations" were placed in circulation?

A25. I cannot give you any figure about it.

Q26. Please tell me what is the book I am showing you now. It seems that it is dated at the foot of the fifth page, Paris, July, 1895?

A26. This document is the catalogue that the firm of Panhard & Levassor wrote and published immediately after the Paris-Bordeaux Race and return, where one of its vehicles driven by Mr. Levassor himself, showed how great was the reliability of the vehicle constructed by the firm? — Monsieur Levassor drove his vehicle in both directions without any stops but those required for taking on petrol and water. This catalogue shows also that the manufacturing of the vehicle had already reached a vast extension, the number of different types of vehicles constructed by the firm reaching 19.

Q27. State why this catalogue was printed, what date, and how many copies were placed in circulation?

Objected to as immaterial and irrelevant.

A27. The object was to let the public know that automobile vehicles could be applied to all sorts of uses. It was printed immediately after the Paris-Bordeaux race. I do not know how many were distributed.

Q28. State whether or not it described the vehicle sold by Panhard and Levassor in July, 1895, if any were sold at all?

Objected to as incompetent, for the reason that it calls for testimony of use in a foreign country.

A28. It describes completely the vehicle sold by Societe Panhard & Levassor in July, 1895. Quite a number of these vehicles were sold, and few of them have come back during the eight years to our shops to be repaired. I even noticed that the motors, especially, were still working quite well. The owners were very well pleased, and I have seen one of them about this matter in my office a few days before my departure for New York. His vehicle will be in a parade organized by the Automobile Club of Paris, where the oldest type of automobile vehicle used, or having seen service, will be exhibited.

Q29. State, if you can, the number of vehicles constructed to run on roads appearing in the catalogue I hand you, which were sold by the Societe Panhard & Levassor pre-

vious to November 1, 1895?

Same objection as to Q28.

A29. At least one sample of each of the vehicles described in this catalogue was constructed. As a matter of fact, no new model was studied and constructed before receiving a formal order from a customer. But I find it impossible to state the exact number of each type sold, as I have never given any attention to this question before now. I must state, however, that by the month of July, 1897, more than 600 vehicles had been constructed and sold. At the time I became manager of the firm ~~mfxR~~ the numbers of the engines exceeded 700, and I started the numbering, ~~im~~ in the name of the new company at 1000 in order to simplify the bookkeeping. I am therefore in position to state that the number of carriages sold by Panhard & Levassor on the first of November, 1895, was certainly im excess of 100.

Q30. In your answer to question 23 you mention shows at which catalogues were distributed. Kindly specify where, when and what was the object of those exhibitions?

Objected to as incompetent, in that it calls for testimony of use in a foreign country.

A30. I have said that petrol engines built by the firm were at first exhibited in the Cycle shows, which took place every year, ~~xxxxxxxxxxx~~ in the fall months, at Paris, at Palace de l'Industrie. At these shows the ptrol engine was exhibited as applied in various industries, for boat propulsion

that the first vehicles were exhibited in 1892, but as early as 1891 catalogues of small engines, describing various purposes to which they could be applied were distributed at those cycle shows. These exhibitions still take place annually in Paris, but after every automobile race there has always been a special exhibition of the vehicles having taken part in the race. It is at these various exhibitions that these different catalogues were distributed.

Q31. Can you state if before January 1, 1895, there existed any parties in France who were constructing and selling self-propelled vehicles, capable of being driven over ordinary roads?

Objected to as irrelevant, immaterial and incompetent, for the reason that the question specifically calls for testimony of use in Paris, France. Evidence of this use is incompetent.

A31. In 1894 the three largest constructors of automobiles were the firm of Panhard & Levassor, who were manufacturing under the French Daimler patents; the firm of Peugeot of Valentigny, who bought their engines from Panhard & Levassor; and the firm of Roger, who constructed vehicles equipped with motors of the Benz Company. Several other constructors, such as Lebrum and Vacheron, also built a small number of vehicles equipped with Daimler engines. All these types of vehicle took part in the races organized by Le Petit Journal over the Paris-Rouen course, on the

Panhard & Levassor vehicle and the Peugeot vehicle. These automobiles showed themselves greatly superior to the steam automobiles, which were also entered in this race (see the publication La Nature, July 20 and August 25, 1894).

Q31. State if you have seen automobile races prior to January, 1895, and if so where and when?

A31. I was present on the 18th of July, 1894, in the morning, at the starting of the automobile vehicles entered in the race of Le Petit Journal. The starting took place at La Portmaillot. At least 20 vehicles reported to start.

Q32. State if the Panhard & Levassor Company had entered vehicles in these races, and if so describe them?

Same objection as to Q31.

A32. The fim of Panhard & Levassor had entered two types of vehicles: a two-seated with a top, the motor being placed at the front of the vehicle; a four-seated vehicle, with a canopy top, the motor being also located at the front of the carriage. These two vehicles won the first prize in their classes. The two-seated carriage was equipped with two chains, each one driving one of the rear wheels, as I have described in my answer to question No. ——The four-seated vehicle had only one chain, driving the rear axle carrying the differential, as I have also described in my answer to the same question. The wheels of these vehicles were made of wood and had plain, solid rubber tires. (See La

Q33. I show you a copy of La Nature of August 25, 1894. State what is the subject of the article commencing page 198?

A33. This article illustrates and summarizes and briefly describes the arrangement of the different types of vehicles which took part in the race of the Petit Journal, run from Paris to Rouen the 18th to 19th of July, 1894. They are there set forth in the order in which the awards were made. The two first prizes (for two and four passenger vehicles) were given to Panhard & Levassor, and the two other prizes went to Messrs. Peugeot for their petrol vehicle equipped with a Daimler engine made by Panhard & Levassor.

Q34. State whether or not the illustrations forming part of this article correctly represent the vehicles as you remember them?

A34. These illustrations were made from photographs actually representing the vehicles at the time of their starting. I recognize in the two passenger Panhard & Levassor vehicle Monsieur Levassor holding in his hand the steering lever. Likewise the four passenger Panhard & Levassor vehicle is driven by Monsieur Mayade, superintendent at that time of the Panhard & Levassor firm, who can be readily recognized in the illustration. Both of these persons have since died as a result of automobile accidents. I also recognize readily the petrol vehicle of Monsieur Roger with its motor in the rear. That motor was of the Benz type driving the jack shaft by means of belts.

Q35. Were you present at one or more automobile races in 1895?

Objected to as immaterial and irrelevant.

A35. Yes, I recall well in the Paris-Bordeaux-Paris race the return of the two passenger vehicle which was driven by Monsieur Levassor. That vehicle and its driver had made the trip there and return, 1175 kilometers, without stops other than those necessary to replenish with fuel, in about 48 hours. Unfortunately the first prize for the performance could not be given to it because it could not be awarded a vehicle with two passengers. Nevertheless the performance of this vehicle was considered most successful.

Q36. Say if the Panhard & Levassor Company had entered vehicles in all of these trials?

Same objection as to Q35.

A36. The Panhard firm never lost any opportunity to show their vehicles. They never failed to enter them in trials or other exhibitions, and unless I am mistaken the first prizes were always taken by them until 1900. Prior to 1895 and during that year the type of vehicles entered were in all cases built according to the arrangement I have described in answer to question No. 17. The seating capacity was either 2, 4, 5 or 6, depending upon the dimensions and shape of the body. The engines were always placed in the front, that arrangement having been adopted by the Panhard-Levassor Company after the very first trials because it

offered facility for inspecting the engine and permitted while running to oil it and to regulate the carburetter if needed.

Q37. I show you a copy of La Nature dated July 6, 1895. Please state the subject of the article beginning on page 84?

A37. This article relates to the Paris-Bordeaux-Paris race. It gives a brief description of the vehicles which finished the run within the time limit. The cuts which illustrate the article represent the vehicles in the order in their class in which they had finished the run. In the lead we find the two passenger Panhard-Levassor.

Q38. What is the publication La Nature, and when and how many times does it appear, and what is the extent of its circulation?

A38. La Nature is a review of sciences and their application to arts and industries. It is edited in Paris by Mason, Boulevard St. Germain No. 120. It appears weekly. Its circulation as near as I can remember is about 40,000. It is on file all over the world in the principal libraries. Besides it is received at all public libraries. The Scientific American often reproduces articles which have appeared in La Nature, and vice versa.

Q39. Please state what is represented in the illustration in the defendant's exhibit 172?

A39. The exhibit before me is a number of the Scientific American Supplement October 6, 1894, on pages 15648 and

15649 of which I find illustrations and descriptions which appeared in issues of La Nature of August 25, 1894, in reference to the Petit Journal race. In comparing these two documents I see that the illustrations are identically the same.

Q40. State if you can what the illustrations in defendant's exhibit 173 represent?

A40. This exhibit is an issue of the Scientific American Supplement August 10, 1895, on the first page of which I find reproduced the article and illustrations given in La Nature in the number dated July 6, 1895, referring to the Paris-Bordeaux-Paris race. The illustrations of that article are exact reproductions of those in the journal "La Nature."

Q41. I show you a paper entitled "Quadricycle Peugeot 1891." Please say if you know what it is?

A41. This paper is an illustrated catalogue of the quadricycle built by the Peugeot firm with Daimler petrol engines bought from the fim of Panhard-Levassor. The trials and purchase of this engine resulted in negotiations between the two firms as early as 1889. During 1890, as is shown by the correspondence to which I have referred in answer to question No. 14, the trials were made jointly by both companies. As early as 1891 the Peugeot firm was in position to deliver this quadricycle which appeared at shows and trials and in the different races. We see in the description

in this catalogue under the heading MOTOR that it is of the Daimler system as manufactured by the firm of Panhard & Levassor, 19 Avenue d'Ivry, Paris.

Q42. I show you a book bearing the name Panhard & Levassor, and dated on the 5th page, "Paris, July, 1896." State if you know what it is?

A42. This document is a catalogue of automobile vehicles of the Panhard & Levassor firm.

Q43. When for the first time did you see the United States Letters Patent No. 549,160, in the name of George B. Selden?

A43. In 1903, I believe.

Q44. Please state whether or not the construction or manner of operation of Panhard vehicles has been changed in any manner whatever in view of the details contained in that patent.

A44. When I first saw the drawings of Mr. Selden's invention the arrangement seemed to me so very antediluvian that I did not attach to it any importance.

Q45. Please state whether or no the examination of this patent by you gave you information which assisted you in the construction of Panhard automobiles?

Objected to as immaterial and irrelevant, for the reason that the Panhard Co. and not the witness is the defendant in this suit, and for the additional reason that the witness has testified that he was not

connected with the defendant Company until the year 1897.

A45. To be frank, when I glanced at this document for the first time the appearance of the drawing showed to me that there was nothing in such an arrangement which could be retained for a matter of this sort. It is only about a year ago that I have been led to more carefully examine this document, when it was brought to our attention as being an anticipation which had some value with reference to the construction of automobile vehicles.

Q46. Please describe the different changes which have been made in Panhard vehicles from November 1, 1895, to the present time?

Objected to as immaterial.

A46. These changes amount to the following: 1897, the motors were constructed up to 4 cylinder in order to obtain a power greater than 7 horse, and to uniformly distribute the torque on the shaft. In this way we got a power stroke for every half revolution. Besides the proper setting of the 4 cranks resulted in a reduction of vibration of the motor which was caused by the inertia of reciprocating parts. 1898--, the steering which had been effected by means of a lever operated by a steering handle was changed, so that an endless screw was used to deflect the steering wheels. Until 1901 there were no important changes either

spect to the power of the ~~mik~~ motor. In 1901 the cylinders of the motor were slightly changed so as to cast in one piece the cylinder and the head with its valves. There was also introduced in the carburetter a throttle arranged in the mixture in-take pipe in order to vary the power of the motor without cutting out impulses. In the change speed box the reverse which had been obtained by shifting the differential so as to mesh with one or the other of the bevel gears at the right or left, the bevel driving pinion was changed in the following manner: the differential was always driven in the same direction as the driving pinion, the reverse being obtained by bringing in an idle gear when on first speed, to engage with the two gears which produced that speed. In 1902 the carburetter of 1901 was replaced by my automatic carburetter. In 1904 the power of the motor used for propelling vehicles having been greatly increased, owing to the adoption of the automatic carburetter, which permitted the variation of the power from 0 to the maximum output of the engine, the clutch arrangement, consisting of friction cone became insufficient, and was replaced for powers exceeding 25 horse by a multiple disc clutch running in a bath of oil. The pressure exerted by means of a spring on the discs results in sufficient friction between them so that the total friction becomes more than the power of the engine. In 1904 also the speed changing gear embodied a combination of gears which permitted direct driving from the

ing through a countershaft. This arrangement is called the "direct-drive." At the same time that the power of the motor was increased the wheels of vehicles were equipped with pneumatics similar to those which had already been used on bicycles. Thanks to this important improvement in wheels, the speed of vehicles which previously had not been practically in excess of 20 to 25 kilometers now made it possible to run at 40, 50 or even 60 kilometers as early as the end of 1899. In 1900 the advent of the larger diameter pneumatic tire permitted vehicles having motors of 25 to 30 horse power, to reach speeds of 80 to 90 kilometers. As a matter of fact, the only obstacle to realizing in practice these great speeds is the condition of the roads. To summarize, we have in the vehicles of 1892 and those of the present day very little difference, as far as the general arrangement of elements is concerned. The engine is still placed in the front, the change speed gear is on the extension of the motor shaft and operates a differential the axis of which is parallel to the axle of the rear wheels or placed on the rear axle itself. In the first case the power of the differential shaft is transmitted by chains, in the second case the driving wheels are driven by the shafts of the differential. As far as concerns the engine the improvements have consisted in increasing the power by increasing the number of cylinders to 4 and increasing the diameter of these cylinders; in improving the carburetter, to insure in all cases a car-

buretion, or a combustible mixture as uniform as possible; in placing in the hands of the operator the essential means for regulating the power of the motor and its speed; in controlling the water circulation and insuring its cooling by passing it through radiators. As for the change speed mechanism, in proportioning it for strength and solidity to the power of the motor; in enclosing in a tightly closed casing all the parts of the transmission. As for the vehicle, providing the wheels with elastic tires (pneumatics) enables the overcoming of obstacles which are encountered on roads at such a high speed so as not to result in shocks too severe for the essential parts of the vehicle.

Q47. Have you made any special study of internal combustion engines; if so, when and for what purpose?

A47. In 1882, for the purpose of driving a derigible balloon, which was then being investigated by the Ministry of War, I undertook the development of an internal combustion engine which was to use as a fuel the hydrogen which inflated the balloon. It was on this occasion that for the first time I thoroughly attacked the complete study of internal combustion engines. At that time these engines could be divided in two general classes: The engines in which combustion took place under constant pressure and those engines in which combustion took place under constant volume. In the first class we find engines, so-called "hot air", using any fuels solid, liquid or gaseous; in the second class we find all the engines which use a charge of

fuel first introduced into the cylinder and then ignited in order to raise the pressure. It is these last named engines which are called explosion engines. In fact it has been suggested to construct engines in which the charge consisted of some kind of powder, such as is employed in fire arms. Those who proposed this solution hoped to be able to produce extremely light engines. This was a gross mistake, because they had not taken into account the weight of the charge, which consisted not only of the fuel, but also the weight of the oxygen which was necessary to support combustion. The weight of the latter is proportionately large as compared with the fuel. In engines in which combustion takes place under constant pressure the mechanical parts are subjected to regular strains, but this involves the evolution of heat during a relatively longer period of time; the ignition of the mixture is effected once for all at the time of starting the engines, in view of which it is possible to use heavier fuel because its combustion need not take place as instantaneously and as accurately as in explosion engines. The pressures reached are not as high as in the latter case, therefore on the other hand the expansion is not as great. For this reason this type of engine which at its advent had appeared so attractive to the constructor in view of its ease of construction, was abandoned when the explosion engine appeared, that is to say, combustion under constant volume, in which the mixture

is previously raised to high pressure. It was Beau de Rochas who embodied in much detail, in a patent granted in France, in 1860, all the features of importance of increasing the pressures of the gas before their explosion. The arrangement indicated by him was only put into practice about 1875 in the Otto engines, so-called Four-Cycle. Prior to that, attempts had been made to compress the explosive mixture by means of pumps previous to its introduction into the cylinder of the engine. The failure to succeed was primarily due to the complication of the mechanical parts and also to the very great negative work; and also to the heat losses through the walls when compressing the gaseous mixture and to the loss of pressure in the charge in the passing of the mixture from the pump to the working cylinder. In combining the operations of suction, compression, ignition and expansion, and exhaust of the gas, all in the same cylinder, a part of the heat stored in the walls during the suction of the mixture is regained. During compression the heat generated could not be dissipated by the walls of the cylinder since they are at a higher temperature. At the time of ignition a temperature as high as possible is obtained and as a result a very high pressure. The energy resulting from expansion is therefore very high. In 1882 no one had dared to undertake the construction of explosion motors of high speed. The ignition of the charge had always been a difficulty in the construction of these motors. Ignition

by electric spark, used from the very first by Lenoir in his engines had only given mediocre results, owing to the lack of constancy in the source of electricity. Therefore after him, this method of ignition was replaced in the motors of Hugon, Otto and Langen and Otto four-cycle, by flame ignition. On this account I was led to abandon the idea of using these engines for derigible balloons. It was about this time that incandescent tube ignition in four-cycle engines was introduced in these engines. An iron tube fastened to the wall of the cylinder was heated externally by means of an open flame to red heat. At the time of the compression the gas in the cylinder is driven into the tube, pressing ahead of it the inert gas of the previous explosion and at the moment when the gas comes into contact with the red hot walls of the tube it ignites and communicates the ignition to the whole charge. Daimler, by adopting this method of ignition, constructed small engines which now could be run at 600 revolutions and above. By thus increasing the speed of rotation, he thus succeeded in producing in the same time a greater number of power strokes, and consequently, succeeded in increasing the power produced for a given weight. In this way it had been through the combustion under constant volume that light and powerful engines have been realized, which it was possible to forthwith apply successfully to the construction of automobile vehicles. This result was accomplished as early as 1889. The engines with combustion under constant pressure on the other hand never

gave any result until the appearance of the Diesel engine. In this engine the fuel is introduced as in the past, during a fraction of the power stroke of the piston, but to realize the great expansion indispensable for a great efficiency, Diesel was led to carry the pressure of the air, in which the combustion takes place to a pressure of 30 to 35 atmospheres. This pressure obtained directly in the cylinder raises the air to such a temperature that the fuel burns immediately upon introduction into the cylinder. Thus there was eliminated that little flame which Brayton required all the time in his engine in order to ignite his mixture as it entered the cylinder, which little flame was at the base of the cylinder. Although the Diesel engine fulfills all the conditions requisite for a good engine it has not been possible to construct such an engine of small power and efficiently light weight to be utilized on automobile vehicles. It can therefore be stated that with our present day knowledge that the constant pressure engine will always be inferior to the constant volume engine for the construction of light engines. As early as 1875 the latter was already superior for the same reason to the constant pressure engine.

Q48. Please state to what extent electric ignition was known in 1880?

Objected to as incompetent, it not appearing that the witness has made a careful investigation of the

A48. Lenoir had employed this type of ignition in his gas engines, but electricity was difficult and expensive to generate. Generally batteries were used. Bunsen cells involved objectionable care and generated noxious gases. For this reason it gave way to the use of ignition by pocketed flame (motors of Otto-Langen, etc.)

Q49. Was there in 1880 an electric ignition system which it was known could be practically used in a vehicle on an internal combustion engine running at 200 to 250 revolutions a minute?

Objected to as incompetent for the reasons specified in the objection to Q48.

A49. No the ignition used by Lenoir had been abandoned. The source of electric supply was defective. All the internal combustion engines used flame, or hot tube heated exteriorly by a flame. The latter mode of ignition could only be used in four-cycle engines with combustion at constant volume.

Q50. When did the Panhard & Levassor Co. begin to use electric ignition?

A50. The Panhard & Levassor Company commenced to use electric ignition in 1899.

Q51. Was there a reason why the Panhard & Levassor Co. did not use electric ignition before that time?

A51. Apparatus for electric ignition did not afford a practical ignition for more than one cylinder at that time.

It was necessary to find a distributor with which a number of cylinders could be ignited from the same source of electricity. In all vehicles of the Panhard & Levassor Co. operating with 2 or 4 cylinder engines, the distributing apparatus was very thorpughly tried before their final adoption for igniting the vehicle engines.

Q52. Have you examined the electric ignition system used in the 3-cylinder Selden engine, and offered as exhibit 89 in the Ford suit? If so, state whether or no that system was known in 1880?

A52. I have examined the electric ignition system used in the 3-cylinder Selden engine, it did not exist in 1880.

Q53. Can the engines used in the Panhard-Levassor vehicles be operated with illuminating gas from the city mains?

A53. Yes, the engines run well that way. They have actually been used as stationary engines by supplying them with illuminating gas taken from the city mains.

Q54. What is the object of the carburetter in the Panhard vehicle?

A54. Its object is to produce from liquid hydrocarbon the quantity of combustible gas necessary to form with the quantity of air drawn in by the cylinder, an explosive mixture such as gotten in gas engines using city gas or water gas.

Q55./ Have you been in the habit of consulting and studying mechanical drawings?

A55. Yes, this specialty is to me indispensable in directing the work and investigations which are being made under my direction at the Panhard-Levassor factory.

Q56. Please examine the Letters Patent in suit and say whether or no you see a valve between the chamber marked T' and the smaller chamber to the left of it?

A56. No, the line in the drawing which defines the limit of that small chamber at the left cannot represent a valve.

Q57. In the patent it states on page 2, lines 1 to 10 that compressed air is admitted to the working cylinder with a definite quantity of liquid hydrocarbon injected by a pump into the combustion chamber T'. Please examine the patent and say whether or not a homogeneous mixture could be obtained by that method?

A57. Examining the drawing in figure 3, the liquid is injected right into the lower part of the chamber T', while air is supplied through the vertical wall at the back. Part of the liquid will certainly remain in contact with the lower wall of said chamber, another part might be projected into the current of air, but it is doubtful if the mixture so formed would be sufficiently homogeneous, and that the proportion by weight of the liquid vaporized and the air forming the mixture would constitute a gas readily and always combustible.

Q58. Is a homogeneous mixture necessary in Panhard vehi-

cles, and if so, say why?

A58. A homogeneous mixture and one in which the gaseous fuel and air have a constant ratio is absolutely necessary for good running of the engine. If the mixture is not so obtained, it cannot be ignited or would be delayed, resulting in incomplete combustion and the deposit of carbonaceous material which would coat the cylinder and valves and soon stop the engine.

Q59. When did you see the Selden machine exhibit 49 in the Ford suit?

A59. I saw that machine for the first time Oct. 29th, 1906.

Q60. State whether upon seeing that machine it was completely dismantled and if sketches of the different parts were made at the time?

A60. I attended the complete dismantling of the engine. Sketches of the different parts were made at the time with mention of the principal dimensions of parts in a way that they could be exactly represented in their relation to the machine.

Q61. Can you describe that machine which you saw?

A61. This engine consists of three horizontal cylinders side by side having parallel axis. On one side are located the three cylinders forming air pumps; on the other side the three working cylinders. The piston of one of the motors and that of the corresponding pump form a rigid part, both

pistons supporting a yoke perpendicular to the axis of the pistons, in which yoke the crank pin of the crank shaft corresponding to its cylinder slides. The crank shaft is located transverse to the three cylinders, its axis being at right angles to the axis of the three cylinders and located in the same plane. The angles between the cranks are equal. On the pump side the cylinders are closed by heads in which the suction valves and delivery valves are located. The delivery valves are connected together by suitable pipes to a compressed air reservoir. On the working cylinder side the cylinders are closed by heads containing chambers disposed as follows: opening into the cylinder is found a large cylindrical chamber the bottom of which joins a small chamber called T'. This small chamber is provided with a valve opening from the inside outward by means of a cam which is mounted on a shaft placed in the rear and below the cylinder heads, its axis being parallel to the crank shaft. The communication from small chamber T' with the large cylindrical chamber is closed by a very thin valve provided with steel leaves forming a spring. This valve is guided in the opening that it closes, by four small pins on the valve. A metal bushing of same diameter as the large chamber presses on the ends of the leaves forming the valve spring and maintain the latter on its seat. On this bushing are maintained ten metal gauze discs kept in place by a sort of sleeve fitting the large chamber and fastened by screws. The valve closing the opening to chamber T' and

which, as said, opens from inside outward, was provided with a small hole in the case of the right hand cylinder only. In the small hole was screwed a screw drilled axillary with a very small hole the size of a pin of ordinary dimensions. In the case of the other two cylinders this same valve was not provided with similar holes and when on their seats there was no communication from the interior to the exterior as has been described for the right cylinder. Each cylinder head carried besides an exhaust valve opening inwardly actuated by a cam mounted on the cam shaft already described. The three valves closing outward by the chambers T' communicated by suitable pipes with the end of the compressed air reservoir to which we have already referred. These valves were moreover separated from the small chambers T' by pieces of wire gauze arranged in the chambers; besides in the common pipe connection between the valves and compressed air reservoir were thirteen pieces of wire gauze. The air on its way from the compressed air tank to the cylinders, when the valve closing the small chamber T' was open, had to pass through first the thirteen pieces of wire gauze in the air pipe, second the wire gauze located below the valve in the small chamber T', third after having finally raised the valve giving access to the cylindrical chamber it had to pass through the ten pieces of wire gauze which covered it. The head of the right hand cylinder was equipped with three small pumps the rods of which were mounted

mounted on an extension of the cam shaft already described. These pumps drove the liquid hydrocarbon from the tank containing it, by means of a pipe leading to the suction valves of these pumps. The delivery valves of these pumps were respectively connected by means of pipes to their corresponding cylinders. These pipes lead into the small chamber T'. A small check valve is located at the termination of the pipe at chambers T'. Every one of the large cylindrical chambers was provided with orifices leading outward and closed by means of plugs, one per cylinder. This plug consisted of an electric spark plug such as is actually found on motor vehicles. The cam shaft was operated on the side opposite to the oil pumps by a train of three gears, causing it to turn at the same speed as the crank shaft. At the gear end the crank shaft supports an electric distributor permitting sending to each spark plug at the desired moment the secondary current of an induction coil actuated by a small storage cell. This induction coil provided with a trembler as well as the storage cell, are of comparatively recent type, being employed for causing the ignition of explosion engines in the ordinary type of automobiles.

Q62. Was there a compressed air tank used in connection with the engine? Give the reasons for your answer?

A62. The compressed air tank mentioned in the patent, into which the air is compressed by the air pumps, previous to its delivery to the working cylinders, was there. But

"Surface carburetter" because its capacity appeared to be rather too small to insure the delivery of air at a practically constant pressure to the three working cylinders. The tank contained besides a mixture of oil and light petrol, over the surface of which the air compressed by the pumps, previous to its admission into the working cylinder, had to pass, carrying with it the vapours from the liquid.

Q63. Can you explain why wire netting or gauze was located in the pipe connecting the so called tank to the cylinders?

A63. This netting or wire gauze was placed for no other purpose than to prevent the combustion which sometimes propagates itself past the inlet valves, to reach the tank and cause it to burst.

Q64. Would the presence of wire gauze in the pipe be required if the so called tank did not contain anything else but air?

Objected to as leading.

A64. It would be useless, since pure air cannot be ignited.

Q65. Have you noticed iron wires on the piston heads of the working cylinders?

Objected to as leading.

A65. I noticed that nuts protruding above the piston and drilled to receive cotter pins were traversed by iron wires connecting them two by two; the appearance of the wire

showed that it had been brought to a high degree of heat.

Q66. What is your opinion the reason for the presence of these iron wires?

A66. In the case of a four-cycle engine, compression preceding explosions, these wires, if brought to red heat, would cause pre-ignition, but in the case of the motor in question, the mixture must be ignited as soon as it is introduced into the cylinder and these iron wires did materially assist the ignition of the gaseous mixture at the proper time.

Q67. Can an engine vibrating to such an extent that the vibrations cause it to move itself bodily on the ground, be of any practical use in the case of an automobile?

A67. It is often more difficult to hold an engine rigid than to mount the same motor on a vehicle frame equipped with springs interposed between the frame and the axles. Many of the engines installed on the first automobile vehicles were unbalanced and the vehicles were shaken by the vibrations of the engine. These motions of the vehicle, which were very apparent when the vehicle was standing still, disappeared, or rather became neutralized or reduced, by the vibrations resulting from the running of the vehicle on the road. There are cases of trip hammers mounted on elastic foundations, which do not show signs of strains, although they are constantly vibrating. It would be next to impossible to attempt to maintain them rigidly fastened to the

vehicle, regardless of its vibrations.

Q68. Would an engine rotating at the rate of one hundred revolutions per minute, capable of running during a period of 4 to 5 minutes, then stopping, be of any practical value in the case of an automobile vehicle?

Objected to as immaterial.

A68. No. What is required above all of an automobile engine is the capacity to run indefinitely, so to speak, without stopping, and to be always ready to deliver the power necessary to overcome resistances met.

Q69. Can an engine running for 20 minutes and then stopping be considered practical for an automobile?

Objected to as immaterial.

A69. No. At the time of stopping one may have to cover a certain distance to avoid accident. The driver must therefore in running an automobile always be able to count upon the engine to deliver the work required by circumstances.

Q70. What is the power developed by the Panhard engine constructed for automobile uses?

Objected to as indefinite, for the reason that no particular automobiles are referred to, and for the additional reason that whatever the defendant may have done since this suit was commenced is immaterial.

A70. Their power varies from 10 to 130 horse-power.

Q71. What is the weight of the 130 horse-power motor?

A71. Its weight, including the fly-wheel, but without accessories, such as the water circulating pump, carburetter and magneto reaches about 230 kilograms.

Q72. Have you ever seen an Otto-Langen engine, and if so when did you see one for the lasttime?

A72. The Societe Panhard & Levassor owns one of these engines and I saw it about two months ago.

Q73. Have you ever operated an Otto-Langen engine? If so, when have you done so?

A73. Two years ago, I operated an Otto-Langen engine owned by Panhard & Levassor Co. It is the last one in the series of engines which had been constructed by the Panhard & Levassor Co. some 20 years ago.

Q74. Do you know the construction and the principle of operation of the Otto-Langen engine?

A74. Yes, all the necessary documents concerning their construction are kept in the files of the P. & L. I have examined them some two years ago, when I ran the engine still in possession of the P. & L.

Q75. Please examine the French patent No. 116,871, granted to Rosenwald, under the date of February 3, 1877, and state whether or not you understand it?

A75. This patent describes a system of locomotion, in which a gas engine mounted on a vehicle transmits its power to the rear wheels of the vehicle. The drawing annexed to the patent represents very clearly an Otto & Langen engine, placed forward of the carriage body and back of the driver's

seat. This engine transmits its power by means of mechanical devices so arranged that there can be no doubt left, as to the possibility of their satisfactory operation.

Q76. Kindly state whether or no the Rosenwald patent, as described and illustrated by the drawing, leads to the belief that such a vehicle could be operated, and give the reasons upon which you base your opinion?

A76. The examination that I have just made of this document permits me to certify that this vehicle should operate. The engine is of a known type, having been proven successful, and the mechanical arrangements adopted to transmit its power to the driving wheels are of a nature to obtain the results sought. As far as the engine is concerned, its supply of gas is assured by a tank in which it is stored. The cooling of the cylinder is provided for. The driver has close at hand a clutching and unclutching mechanism, as well as a braking device combined with the unclutching mechanism. Finally, the steering of the vehicle is effected by moving the fifth wheel, by means of a lever placed in the hand of the driver.

DIRECT EXAMINATION FINISHED AT 2:40.

Counsel for plaintiff states that he does not understand that the direct examination is closed and will not be closed until the same has been translated into the English language and desires the witness

beginning the cross-examination.

Counsel for defendant states that the deposition was taken in the French language which he does not understand contrary to his request and solely at the request of Mr. S. R. Betts, and further that he will produce the witness for examination at 10:30 tomorrow and if complainant will not then proceed he will request the examiner to close the deposition.

Counsel for complainant calls attention to the fact that what has been taken down is not in fact a deposition, was not commenced as a deposition should be commenced, and in fact was not intended to be a deposition.

ADJOURNED till Saturday November 4, 1906, same place, at 10:30 A. M.

November 5th, 1906.

Met today pursuant to adjournment November 3rd, 1906.

PRESENT:

Commissioner Shields,

Messrs. Murray and Parker for the defendants,

Messrs. Betts and Peters for the complainants.

Counsel for the defendants offers in evidence the following exhibits:

Defendants' counsel offers in evidence letter from L. F. de Peugeot to Panhard & Levassor, dated 17th of March, 1890, Same is marked defendants exhibit No. 178, Nov. 3, 1906. J. A. S. Exr.

Letter from L. F. de Peugeot to Panhard & Levassor, dated July 30, 1890, and the same is marked defendants exhibit No. 179, Nov. 3, 1906, J. A. S. Exr.

Letter from A. Peugeot to Levassor, dated October 3, 1890, and same is marked defendants' exhibit No. 180, Nov. 3, 1906, J. A. S. Exr.

Letter from L. F. de Peugeot to Panhard & Levassor, dated 1890, and the same is marked defendants' exhibit No. 181, Nov. 3, 1906. J. A. S. Exr.

Paper entitled "attestations", and same is marked defendants' exhibit No. 182, Nov. 3, 1906. J. A. S. Exr.

Catalogue of Panhard & Levassor, dated January 1892, and same is marked defendants' exhibit No. 183, Nov. 3, 1906. J. A. S. Exr.

and same is marked defendants' exhibit No. 184, Nov. 3, 1906. J. A. S. Exr.

Catalogue of Panhard & Levassor, dated December 1, 1895, and same is marked defendants' exhibit No. 185, Nov. 3, 1906. J. A. S. Exr.

Article entitled "Voitures Automobiles", commencing at page 198 of La Nature of August 25, 1894, and same is marked defendants' exhibit No. 186, Nov. 3, 1906. J. A. S. Exr.

Catalogue of Panhard & Levassor, dated July 1895, and same is marked defendants' exhibit No. 187, Nov. 3, 1906. J. A S. Exr.

Article entitled "Course des Voitures Automobiles" commencing at page 84 of copy of La Nature, dated July 6, 1895, and same is marked defendants' exhibit No. 188, Nov. 3, 1906, J. A. S. Exr.

Catalogue of Peugeot Freres, dated 1891, and same is marked defendants' exhibit No. 189, Nov. 3, 1906. J. A. S. Exr.

Catalogue of Panhard & Levassor, dated July, 1896, and same is marked defendants' exhibit No. 190, Nov. 3, 1906. J. A. S. Exr.

Counsel for the defendants states that he will give a translation of the testimony so far given, it being understood that the same is subject to correction and an agreement between counsel as to a correct translation. If they cannot agree then the Commissioner

shall appoint a translator to decide the questions which may arise.

The cross-examination of the witness is adjourned to this office at 2 o'clock Monday, November 5, 1906.

November 5th, 1906.

MET PURSUANT TO ADJOURNMENT.

PARTIES PRESENT AS BEFORE.

CROSS-EXAMINATION BY MR. BETTS.

XQ77. When did you arrive in this country?

A77. On the 26th day of October last.

XQ78. What was the object of your coming here?

A78. I came to answer the questions which I may be asked about the Selden case.

XQ79. Did you come over from Europe specially for that purpose?

A79. It has been the cause of my trip.

XQ80. What conferences have you had in Europe about your testimony before coming here?

A80. No discussions whatever.

XQ81. Who asked you to come here?

A81. The firm taking care of our interests in New York - Coudert Brothers.

XQ82. When was that request made?

A82. Several months ago.

XQ83. Tell me just when?

A83. I do not remember when, as I only studied this case shortly before leaving.

XQ84. Did Coudert Brothers write you on the subject of your testimony?

A84. Messrs. Coudert Bros. wrote to the firm of

Panhard & Levassor asking them to send to America some member of the firm as well posted as possible on the subject, for the purpose of testifying.

XQ85. Did you see the letters written by them?

A85. No, I have not seen these letters.

XQ86. Have you read before testifying any of the evidence concerning the Selden patent?

A86. I believe that I saw for the first time the Selden patent in 1903. I have not seen any description, evidence or testimony relative to this suit.

XQ87. Has a resume of the evidence been given to you?

A87. I have only been told of its substance since I have been under examination.

XQ88. Who have you consulted about your testimony here?

A88. The firm of Coudert Brothers.

XQ89. Have you had conversations with Mr. Jesse Smith or Professor Carpenter?

A89. I saw these gentlemen for the first time on the 29th of October last, but as I do not understand the English language I was only able to watch as a spectator the taking apart of the Selden motor which these gentlemen were having done.

XQ90. Have you read or been told of the testimony given by Dugald Clerk?

A90. No. This is the first time that I am told about it.

XQ91. Have you ever seen or read a book written by Dugald Clerk on the subject of gas engines?

A91. No, I have never seen or read this work.

XQ92. Can you read books written in the English language?

A92. No, I cannot.

XQ93. Did you ever hear of Dugald Clerk of England as an authority on gas engines?

A93. Yes, vaguely.

XQ94. Did you ever hear of what is termed the Clerk Cycle for gas engines?

A94. I do not remember.

XQ95. Who do you consider as an authority on gas engines?

A95. I have always considered that in gas engine matters the men who have succeeded in making a step forward were practical men-- not theoretical men-- with the exception of Beau de Rochas. The theoretical men have built theories that have not been confirmed by actual practice.

XQ96. You have mentioned only the name of Beau de Rochas. Are there other authorities that you recognize?

A96. Every one of the men who study this subject with the view of establishing its theory are interesting,--

but at the present time we are not sufficiently in possession of the factors that would enable us to fully understand the reasons why it is possible to transform into work only a very small part of the heat developed in the combustion from which we are trying to realize work.

XQ97. I ask you if you know the names of any others than Beau de Rochas, whom you recognize as authorities or experts on the subject of gas engines?

A97. I cannot cite the name of any one in preference to the other,- each has contributed his stone in the upbuilding of the edifice.

XQ98. Do you consider yourself an authority on gas engines, or only as a stone-carrier?

A98. No; I believe that I have carefully studied the subject and know it well enough to enable me to appreciate the direction in which work can be done to effect successful improvement.

XQ99. Do you consider that Beau de Rochas and yourself are the only ones you can mention?

A99. Such has never been my intention. Beau de Rochas has been a pioneer, who had foreseen without being able to realize a method of operation, which was only brought to light in practice about 15 years later. From that point of view there can be no question as to how my personality figures in this matter.

XQ100. Do you recognize any American as an expert

and authority on the subject of gas engines?

A100. In principle, in order to explain phenomena, hypotheses are advanced upon which theories are built. Such theories may be used as a guide in practice until they are disproved by results. Those initiating the establishment of a theory may be looked upon as authorities, in the case of all apparatus which confirms their hypotheses. This is just what has taken place in the history of gas engines. At the present time these engines are divided into two types of operation,- the motors in which combustion takes place at constant pressure, and those in which combustion takes place at constant volume. The former which at first were in favor with constructors have been greatly surpassed at the present day by the second. Eminent Americans have been paying attention to these different motors and their principles of operation, and therefore can be consulted to advantage.

XQ101. Give me the names of Americans whom you recognize as authorities on the subject of internal combustion engines?

A101. I cannot give the name of any one who was such when he was practically working on the subject. Thus Brayton did devise and construct an engine which for his time and for the object intended was of interest.

XQ102. Did you see the three Brayton engines in a garage in New York October 29, 1906?

A102. Yes. I saw three old engines which appeared

not to have run for a long time.

XQ103. When did you see for the first time an internal combustion engine of the Brayton compression type?

A103. October 29th last at an automobile garage.

XQ104. Do you think that the three Brayton engines which you saw October 29th, 1906, would be capable of propelling a vehicle on ordinary roads in the condition as they then were?

A104. It does not appear that these motors were constructed for the purpose of being put on a vehicle to propel it. They are engine too heavy per horse power and constructed for quite a different purpose than for propelling vehicles.

XQ105. For whatkind of work do you think that these three Brayton engines, as far as you kmow were built?

A105. It would seem that one was intended for a shop motor, while in the two others from the arrangement for effecting the two directions of the drive of the power shaft it would seem they were constructed to be put in boats.

Adjourned until Wednesday morning at 10:30, same place.

November 7th, 1906.

PARTIES PRESENT AS BEFORE.

CROSS-EXAMINATION BY MR. BETTS.

XQ106. Is the Brayton engine which you referred to in answer to question 101 an internal combustion engine of the compression type?

A106. As this question is put it does not define the method of operation of the Brayton engine unless one knows it.

XQ107. Can you describe the principle of operation of the Brayton engine referred to by you in question 101 and state if this engine is a compression engine or a non-compression engine?

A107. In reply to question 100 I have stated that engines may be divided into two main classes. At the time Brayton made his engine it was known that engines of either class should be operated with previous compression. The Brayton engine as I know it is a compression engine included in the class of constant pressure combustion engines.

XQ108. Are the Panhard and Renault engines, which are involved in the present suit, compression engines?

A108. These engines, like all engines of to-day, are compression engines, but to completely define them one must add that combustion takes place at constant volume.

in suit a compression engine?

XQ109. In the specification of the Selden patent it states in line 105 et seq. that the engine used is of the compression type, but this phrase is absolutely vague and would not define the type of engine used if not supplemented by the brief description which follows, and by the annexed drawings. In studying closely that description and consulting the drawings one recognized quite clearly that the Selden engine belongs to that type of combustion engine under constant pressure.

XQ110. Do you not recognize a type of internal combustion engine which is a non-compression type?

A110. Pressure or compression are only relative. For instance, the Lenoir engine, in which admission was at atmospheric pressure, was said to have no compression, but there was always the atmospheric pressure. In certain cases the pressure at which combustion takes place may be below atmospheric pressure. This happens in some cases when regulating the power. It is on this account that the term "internal combustion engine of compression type" is a very vague term and does not determine a type of engine.

XQ111. In the Lenoir engine does not combustion take place at constant pressure or constant volume?

A111. Combustion takes place at constant volume.

XQ112. Why do you not use a Lenoir engine on your Pan-

A112. We actually do use a Lenoir type of engine, a type improved according to the theories of Beau de Rochas. That is to say an engine in which the pressure of the gaseous mixture is raised as high as possible at the time of ignition. Combustion takes place at constant volume, and very quickly precisely on account of the high pressure at which it takes place.

XQ113. Did Beau de Rochas ever make an engine in accordance with the theories you mention?

A113. I stated in answer to question 99 what Beau de Rochas had done. He enunciated a theory which was never put into practice until fifteen years after his death.

XQ114. Who first made an operative engine based on the Beau de Rochas theory?

A114. The Otto "four cycle" engine.

XQ115. Who was Otto? Can you say where and when he made and operated the first four-cycle engine you refer to?

A115. Otto was, I think, a German whose work on gas engines is very important. After the Lenoir engine had proven to be so mediocre, he built with Langen the engine called "Otto and Langen", which had a great expansion. Later, by applying the Beau de Rochas theory, he built about 1873 the engine bearing his name and operating on the four cycle principle. It is since that time that engines operating with gas or petrol or liquid hydro-carbon have given results capable, in respect to efficiency, of com-

parison with the best steam engines.

XQ116. You give 1873 as the date that Otto actually constructed his four cycle engine. Is it not rather in 1876 that he built that engine?

A116. Otto's work on this question dates back to 1870. I cannot, therefore, give an exact date as to the appearance of his engine. To be definite on the subject it suffices to refer to the date of his patent. But of this I am certain, that in France their commercial production was entrusted to the Panhard et Levassor firm before the exposition of 1878. During that year while at the aeronautic station I bought and accepted, at the shops of that firm, a two horse power Otto four cycle engine for installation at the balloon sewing shop, which installation I referred to at the beginning of these interrogatories.

XQ117. What is the weight complete of the Otto four cycle engine which you state you purchased from the Panhard et Levassor Company in 1878?

A117. That engine was a shop engine. It's base was heavy. I cannot remember its weight.

XQ118. Give as nearly as possible the weight of this Otto engine of 1878, including its base, cooling system, and all parts necessary for its operation.

XQ118. I said that this engine was intended to be stationary in a shop. Consequently as for the cooling system the only object was to have it capable of running all day without replenishing water. The weight of that

water and tank was therefore very great, and it is quite impossible for me to give even approximately the weight of the complete apparatus. The same may be said of the base or bed plate on which the engine proper is mounted.

XQ119. Give the weight of this Otto engine of 1878 without including the weight of tank, water or base.

A119. It is impossible for me to give it. I want to repeat that this engine was for a shop and not intended to be a light engine. The weight under the circumstances was therefore an advantage.

XQ120. Has the Panhard Company ever built an Otto four-cycle engine like that of 1878 and mounted it on an automobile or a wagon intended for ordinary road use before 1891, the time you say the Panhard et Levassor firm made their first automobile vehicle equipped with their Daimler engine, as you have stated in reply to question 14?

A120. The first trial of this kind which the Panhard et Levassor firm attempted dates prior to 1891. In 1891 we delivered to a customer the first automobile vehicle. The Otto engine was adapted by Daimler about 1882 for use on vehicles.

XQ121. Do you know at what date a Daimler engine was mounted on a road vehicle and seen in public, so far as you know?

A121. As far as I remember the first Daimler trials

can be carried back to 1883; as for the application of his small engines for vehicle propulsion Daimler's patents on this subject can be consulted to advantage.

XQ122. What is your authority for this statement?

A122. I have known Mr. Daimler in 1897, when I went to visit him at Cannstadt, Germany, in October. In the house he lived in he showed me the laboratory and shop where he had studied and first built his little engine, then the first vehicle on which he had made his first trials.

ADJOURNED UNTIL 2 P. M. SAME DAY.

SAME PARTIES PRESENT.

XQ123. Why was the work of Daimler necessary to make it possible to adapt the Otto four cycle engine of 1878, for the propulsion of vehicles on roads?

A123. Daimler, who had been working for many years in the Otto works tried to produce an engine sufficiently reduced in weight and dimensions with the object of adapting the Otto engine to automobile vehicles, to boats, and in general for all uses requiring as small bulk as possible on the part of the engine.

XQ124. Was there not even in 1878 a desirable advantage in reducing the weight per horse-power of the 4-cycle Otto engine?

A124. Upon the first appearance of the Otto gas engine there was such a public demand for it as a stationary engine, that it seems that they were above all occupied at

that time in meeting that demand. As soon as they were confronted with the question of using it for vehicle propulsion it was immediately studied and constructed for that purpose. A very few years sufficed for that as shown by the above dates.

XQ125. Do you know if Otto himself ever adapted his 4-cycle engine for the propulsion of a road vehicle?

A125. I know nothing on that subject.

XQ126. Have you ever heard, or seen, or known that Otto adapted his 4-cycle engine for the propulsion of road vehicles?

A126. I know nothing about such having been done.

XQ127. In 1878 you had a heavy Otto 4-cycle engine; at the same time you were working on the development of an internal combustion engine which should be lighter per horsepower developed;- why did you not succeed then in constructing an Otto engine of the type constructed later by Daimler?

A127. The engine which I studied at that time was not a 4-cycle engine, but an engine with combustion at constant pressure.

XQ128. In reply to Q116 you state you purchased and accepted from the Panhard et Levassor Co. a 4-cycle Otto engine in 1878, and that you yourself were working on an internal combustion engine light in proportion to its power,- why did you not then develop the 4-cycle Otto engine into the motor later produced by Daimler and applicable to road vehicles?

A128. I said that in 1878 I purchased an Otto shop engine for use in our balloon factory, while studying later on light engines I had neither the experience nor above all the genius of Daimler. I was evidently following on the wrong track, and succeeded ultimately in the object I had in view (steering balloons), by using an electric motor.

XQ129. What were the particular difficulties that had to be overcome in the construction of the heavy 4-cycle Otto engine of 1878 which required "the experience and the genius of Daimler" in order to develop this engine and convert it into an engine capable of driving vehicles on roads?

A129. Above all it was necessary to realize the accurate and certain ignition of the gaseous mixture introduced into the cylinder. It was this special point in particular that Daimler succeeded in solving in an almost perfect manner. Besides it was necessary to reduce as much as possible the weight of the reciprocating parts in order to increase the speed at least 600 or 700 revolutions per minute; finally the reduction as much as possible of the number of parts composing the motor.

XQ130. Then Otto himself did not solve these difficulties you mention as solved by Daimler?

A130. Otto succeeded in producing a good ignition for engines which he built. These engines, as I have already said, were especially adapted for stationary purposes, the number of revolutions practically not exceeding 200 per minute.

XQ131. But Otto himself did not solve in his 4-cycle engine of 1878 the difficulties involved of making it applicable to road vehicles, but left it for another to solve?

A131. Otto, as I have already stated, does not appear to have devoted himself to the application of his engine for the propulsion of vehicles. Had he been confronted with the necessity of doing it, there can be no doubt he would have succeeded in constructing an automobile vehicle propelled by his engine. As far as Daimler is concerned, he has from the very first effected an almost complete solution of the problem with regard to the adoption of the Otto engine to a vehicle. The present engines differ only from that devised by Daimler in details of secondary importance.

XQ132. What fuel has been used by the Panhard and Renault automobile engines?

A132. They chiefly used the petroleum derivative "benzine", products of coal distillation, and pure alcohol more or less carburetted with "benzine".

XQ133. Are these fuels as used known by the general term of liquid hydro-carbon?

A133. Yes. These are the liquids which are generally termed liquid hydrocarbon, except alcohol, which is a liquid hydro-carbon combined with its equivalent of water, and which, on that account, generates less heat during combustion per unit of weight.

XQ134. Do the engines of the Panhard and Renault automobiles compress the charge before ignition?

A134. These engines which are 4-cycle engines, with combustion at constant volume draw the explosive mixture in without compression, then compress it prior to ignition. These operations are effected in the cylinder of the engine itself.

XQ135. What is mixed with air to make the explosive charge in the engines of the Panhard and Renault automobiles?

A135. In these engines, like engines which employ gas or liquid hydro-carbons, the combustible mixture is composed of a mixture of air with the vapor of the liquid hydro-carbons employed, combining these two fluids in a proper ratio by weight. This ratio must be substantially constant in order to get complete combustion.

XQ136. Then the engine of the Panhard and Renault automobiles use a liquid hydro-carbon vapor mixed with air to constitute the charge.

A136. Yes, in all explosion engines where the mixture must be homogeneous in order to simultaneously burn throughout in a very short period of time.

XQ137. Is not the charge for the Brayton engine also composed of a liquid hydro-carbon mixed with air?

A137. The particles of hydro-carbon entering into combustion with air cannot be burned unless first transformed into a gas. As for the Brayton motor, the combustion can only take place progressively upon the introduction of air and hydro-carbon, the latter may be separately introduced,

its vapors may be burned by air entering the cylinder under compression in the same manner in which the petroleum in an ordinary lamp is burned in a stream of air which produces the flame of the lamp. In the Brayton engine and in all engines in which the combustion takes place at constant pressure the fuel is burned progressively, either in proportion to its introduction with air, with which it may be previously mixed, or by air introduced which enters in close proximity to the hydro-carbon, separately introduced, carrying with it the heat generated by previous combustions.

XQ138. What do you rely on for your statement of the operation of the Brayton engine, as you give it in answer 137?

A138. On the very description in Brayton's patent of February 10, 1872, granted M. Brayton, numbered 94,180, and besides, upon the theory of operation of all constant pressure combustion engines.

ADJOURNED UNTIL NOVEMBER 8, 1906, SAME PLACE, at 10:30 A. M.

MET PURSUANT TO ADJOURNMENT.

SAME PARTIES PRESENT. SAME PLACE.

XQ139. Is the Brayton patent of February 10, 1872, #94,180, you refer to in answer to question 138, the Brayton French patent of that day and number?

A139. Is the patent from which I am quoting a reproduction of the American patent taken by Brayton for his motor?

XQ140. Please answer whether the Brayton patent of February 10, 1872, No. 94,180, actually referred to in giving your answer to question 138, is not a printed copy of the French Brayton patent of that date and number?

A140. The very title of the pamphlet in which the Brayton patent is inserted indicates that this document is really a reproduction of patents taken in France at that time. The document which I have placed on the table is an official publication of "Imprimerie Nationale."

NOTE: The printed copy referred to by the witness in his questions and answers 138, 139, and 140, is marked for identification at the request of complainant's counsel, and a copy or translation will be agreed on if it is hereafter desired to offer one.

XQ141. Please look at the drawing of the United States Letters Patent to George B. Brayton, No. 125,166, dated April 2, 1872, and state whether they are not exactly

the same as drawing appearing in connection with the printed copy of the French Brayton patent No. 94,180 of February 10, 1872, to which you have referred?

A141. Yes; these drawings are absolutely the same, and represent exactly the same arrangements.

XQ142. Do you know of any other French patent to George B. Brayton than No. 94,180, of February 10, 1872, to which you have referred in your testimony?

A142. I know of none.

XQ143. Is your knowledge of the Brayton engine and of its construction and operation based on this Brayton French patent No. 94,180 of February 10, 1872?

A143. Yes; partly on that, and partly also on the work which has been done by other persons with a view to explain and describe the history of gas engines at large.

XQ144. Did you ever before see the United States Letters Patent to George B. Brayton, No. 151,460, dated June 2, 1874, a copy of which is now shown you?

A144. I have not seen the document which is shown me but I recognize the arrangement owing to the knowledge that I have acquired from other sources.

XQ145. In answering the last question, you looked at the printed copy of "La Nature" dated November 20, 1880 and published in Paris. Does this contain a description of the Brayton engine in conformity to what is shown of his United States patent No. 151,568, of 1874?

A145. The description given by the publication "La

Nature" refers to a Brayton motor using petroleum oil as a fuel. The design appears to be similar to that shown in the drawing of the American patent, No. 151,468. I must, however, call attention to a mistake in the description given by "La Nature" in error, which is not justified or reproduced in the drawing in the publication. As a matter of fact, a paragraph of that description says, that the cam shaft rotates at half the speed of the engine shaft, and that the engine operates according to the 4-cycle Otto type. The drawing shows, on the other hand, very clearly, that the cam shaft turns at the same speed as the motor shaft, and that this type of engine is most certainly an engine in which combustion takes place under constant pressure. Moreover, it is shown very clearly in the latter part of the description that the description and drawing referred to an engine of this type. It is said besides that, referring to a lecture delivered by Prof. H. Draper before the American Philosophical Society, that this engine "is started by means of a match, and that in less than one minute it begins and continues to operate normally." This last statement constitutes, therefore, irrefutable proof that the operation of this motor, supplied by petroleum as fuel, is based on the same principle as the one described by Brayton in his first patent of 1872. On that there can be no question that we have to deal in this case with a combustion engine which is of the "constant pressure" type notwithstanding the fact that the fuel

is delivered to it in liquid form. Moreover, Brayton claims in a very precise manner that this method of combustion does not exert a spasmodic or explosive force on the piston, but rather a pressure caused by the expansion behind the piston of expansable gas when it begins to act upon it and during the whole period of admission of the gaseous mixture. This manner of utilizing the motive power, developed by the combustion of the gaseous compounds, differs radically from the method which characterized all the engines previously built to utilize the same motive power.

XQ146. Did you ever hear or know of a Brayton engine described or illustrated as of the 4-cycle type?

A146. No, I have never heard of it or known of it. At this time the Brayton engine was referred to as the most perfect type of internal combustion engine operating at "constant pressure". Engines operating exactly on the same principle but using coke as fuel have even been built, and I have seen several of them in operation at this time or shortly after, that is to say, after 1880.

XQ147. How closely did the Brayton vertical engine, which you saw at a garage in New York on October 29th or 30th, 1906, conform in construction to what is shown and described in "La Nature" of November 20, 1880, to which you have referred?

A147. I have not verified all the details in the construction of this engine, but it appears that it very closely resembles the engine shown in the cut in the publication

NOTE: The printed copy of "La Nature," dated November 20, 1880, referred to in the testimony, is now marked for identification at the request of complainant's counsel, and a copy of translation will be agreed upon if it is afterwards desired to offer one.

MET PURSUANT TO ADJOURNMENT, SAME DATE.

SAME PARTIES PRESENT, SAME PLACE, 2:40 P. M.

XQ148. What are the differences in construction between the Selden 3-cylinder and the Selden single-cylinder engine, on the one side, which you saw at the garage on October 29th, or 30th, and the Brayton vertical engine you saw there?

A148. The 3-cylinder and the 1-cylinder Selden engine which I saw at the garage appeared to me as having been studied and constructed according to the principle set down by Brayton in his several patents, of which the vertical engine that I saw at the same place is an embodiment. The differences existing between those two engines are of two kinds: First, differences which relate to the design of mechanical parts and their arrangement and assemblage, which can be almost infinitely varied without modifying the actual principle of operation of the engine; second, in the Selden 3-cylinder engine, as it is built and in the description given in the patent relating to it, I must note an obscure point relating to the formation of the combustible mixture; in this description, beginning with line 105, it

is stated that the air compressed by the pump is led into the working cylinder through a valve operated by a cam, together with a given amount of liquid hydro-carbon injected by a pump into the combustion chamber. This point appears to me to be very vaguely described in the patent specification; and on the other hand, no special arrangement seems to have been provided in the engine to insure the formation or production of a gaseous combustible mixture, capable of causing a proper operation of the engine. The drawing which forms parts of the Selden patent is still more silent on this point, and one cannot help but wonder whether or not Selden did clearly realize the great importance of this special point when he filed his patent and later on constructed his engines. This disclosure appears the more striking when one considers that in all his several patents Brayton tookespecial care to give the most precise and complete details as to how he conceived the production of combustible mixture, preceding its introduction into the cylinder. Third, in the Brayton patent, also in the engine built by him, there can be found located on the admission valve, a small orifice arranged so as to allow the continuous passage, either of carburetted air, if the combustible gaseous mixture has been formed before reaching this valve, or of compressed air, which becomes carburetted in its passage close to the porous surfaces, soaked with hydro-carbon, which is placed beyond the valve. The purpose of this being to maintain a small

flame above the wire netting in the cylinder, which flame will serve for the purpose of causing the inflammation of the gaseous mixture when the inlet cam allows it to enter the working cylinder for driving the piston. This small hole only exists in the valve of one cylinder in the 3-cylinder Selden engine. Fourth, In the Brayton engine described in his second patent, 151,468, the space existing between the top of the cylinder and the top of the piston is reduced as much as possible. This arrangement is excellent, and Brayton did certainly adopt it for the purpose of increasing the efficiency of his engine. In the Selden engine which I saw at the garage, this excellent arrangement did not exist.

XQ149. Have you ever made actual tests with the Brayton engine by taking diagrams with indicator or with the manograph to determine what takes place in the working cylinder, and if so, what was the result?

A149. No. I have made no such tests.

XQ150. Have you ever made actual tests with either the Selden 3-cylinder engine or the Selden 1-cylinder engine you saw at the garage, by taking diagrams with indicator or with the manograph to determine what takes place within the working cylinder, and if so, what was the result?

A150. No, I made no tests.

XQ151. You have spoken of "donstant pressure" and "constant volume" type of gas engine. How are these types

distinguishable in diagrams obtained, showing what takes place within the cylinders?

A151. The mere inspection of diagrams does not permit one to determine in any absolute manner the mode of operation of an engine. The shape of the curves shown by the diagrams is completely modified by advancing or retarding ignition, and may lead to a false interpretation. Diagrams must merely be considered as complementary information and cannot be relied upon as always showing what is going on inside of the cylinder and what is the result of the mechanical arrangement used.

XQ152. What is your understanding of the words "constant pressure," and what do you mean by them in your testimony?

A152. I have already stated in my answer to question 47 that internal combustion engines are divided into two classes, one of which includes the engines in which combustion takes place under constant pressure. This type of engine is clearly characterized by the Brayton engine, the method of operation of which is described in all its detail in the patents mentioned heretofore. I need not describe again the theory of the operation which has been so well set forth by Brayton, but from a mechanical viewpoint this engine may be distinguished from those of other classes (engines in which combustion takes place under constant volume) in that, in the former type of engine the admission valve always opens from the interior of the

cylinder to the exterior, to allow the gaseous mixture to pass; while in the other class of engines this same valve opens from the exterior to the interior of the working cylinder. The engines belonging to the class in which combustion occurs under constant pressure present also this peculiarity, which differs from the engines belonging to the second class, in that they can be operated by supplying them either with compressed air from a tank, or by supplying them with steam generated by a boiler under pressure. The Brayton and Selden engines, which I have seen, precisely comply with the latter condition.

XQ153. From whom did these expressions, "constant pressure" and "constant volume" come into the internal combustion engine art?

A153. These expressions are currently used in lectures which have been delivered for a long period, by eminent professors. They result, moreover, from the studies and the works of Brayton, who very clearly established this distinction in two paragraphs of his patent specification of 1872, which I have cited in answer to question 145.

XQ154. Are you unable to state who first classified internal combustion engines as "constant pressure" and "constant volume?"

A154. No; this classification has been known for more than 30 years, and it is so logical that it must have naturally originated in the minds of the people who have been occupied with these questions. It is currently used

XQ155. Then this classification of the engine, as constant pressure and constant volume, in your belief, was one which grew up practically from observation of the engines themselves?

A155. These appellations have not resulted from the construction of the engines themselves, but from the very theories that led to their construction. Practical results showed, after the trials of Lenoir, that it would be simpler to burn the fuel as it is done in a lamp or in a fire place, that is to say, in a more regular and more progressive process than to burn the whole mixture suddenly, as had been attempted by Lenoir. The efforts of the mechanical parts are thus rendered more regular, and it was Brayton who seems to have been the first who had the conception of the combustion under constant pressure, and who well disclosed its whole action.

XQ156. What is the first printed publication which, to your knowledge disclosed or used both the terms "constant pressure" and "constant volume", as classifying internal combustion engines?

A156. I am not able to say. These expressions were used for a very long time by all persons occupied with these questions, and although at the present time the Brayton and similar engines have been abandoned, for at least 25 years the classes of engines have been represented, on the one hand, as "combustion under constant volume", by all the 4-cycle engines using either city gas or water

ranging from 1/4 horse-power to 3,000 horse-power, and in speeds from 1800 to 100 revolutions per minute; and on the other hand in the class of "combustion under constant pressure" we only find the Diesel engine, which is nothing more than the Brayton improved, in which heavy oils can be burned.

ADJOURNED UNTIL 9:30 A. M. NOVEMBER 9, 1906.

November 9, 1906.

XQ157. Referring to the Diesel engines which you mention, have they been practically and successfully built and operated?

A157. Diesel engines have been continuously made for less than six years, but their very delicate construction, necessary in view of the extreme accuracy required, does not at the present time permit their being made except as relatively heavy engines per unit of power, and does not permit them to exceed 100 to 120 revolutions per minute. In practice, it has not been possible to go below 25 horse-power for a single cylinder, and at no time has it been thought possible to use this type of engine in the construction of automobile vehicles.

XQ158. But is it not a fact that the Diesel engines, as known to you, are very efficient?

A158. Yes, the Diesel engine which is a development of the Brayton engine is an improvement over the latter and gives an efficiency much better than was possible with the Brayton engine.

XQ159. In fact have not the Diesel engines shown a higher efficiency than any other internal combustion engines?

A159. No, at the present time the consumption per horse-power of Diesel engines is the same for like power developed, as engines with combustion under constant volume, but the Diesel engine is the only one that can practically use liquid fuel of high specific gravity - that is to say,

what one calls heavy oils. This latter advantage is inherent in the mode of operation of the engine, that is to say, the way that the fuel is introduced into the cylinder and burned. As a matter of fact, the fuel in the Diesel engine , as in the Brayton engine, is admitted during a certain period of and from the beginning of the piston stroke, and burns all the time it is being introduced. The combustion is therefore progressive, by successive quantities, which facilitates the combustion of heavy oils.

XQ160. Did you personally use, or can you cite any use of the term "constant pressure" as denoting a cycle of internal combustion engine prior to 1879?

A160. I cannot recall at so early a date the name of any work positively containing these terms, which, after all, are only expressions summarizing the analytical study of thermodynamics phenomena made use of in the construction of engines.

XQ161. But did you personally use the term "constant pressure" prior to 1879?

A161. I cannot recall that I made use of that expression, but I am certain that at that period internal combustion engines were grouped in those two classes which are perfectly defined by these expressions. After all, the expression itself cannot change the order of things. In 1882, when I was working on an engine for balloons, I thought that the method of causing the fuel to burn pro-

enable me to produce more easily and more surely a light engine. I had made a mistake and I did not persist in it. Mr. Selden, as early as 1879, had the same idea as I. He thought that employing the method used by Brayton, for the construction of his engines, would enable him to realize an engine capable of propelling a vehicle. He was mis taken as I also was, but he did not recognize his mistake. The engine which he constructed is a reproduction more or less well built (rather less), of the Brayton engine. His engine, such as could have been constructed at that time, that is, confomming to the specification and drawings of his patent, is an engine incapable of running. Later on, by the use of a recent method of ignition he endeavored to obtain better results, but as it exists, and as I have seen it in the automobile garage Oct. 29th and 30th last, this engine is incapable of running under load for more than a few minutes. The reasons therefore, upon which I base my opinion can be readily appreciated by all persons familiar with thermodynamic questions and in particular the question of construction of internal combustion engines.

XQ162. Was there any effort made to rum the Selden 3-cylinder and 1-cylinder engines at the garage in New York in your presence on October 29th and 30th?

A162. A trial was to have been made with them in the presence of experts. The latter desired to first examine these engines in all their details. That examination

had permitted the ascertaining of certain differences in arrangement from such as are indicated in the patent, and of such a nature as to modify the operation of the engines from the operation that may be construed from the patent. The engines were then reassembled in conformity with the specification of the patent and the experts then requested that they might see the engine run. The party's plaintiff declined, - I do not know for what reason, and the engines were not put in operation.

XQ163. As you never saw an attempt made to run these Selden 3-cylinder and 1-cylinder engines, how can you say how they will run?

A163. I have said that the Selden engines were a bad copy of the Brayton engine, and here are the reasons: (1) The Ratio of the volume of the pump and the volume of gas introduced into the working cylinder is too small to give a sufficient compression to obtain passable efficiency. (2) The volume of clearance behind the working piston at the beginning of the admission of gas is too large, as well, in order to obtain good efficiency. (3) The admission valve stem passes through an opening which permits loss of air at the time the valve is opened in a manner which very appreciably diminishes the compression. (4) No suitable arrangement to insure a homogeneous and combustible mixture is found in this engine where the liquid hydro-carbon enters to mix with the air. This point, however, is very important and Brayton took care to describe very minutely in his pat-

ent the particular arrangement that he intended to insure what is called carburetion. (5) The liquid hydro-carbon cannot fail to incompletely mix with the air introduced, in view of which it must uhdergo decomposition, owing to the action of the heat generated during the operation of the engine and produce carbon deposits, which in time will clog either the gauzes or the exhaust valve or even the walls of the cylinder and the piston. (6) Finally the patent and annexed drawing do not mention or indicate any cooling system for the head or the cylinder. Without doubt, Mr. Selden, for the purpose of making his engine lighter, omitted that important part of the engine which had not been neglected by Brayton. To summarize, in the engine which is described in the patent the ignition of gas is badly provided for, because the combustible mixture may vary at any moment, owing to the fact that there is no special arrangement to produce a suitable and homogeneous mixture. There is no cooling means for the walls, and as the expansion of gas in this engine is very little, the drop of temperature of the gases is almost solely due to the transmission of heat through the walls. The cylinder walls not being properly cooled, the lubricating oils would be rapidly brought to a temperature of decomposition and volatilization causing carbonaceous deposits, which, at the end of a short time will stop the operation of the engine. The carbonaceous residue from the liquid hydro-carbon introduced and imperfectly

with the action of the valves and very soon vary the condition of operation of the engine. I understand by good operation of an engine, operation at full power a few minutes after starting and continuous at full power for several hours. Engines which are not capable of running steadily and regular for at least ten hours cannot be considered practical engines. The Brayton engine is certainly capable of fulfilling these conditions.

XQ164. Does your last answer 163, apply to the actual Selden engines you saw at the garage?

A164. I am sure there is here no desire on any one's part to deceive anybody. As a matter of fact, the Selden patent defines the question here at issue, (1) by a specification, (2) by the drawings. The Selden engines which I saw at the garage are made in accordance with the general provisions and details shown and described in the patent. Still, apparently, some details have been modified afterwards. I do not insist upon the question of dimensions, particularly of the air inlet and its distribution. I admit that the patent drawings are rather diagramatic of the construction and relative dimensions have not been observed, but I believe, and especially as concerns ignition, that the principle set forth in the patent and well defined as a matter of fact in the arrangement used by Brayton and reproduced, so to say, by Selden in his patent, must be considered in full in the matter at issue. I need not, therefore, for the present, take into account an arrange- 957.

parts used in effecting it, and which has been employed to materially alter the original ignition system.

XQ165. Do you consider it reasonable to impose on the engine of the Selden patent tests and conditions as to power and perfect operation only now being met by the perfected internal combustion automobile engine of the present day?

A165. My answer to question 163 does not require of the Selden engine that it shall produce the power which is actually given by engines employed in automobiles. It simply states the conditions which it was fair to impose at that time on any engine worthy of the name. When I speak of maximum power, I mean the power of which an engine is capable, not power of another engine. As far as it concerns the duration of operation, that is a factor independent of the type of engine or its power; what was true in 1879 is true today, that is, so long as an engine is built to produce work it cannot be looked upon as good unless it is capable to continue in operation for ten hours. Such a clause is always included in the specifications between customers and manufacturers in which it is agreed to furnish engines. However, in this particular case, I figure that after two hours of regular operation equilibrium of temperature between the different parts of the engine is established. As a matter of fact, admitting that the Selden engine would really run regularly at starting, it would, long before that time, reach a temperature which would cause it to stop.

XQ166. Does the admission valve open outwardly in the

A166. The Diesel engine, as I have explained, is a Brayton engine improved in the following manner: In the Brayton engine air compressed by a pump is introduced into the cylinder to burn the fuel progressively as it enters. In the Diesel engine the improvement consists in completely separating the air and fuel and introducing the former first into the cylinder at a very high pressure, then in further raising the pressure by the piston of the cylinder acting as a pump, up to 35 atmospheres, the fuel mixed with air is then introduced by a valve opening from the interior to the exterior.

ADJOURNED UNTIL MONDAY, NOVEMBER 12th, 1906 AT 10:15 SAME PLACE.

Monday, Nov. 12, 1906, 10:45 A.M.

XQ167. Was not the water jacketing of internal combustion engines known practically prior to 1879?

Objected to as irrelevant and immaterial for the reason that Selden's patent expressly claims water cooling by enclosing water in the crank case as an improved form of engine.

X167. Yes, it was known ever since work was begun on the construction of internal combustion engines.

XQ168. For example, was not the Otto engine you had in 1878 provided with a water jacket for cooling purpose?

Same objection.

A168. Yes, evidently, and no one has ever doubted it. Feeling that this whole discussion is spreading over matters of secondary interest, I would like, before defining the meaning attached to these two definitions, "combustion under constant pressure" and "combustion under constant volume," to submit a few technical explanations with a view to clearly establishing the reason for these definitions. At first let me say that the term "compression" employed in connection with thermic engines is but of secondary importance as it cannot be used to define the two classes of engine in question. All internal combustion engines operate with compression. It is merely a question of the relative degree of compression.

In order to well represent the phenomena taking place inside a cylinder of an internal combustion engine, I am

I will first take up the case of the Lenoir engine as an example. Let AB be a line representing the piston stroke. Let us represent by ordinates above these lines the pressures beginning from vacuum, which vacuum is represented by AB. The atmospheric pressure line would be represented by the line ab. At the moment when the piston is at the end of its stroke in B moving towards A, the pressures will be less than atmospheric pressure, being represented by the line bm and representing that point of the stroke at which the admission ceases and ignition is effected. At this point m the piston possesses a comparatively high speed and the piston speed is in fact represented at any part of the stroke by the projection on AB of an object starting from B and describing at a constant speed the half circumference BOA. If now, for instance, the period of time during which combustion occurs is represented by the arc of circumference m'n', the piston will have progressed from mn measured on BA during the same period of time. It can be now readily understood that the volume of the combustible gases Bm at the time of ignition has become greatly increased during the time occupied by the combustion, since it has become Bn.

The Lenoir engine cannot therefore be said to be an engine in which combustion occurs under constant volume. Neither is it possible to consider it as an engine in which combustion occurs under constant pressure, since the curve representing the pressure during the period of time occupied by the ignition follows the line mb and from that point it nearly follows a hyperbolic curve which represents

the law of expansion of gases, until the piston has reached point Q, at which point exhaust takes place.

It is the study of this diagram which has led investigators to occupy themselves with the realization of means permitting a better utilization of the heat developed by the combustion, by obtaining greater expansion.

Two methods presented themselves: First, trying to obtain the condition of expansion taking place in a steam engine by doing work from the very beginning of the piston stroke, causing the gases to burn from this point up to a certain point of the piston stroke, after which the gases would expand while continuing to do work.

It is this type of engine which has been designated under the terms of "constant pressure motor." This expression correctly represents the phenomena which it is intended to produce in the cylinder and which as a matter of fact takes place nearly as intended.

The phenomena are reproduced in Figure 2 in which the same notations are employed. B, that is to say at the time when the piston is at the verge of beginning its power stroke, the mixture is admitted at a pressure which is above atmospheric pressure, ignition beginning simultaneously. The admission continues until n at a very nearly constant pressure, which pressure is the one given by the tank or the pump feeding the motor. In this case the period of time occupied by the combustion is much greater and can be measured from the half-circumference by the arc Bn'. One will notice the complete analogy existing between this

diagram and the diagram obtained in a steam engine. This diagram represents the mode of operation of the Brayton engine.

The second means of causing combustion to do work on the piston from the very beginning of its stroke consists, according to the principle laid down by Beau de Rochas, in locating the explosive mixture in a closed chamber of well defined volume located behind the piston and igniting the mixture before the motion of the piston begins: i. e., when its speed is zero. Figure 3 gives an explanation of the phenomena resulting from this mode of operation. At B the piston speed is zero. The combustible gases stored behind the piston (after having been previously compressed to a pressure represented by Bm) burn at a speed which increases greatly the higher the pressure produced. As the piston moves at a very slow speed, if the period of time required for the combustion is represented by the length Bn', combustion will have been completed while the volume will not have, so to speak, very much changed. The pressure reached will be considerable at the start and the work of expansion will immediately begin, lasting almost during the whole stroke of the piston; that is until the exhaust begins at q. But experience has shown that there was still a further advantage in causing combustion to take place under a volume as constant as possible. To accomplish this result experimenters have been led to cause the ignition of the mixture to take place even before

the piston has reached the dead center, in such a manner that the ignition will have been completed before the piston has materially progressed in its power stroke.

Figure 4 indicates how these phenomena take place.

In Figure 3 the period of time occupied for the ignition is measured by the angle BOn'; this same angle on Figure 4 is located so as to include between the points m' n' the point B. Combustion is therefore completed before the piston has materially progressed in its power stroke. The quantity Bn' is what is termed early ignition. This early ignition, as it has just been defined, and which is most necessary to effect in internal combustion engines in which combustion takes place under constant volume, is another point which characterizes the two classes of engines in question.

It is indeed not possible to compare the operation of the Lenoir engine to the mode of operation which we have just analyzed (Figures 3 and 4). One may object that the Lenoir engine, operating without previous compression of the combustible mixture, should differ from a Brayton engine for instance, in which the ignition of the charge (said to be under pressure) is accomplished after its introduction. We may then represent what takes place by Figure 5. This figure, judging from its appearance, is not anything else but the reproduction of Figure 1, in which the atmospheric line passes below the point m. Com-

bustion takes place during the period of time m'n', during which the volume of the cylinder has increased to almost double its original volume. It cannot therefore be stated that combustion takes place under constant volume. It does not take place either under constant pressure. Yet this mode of operation which brings us back to the so imperfect arrangement of Lenoir, is precisely the one which takes place in the case of the Selden engine when timed ignition is effected by means of the spark plug which has recently been employed to operate this engine.

We may also represent, in a most striking manner, the major differences which distinguish the engines in which combustion takes place under constant pressure, from those in which combustion takes place under constant volume, and for this it is only necessary to take into account the work absorbed by the compression of the combustible mixture before its combustion. Figure 6 brings up these differences. In the engine in which combustion takes place under constant pressure, the actual work produced is represented by the surface A d c, which is the difference between the work performed by the working piston A d C D, and the work of the pump A c C D. In the engines in which combustion takes place under constant volume, the work produced is the difference between the work done on the working piston A d f B, and the work required by the previous compression

of the mixture A c B. The two principles which govern these operations are very different. It is not therefore surprising that the results produced are also different. This difference is shown quite well by Figure 6, which shows that with combustion taking place under constant volumes it has become possible to obtain today an amount of work almost double that obtained in the case where combustion takes place under constant pressure. And indeed, it is only since the work of Diezel, and in fact quite recently, from a practical point of view, that it has become possible to burn under a great pressure comparable to that obtained in engines in which combustion takes place under constant volume; that it has become possible, as I have already said, to burn the combustible in a progressive manner as it is introduced into the cylinder, and during a very short fraction of its stroke, so as to make possible expansions comparable with the expansions which are secured in engines in which combustion takes place under constant volume. In summing up the difference existing between the Selden engine and the engines which are at the present time used on automobiles, they can be characterized by the following points:

Storing of the charge behind the working piston and ignition of this charge by early ignition in such manner that combustion is completely effected before the piston, which is crossing at this time its dead center, has had

time to materially vary the volume of the cylinder in which combustion takes place. This mode of operation in 4-cycle is the only one, as I have explained, in question number , by means of which a maximum pressure can be attained at the time of combustion with a minimum of mechanical complication. All other types of engines using pumps to compress the mixture previous to its combustion cannot enter into this class. The point of maximum pressure is not reached at a dead center, and as this condition is absolutely indispensable and necessary to obtain a good efficiency of engines in which combustion takes place under constant volume, the engine using pumps cannot enter into the same class.

Returning now to the question of water circulation, I will say that the circulation of water, the object of which is to prevent the temperature of the walls from reaching too high a degree under the action of the heat resulting from the combustion of the mixture, must be the most effective the less the expansion of the gases after burning. Thus, it can be conceived, and as a matter of fact practical results have shown, that in the case of combustion engines operating under constant volume, where all the work produced is caused by the expansion of gases, the cooling of the walls need not be as great as in the engine in which the work produced is only partly due to expansion. This point can be more easily grasped if in a

combustion engine operating at constant volume, ignition is caused to take place late, instead of causing it to take place at the necessary time. The operation of an engine effected in this defective manner resembles very closely that of the Lenoir engine, where the pressure, during the combustion, varies at the same time as the volume. It also resembles closely that of a combustion engine operating under constant pressure, since combustion takes place during a fraction of the piston's stroke.

The water circulation, which was thought necessary from the very beginning in the construction of gas engines is therefore much more necessary in the case of engines of the Brayton and Selden type, as I have just explained. One cannot therefore understand why the Selden engine is not provided with some kind of water circulation.

MET AT 4:35 P. M. SAME PLACE.

SAME PARTIES PRESENT.

I have thought it necessary to volunteer the above explanation because I was of the impression, judging from the question which had been addressed to me by the honorable attorney for the complainant, that I had not made myself sufficiently clear upon the question of classifying motors into:

(C) Motors in which combustion takes place under constant pressure,

35-94

Motors in which combustion takes place under constant volume.

I trust that I may be excused on the ground that previous to my arrival in New York I had no idea whatever of the sort of question that would be addressed to me.

Besides, during the two and a half hours that have just elapsed between the time set for the hearing and the actual time of its beginning, I have had the pleasure to notice, while glancing through a treatise of Dugald Clerk on gas engines, which happened to lay on the table, that I was in accord with his ideas on the subject, (Page 29), with the exception, however, of a slight difference of opinion concerning the early gas engine, and about which I have given reasons that I believe justify their exclusion from this very logical classification.

November 13, 1906.

MET AT 10:40 SAME PLACE.

SAME PARTIES PRESENT.

First question asked the witness at 11 o'clock.

XQ169. I have asked you a very simple question 168, which is as follows: "For example, was not the Otto engine you had in 1878 provided with a water jacket for cooling purpose?" Is not the first part of your answer to this question 168, as follows: "Yes, evidently, and no one has ever doubted it." Is not this answer a direct answer to a well defined question?

A. Yes, it is the answer to the question, but I wanted to mention the other matter which I afterward referred to.

XQ170. Have you not been told that you were to answer my questions directly and not to volunteer theories which are not direct answers to my questions?

A. That statement was necessary at the end of my answer to 168, to enable me to properly answer question Q which would be put to me later.

XQ171. Have you ever been a witness in a suit and cross examined by an attorney?

A. I have been called as an expert in France, which corresponds somewhat to the present examination.

XQ172. Do you not understand that while testifying

in this case your duty is to answer my questions, and to give direct answers to the questions I ask you?

A. I fully understand my duty, but I discharge it in such a manner as to most clearly set forth the facts relating to this case.

Complainants counsel now request defendants' counsel to instruct the witness, as the witness does not appear to be familiar with the practice on cross-examination in this country, that the answers of the witness should be responsive to the cross question asked and not introduce new matter, which is irresponsive.

Counsel for defendants states that the witness is under oath that he understands that he is under oath and that he is making such answers as he deems proper. The explanation which he made in answer 168 was given because counsel for complainant had been examining him about the two types of engines therein referred to and because the witness deemed it his duty to clearly set forth what he meant by his classification of internal combustion motors into such classes.

Counsel for defendants further states that counsel for complainants has not been cross examining the witness on matters brought out on the direct examination and that

he has warned and that he now warns said counsel that he will insist that the witness has been made a witness for the complainants.

Counsel further protests against the unwarranted delay and length of time consumed so far on cross-examination and calls attention to the fact that since the cross-examination commenced counsel for complainants has never commenced at the time to which the meeting was adjourned but has without exception been from fifteen minutes to two hours and a half late, and this in spite of the fact that he is aware that the witness desired to sail for Europe last Thursday, November 8th, and now wishes to sail.

Complainants' counsel calls attention to the fact that this witness is being examined and cross-examined in the French language involving the translating of all questions and answers from English into French and back into English in order to make a record, this being done because it was stated to complainants' counsel at the beginning of the witness' testimony that he could not speak or understand or read the English language, at least in such a way as to be able to testify. This method adopted wholly by reason of the witness' inability in this respect has inevitably caused delays and effort

having been made to proceed during the entire working day, involving translation into English of each day's testimony, a work of four or five hours usually to be done between the hours of five P. M. on one day and 10 A. M. the next. That Complainants' counsel and Experts are greatly handicapped in this whole matter by the necessity of making the record in French, and that it is physically impossible to proceed with the expedition had in this matter, and that the statement as to a delay of two hours and a half caused by complainants' counsel is absolutely misleading, as by consent necessary time was taken to translate the irresponsive answer of witness, Number 168, Complainants' counsel being unable to proceed until the technical answer has been actually translated.

Counsel for defendants states that the examination and cross-examination are being conducted in French at the request of Mr. S. R. Betts, counsel for the complainants, that before the examination commenced, counsel for defendamts suggested that the regular practice of employing an interpreter be adopted.

Counsel for defendant now requests that the Commissioner designate an official interpreter.

With regard to the delay, Counsel for defendants wishes to state and charges that there is an unwarranted delay

in the part of the complainants. That yesterday, about 11:45, counsel for complainants refused to proceed further until he had a translation made of the answer to question 168, that an adjournment was then taken until 2 o'clock. That about 2 o'clock counsel for complainant said that he could not have the translation completed until about 3, at which time he agreed to appear, that as a matter of fact he did not appear until 4:30, and then stated that he did not intend to cross examine any further, and that as the record will show did not cross examine him.

Complainants' counsel states that the translation of the very technical answer referred to occupied by LePontois, who has been acting as the official translator of this testimony from the time the adjournment was taken, working at Mr. Betts' office with stenographers, and without lunch, until after 4 P. M., and that complainants' counsel and expert immediately on receiving the translation and hastily glancing over it, came back to Coudert Brothers' office, where they found that the witness, Mr. Krebs, desired to add something to his answer, which he then did, consisting of the last paragraph thereof, and it then being 4:45 adjournment was taken.

Examiner being present says that the Examination of this witness shall commence at ten o'clock each day until

3-60

one o'clock, recess taken until two o'clock to continue to 4:45 each day until the testimony of the witness is completed, exclusive of Sunday, and on Saturdays from ten to half past one.

The Examiner states that with the consent of counsel for the respective parties, he appoints Leon LePontois as interpreter.

(Complainants' counsel, in view of the situation presented, and the refusal of defendants' counsel to inform the witness that the answers must be responsive to the question, now requests the Commissioner, John A. Shields, Esq., to personally instruct the witness as to his duties in answering cross-questions, and in particular that his answers must be responsive to the question, and must not contain volunteered and irresponsive matter.)

The Examiner instructs the witness that he must answer the questions directly and in response to the question put and in accordance with his view of the matter.

XQ171. Who called your attention to the book of Dugald Clerk on "the gas and oil engine" (published by John Wiley & Sons New York 1904) and which you referred to in answer to XQ168?

A. I found it lying on the table and merely looked over it as I stated im my answer to XQ168.

XQ172. Had you ever seen this technical work of Dugald Clerk or any edition of it before you found it lying om the table yesterday as you say ?

A. No, never.

XQ173. Did you discuss this work of Dugald Clerk with any one before you gave your answer to XQ168?

A. No.

XQ174. Do you understand or can you ~~xxxxx~~ read technical English sufficiently to understand accurately that book of Dugald Clerk in English?

A. Yes, I can follow an English technical description in a general way and more especially when this description is supplemented by drawings.

XQ175. How did you happen to turn to the particular page No. 29 of the Clerk book which you have referred to in answer 168?

A. By merely looking over the book and I made a note of it.

XQ176. There are no drawings for page 29 of Clerk's

A. The terms are almost French.

1 P. M. Adjourned to meet again at 2 P. M.

Met at 2 P. M. pursuant to adjournment.

XQ177. Referring to your answer in 168 did you discuss the subject matter of that answer with any one before giving it on the record?

A. I did not speak to any one about it. I had studied the matter forming the base of that answer on Sunday.

XQ178. Did you discuss the subject matter of that answer 168 on either Saturday November 10th or Sunday, November 11th, with any one?

A. I have not discussed the matter with any one.

XQ179. Have you ever published in print any discussion relating to the subject matter of that answer No. 168?

A. I have not written or published any article on this matter but Iknow this question as I studied it practically and also because of the work that has been done on internal combustion engines. I have been compelled to more thoroughly yet study it after the first questions that have been asked me on this subject, so as to sum up my ideas on the matter in a precise manner and I possess this subject very clearly at the present time.

3-43

XQ180. What printed work do you recognize as an authority upon the subject matter covered by your answer No. 168?

A. Quite a number of books have been published on the subject of internal combustion motors. Every author of course has his own interpretation of phenomena, but all the different opinions are of course subject for discussion. I have summed up in my answer the actual state of the question and such as it has been established since a very long time.

XQ181. You have not answered my XQ180 which asked you to state what printed work you recognized, if any, as an authority upon the subject matter covered by your answer No. 168?

A. I do not recognize any one as an authority on the question as the various opinions are subject to discussion.

XQ182. Then in your opinion the classification of internal combustion engines is not yet definitely determined?

A. Yes; this is a part of the theory of internal combustion engines on which every one agrees, with the exception of slight difference of opinion on secondary matters as I have stated in my answer to question 168.

XQ183. Is there any expert authority who has printed and published his views in French on the subject of classification of internal combustion engines and whom you recognize as an authority?

A. No; I can not say that I can cite the name of any one having written a book on the subject, for I do not remember the names of the authors of the numerous books that I have

read on the subject, In a general way all experts agree on this subject, and Clerk himself, as I have been able to ascertain in reading part of his book yesterday, is of the same opinion.

XQ184. Dugald Clerk in his book you have referred to, throughout distinguishes between engines igniting the charge without previous compression and engines igniting the charge with previous compression, the compression referred to being always that above atmosphere. Do you not recognize that there is such a distinction?

A. Such a difference does not possess the importance which seems to be attached to it. It is merely a question of where you place the starting point. This whole discussion can be better generalized if the absolute vacuum is considered as the starting point. This same reasoning applies to the questions of temperature. The theories regarding these questions are always based on being the absolute zero as the starting point.

XQ185. But supposing the starting point is at atmospheric pressure as the question supposes and answer XQ184?

A. I can answer this question in stating that Clerk commits a slight mistake in his distinction and to demonstrate it I merely propose to bring a motor (with previous compression) at a height superior to five

thousand meters, for instance the pressure at which the mixture will be introduced im the cylinder will then be lower than the atmospheric pressure, considered at the sea level.

XQ186. The absolute zero you referred to im answer 184 as being the starting point on which the theories are based is merely a theoretical starting point, is it not?

A. The study of natural philosophy teaches us that im order to establish a better term of comparison between phenomena, we endeavor to free them as much as possible of the secondary questions, which might render their general inspection more complicated or more obscure. In analytic algebra, the functions representing the progressive development of the phenomena are all brought back to what is called their primary ordinates. The absolute zero is no more an abstracted word than the absolute vacuum is. The absolute zero can be absolutely determined.

XQ187. Can any practical internal combustion engine be started at what you call the absolute zero? in the last answer?

A. I will answer this question by asking you whether one can place himself in ~~you look at it from the, infinite, point of view~~ and nevertheless the, infinite, does exist.

XQ188. Referring to the Lenoir engines as you have known them, do they ignite the charge at a pressure which is never above atmospheric pressure, and without previous compression of the charge?

A. Ignition takes place at a pressure which is inferior to the pressure at which the charge is introduced in the cylinder, In the case of the Lenoir engine, the pressure of admission is that of atmospheric pressure.

XQ189. Referring to the Brayton engines, do they ignite the charge at a pressure which is above atmospheric pressure and with compression previous to ignition?

A. In the Brayton motor the mixture is introduced in the cylinder at a pressure which is above atmospheric pressure. This pressure is obtained by means of a pump which has previously compressed the air of the mixture in a tank at a suitable pressure. Ignition is effected at the pressure possessed by the gases after their introduction in the working cylinder (See drawing No. 2 and corresponding explanations in my answer 168).

XQ190. Referring to the Otto four-cycle engines used in the Panhard automobiles, do they ignite the charge at a pressure which is above atmospheric pressure, and with compression previous to ignition?

A. In the case of Otto four-cycle engines, igniting is effected under various conditions of pressure, These pressures depending on the amount of work which is required from the engine. These pressures are, even and very often below atmospheric pressure, But in all cases the mixture has been previously compressed behind the piston. This follows from the very principle upon which this class of motor is based. (See explanation and drawings 3 and 4 shown in answer to question 168).

XQ191. In the Otto four-cycle engines of the Panhard Company as actually operated, is not the charge at the moment of ignition at a pressure above atmospheric pressure?

A. I have just answered that the pressure at the time of ignition is extremely variable. In the case of powerful engines running with very small load and running very slowly I have often noticed by diagrams taken, that this pressure at the time of ignition was below the atmospheric pressure. This can be readily understood since the quantity of gas introduced at the period of admission has been so small that during the compression stroke it cannot be compressed to atmospheric pressure.

Adjourned to ~~Tuesday~~ Wednesday, November 14, 1906, at 10 A. M.

November 14, 1906.
Met at ten o'clock, pursuant to adjournment, same place, same parties present.

XQ192. Do you mean to testify that the automobile engines of the Panhard Company as actually used in operating the automobile vehicles in general use ignite the combustible charge when it is at a pressure less than that of the surrounding atmosphere?

A. The statement that I have made is the result of observations that I have made in my laboratory. Referring now to the question just addressed to me, I can say that on an automobile the motor delivers the power which is required of it. This power is limited on one hand by the maximum which can be delivered by the motor, on the other hand by the power required by its mere operation without carrying a load. The pressure at which ignition takes place is, therefore, a direct function of the power which is to be delivered by the motor. I have not ascertained whether or not the motor being placed on a vehicle the pressure at which ignition takes place falls sometimes below that of the atmosphere. I will add now that I do not consider this "point" as presenting any interest whatever.

Counsel for Complainants objects to answer as not being responsive.

XQ193. XQ192 repeated.

A. ~~The statement that I have made is the result of observations that I have made in my laboratory. Referring~~

A. I have never intended to state that in the case of the Panhard-Levassor automobile the ignition of the mixture is accomplished in practice under a pressure below that of the atmospheric pressure.

XQ194. What has been your practical experience with two-cycle internal combustion engines on vehicles?

A. I have never experimented with two-cycle motors on vehicles, but I have experimented with them in my laboratory as I also have done with four-cycle motors.

XQ195. Do you not know that two-cycle internal combustion engines have been used and are being used on automobiles?

A. I know of it. I also know that steam motors are used for the propulsion of automobile vehicles. This does not prove, however, that there is any point of similarity betweem these motors.

XQ196. Do you know of a vehicles which was called the Roger vehicle, and driven by a two-cycle internal combustion engine, and was that vehicle used in France?

A. I have heard of the existence of the Roger vehicle. It has been used in France. This type of automobile has not been in use as far as I know for the last ten years. I cannot tell whether the motor mounted on this vehicle was a two-cycle motor or a four-cycle motor.

XQ197. Was the engine known as the "Benz" engine used on the Roger vehicle in France?

A. I believe that the Roger vehiclesthat I have seen were equipped with a Benz engine.

XQ198. Were the Benz engines which you knew of as used on the Roger vehicles two-cycle engines?

A. No; the motor which I saw mounted on a ~~xx~~ Roger vehicle in about 1894 or 1895 appeared to me to be a four-cycle motor.

XQ199. Do you not know that Benz two-cycle engines were used in France?

A. I know that Benz two-cycle engines have not only been employed in France but even constructed there.

XQ200. Do you not know that Benz two-cycle engines (which you have just testified were made and used in France) were used to propel automobiles?

A. This may be quite possible but I have never paid ~~xxxxxxxxx~~ any attention to it.

XQ201. Did you ever hear or know of automobiles made and run in the United States under the names of ~~Ex~~ "Elmore" or "Duryea" and which have been driven by two-cycle internal combustion engines?

A. In my answer to question 195 I have stated that I knew of the existence of automobile vehicles propelled by means of two-cycle motors. The names of Elmore and Duryea are not unknown to me .

XQ202. Do you know the names of Elmore and Duryea in connection with automobiles driven by two-cycle internal combustion engines?

A. Yes, I have examined this question at the proper time. The engine used at a time by these constructors have not excited my interest for a long time; unless I am mistaken this type of motor has not been manufactured for a long time.

XQ203. Do you not know that the Elmore Companies of the United States have during the last few years made and sold hundreds of automobiles driven by two-cycle internal combustion engines and are still making and selling them?

A. I am very glad to know of it, but I knew nothing about it.

XQ204. On a two-cycle engine is it not possible to have ignition in advance of dead centre, substantially as in the four-cycle engines?

A. I have not studied the process of realizing this advance. But as matter of fact it is not possible to obtain such advance to ignition, in the case of the two-cycle motors, such as they are defined, by the Brayton and Selden patents, which engines belong to the class of internal combustion engines in which combustion takes place at constant pressure.

(Accent.) There exist indeed two-cycle engines which really, however, belong to the four-cycle type. In these engines, this motor these two parts of the cycle, expulsion of burned gases, and introduction of the fresh combustible mixture are suppressed by a very clever form of mechanical construction. In the construction of these motors the cycle of operation takes place under such conditions that at the time of ignition, the explosive mixture finds itself in the conditions which are absolutely necessary and even indispensable to enable the combustion to take place under constant volume. It may be, therefore, said that although these motors belong to the two-cycle type of engines, they really belong to the class of internal combustion engine in which combustion is effected under constant volume.

XQ Answer objected to as irresponsive and volunteered.

XQ205. But you have not directly answered my question No. 204, which was whether on a two-cycle engine it is not possible to have ignition in advance of dead centre?

A. The appellation (two-cycle engine or four-cycle engine) is not sufficiently clear, as I have shown you in my last answer, to enable me to answer your question in a precise manner. This appellation needs to be completed by some information which would enable me to know whether you are speaking of an internal combustion engine in which combustion takes place under constant volume

or under constant pressure. I could also answer your question, if you stipulated the name umder which the motor, you refer to, is known. This question as formulated by you is mot precise; it is much too vague to permit me to answer it in a way which would not lead to a misinterpretation of my answer.

XQ206. Are there not two cycle internal combustiom engines in which it is possible to have ignitiom im advance of dead centre?

A. Yes; provided that the mode of operation of these motors is such that combustion does really take place under constant volume.

1 P. M. Adjourned for lunch, to meet at 2 P. M., same place.

Met at 2:10, P. M.

XQ207. Can you refer me to any published work where two-cycle engines are distinguished as "constant pressure and "constant volume" two-cycle engines?

A. I could not for the reasom that two-cycle engine may belong in some cases to either one of the classes (constant volume, constant pressure).

XQ208. How do you determine im a specific engine which way it is run under particular conditions? This question is asked in view of your answer 207.

A. In order to determine the way in which it runs I will be obliged to examine the motor or to look at a drawing of it supplemented by a description of some kind.

XQ209. What would be your actual examination of any engine by which you would determine which way it was running under existing conditions?

A. The process of examination, varies according to the case. There can not be a special means fitting all cases. The result is deducted from the chain of conclusions which result from the progressive examination of the means adopted for the realization of the motor.

XQ210. In the case of your Panhard four-cycle engines what is the actual method you adopt to determine actual conditions and operations within the engine cylinders while the engine is running?

A. The type of motor being perfectly well determined since in this case it is a Panhard-Levassor motor, I know that I have to deal with an engine in which combustion is effected at constant volume. The process used to make certain that every organ operates normally and as intended that it should, consist in running the motor under a load by means of a brake and to set the point of ignition so as to

obtain the maximum power corresponding to the dimensions of the engine. In the case where we have to deal with an engine having new dimensions, the brake test is sometimes completed by the examination of the diagrams which confirm the first test and give curves similar to the one I have shown in figure 4 in my answer to question 168.

XQ211. Does the brake test you refer to in answer 210 determine whether the engine is running at constant pressure or at constant volume?

A. The brake is merely an apparatus having for function to measure the power developed by any motor. It does not make any difference whether this motor is a steam or a gas, or an electric motor. The brake can give in each case but one information, that is the power which it absorbs, which is equal itself to the power delivered by the motor to which it is attached.

XQ212. What do you mean by "the examination of the diagrams" as you say in answer 210. How are these diagrams made and for what purpose?

A. The examination of the diagram furnishes information about the ~~manner in which the~~ variations in pressures ~~are formed and vary~~ inside the cylinder. These informations are of a great help in determining whether the pressures take place and succeed each other as intended.

3596

T.B.D.

XQ213. How are these diagrams secured from the cylinders of the Panhard engine?

A. Exactly in the manner required by the apparatus used to take the diagram.

Answer objected to as not responsive.

XQ214. Well, what apparatus is used to take diagrams from the cylinders of the Panhard engines at their works under your direction?

A. I have employed Richard indicators, Carpentier registering indicators and several types of manographs.

XQ215. Does the card diagram when taken confirm the fact that the engine is running on the constant volume cycle as has been assumed by you as predetermined in the case of Panhard engines?

A. In the cases where the engine operates badly or when its normal mode of operation is modified, such diagrams are obtained that it does not become possible to determine by their mere examination whether or not one deals with a motor operating in such a manner that combustion takes place under constant volume.

Objected to as irresponsive.

XQ216. Referring to XQ and answer 215, state what is the fact when the engine operates well?

A. Yes; ~~always~~ in the case of the Panhard motor I will say that when the motor operates satisfactorily, the diagram is always similar in shape to the model diagram that I have given, figure 4.

359

XQ217. If an internal combustion engine runs at constant pressure, would not the taking of diagrams in the way you have described show that fact?

A. Yes, since the diagram will be a picture expressing the variations in the pressure which it has been intended to realize.

XQ218. Do not the diagrams obtained from the cylinders of Panhard engines show differing pictures of what is occurring within the cylinders corresponding to varying conditions under which the engines are run?

A. Diagrams do not always indicate what is going on inside the cylinder. As I have said in my answer 215, The internal combustion motors operating under constant volume are liable to be placed in conditions of operation very similar to the conditions in which the motors operating under constant pressure are placed. I will even apply this remark to the Lenoir motor. This is one of their peculiarities, but it does not follow from this remark that they must be classified in the class of the constant pressure motor. A motor which has been constructed and set in view of operating normally with combustion under constant volume may be made to imitate the behavior of a motor operating under constant presure and even that of a Lenoir motor, but such motor will never be able to operate as well . I will take the liberty in order to show that

no confusion can be ~~made~~ on the subject to propose the following comparison: will it ever ~~come~~ to any one's mind to comprise in the same class, man and a monkey, and yet man can do all what is accomplished by the monkey, but the latter cannot accomplish what is done by man. The conclusion seems to me very easy to deduct from the above.

Adjourned to ~~Wednesday~~ Thursday, November 15, 1906, at ten o'clock at the same place.

November 15, 1906.

Met pursuant to adjournment, parties present as before.

CROSS-EXAMINATION OF THE WITTNESS ARTHUR CONSTANTIN KREBS, CONTINUED BY MR. BETTS.

XQ219. You say in answer 218 that "the internal combustion motors operating under constant volume are liable to be placed in conditions of operation very similar to the conditions in which the motors operating under constant pressure are placed." Specify the conditions of operation to which you referred in that statement.

A. I have not made the statement that engines which have been constructed in view of causing the combustion to take place under constant volume, could operate as engines constructed to burn the gases under constant pressure. I have said that diagrams ~~xxxxxxxx~~ given by engines ~~xxxxxx~~ in which combustion takes place under constant volume can in some cases resemble very much ~~xx~~ the diagrams given by engines in which combustion takes place at constant pressure, when they operate normally according to the cycle selected. It is for that reason that in my answer No. /51 I stated diagrams ~~xxxxxxxxx~~ cannot be trusted to determine (a priori) ~~xxxxxxx~~ to which category of ~~xxxxxx~~ engines, the engine under observation belongs. These appearances are produced when the combustion is retarded by a suitable course, (voluntary or involuntary).

XQ220. Do you classify internal combustion engines by their construction, as distinguished from classifying them by their thermic cycle of operation when you refer to constant pressure and constant volume?

A. It seems to me that there can be no doubt about this question. Engines are classified according to the thermic cycle on which they operate.

XQ221. Do not the card diagrams obtained from internal combustion engines represent the thermic cycles on which the engines are operating at the time the diagrams are taken?

A. No; they cannot represent exactly what is taking place in the cylinder on account of their construction. The moving parts of indicators possess a certain amount of inertia which often introduce errors in the curve traced by them. These errors have to be rectified afterwards as well as possible. I have already said in my answer 151 that the diagrams cannot be solely depended upon to approximately determine what is going on inside a cylinder, unless the type of motor which has given the diagram is previously known.

XQ222. Can you state any better or more accurate way of determining what is actually taking place as to pressure within the engine cylinders in actual operation, and the actual thermic cycle on which they are operating

than by obtaining card diagrams?

A. The best method as I have already stated is the brake method. Theory indicates that the maximum amount of work obtained for a given amount of combustible fuel burned, corresponds with the greatest expansion. As a matter of fact, the expansion is much greater if the pressure existing behind the piston at the moment where it begins its stroke is as large as possible. It is in order to obtain this ideal condition that Beau de Rochas has described the best method which can be employed, that is to say, to cause the combustion to take place under constant volume. Actual experience has confirmed his theories, and from it the special category of motors operating under constant volume is born.

Answer objected to as entirely irresponsive to the actual question which is now repeated.

XQ223. I now repeat XQ222 which you have entirely failed to answer:

"XQ222. Can you state any better or more accurate way of determining what is actually taking place as to pressure within the engine cylinders in actual operation, and the actual thermic cycle on which they are operating, than by obtaining card diagrams?"

A. Diagrams cannot be said to constitute a method for the determination of the true thermic cycle on which the operation of an engine is based. It is in fact possible to obtain from steam engines or from air pumps diagrams which are very similar to those given by thermic engines. The examination of a diagram does not even permit to determine whether or not one has to deal with a thermic cycle.

Answer objected to as not responsive to the question, and as not answering it.

XQ224. XQ222 and XQ223 is now repeated to the witness.

A. I wish to know whether by the word "actual" you mean the ensemble of the diagram or a point of this diagram at a determined point of the piston stroke.

Adjourned to meet at 2 P. M.

Met pursuant to adjournment.

XQ225. I mean the ensemble of the diagram?

A. I will answer question 224 by dividing it in two parts, As These two parts, in my opinion, cannot be linked together.

First part. I do not know of more accurate means to obtain diagrams than the apparatus of which I mention the names in my answer 214.

Second part. No. It is not possible to determine by the reading of a diagram the type of motor that one has to deal with, "steam, compressed air, internal combustion, etc." It is still more impossible to determine by its appearance the kind of thermic cycle which has been employed to trace a diagram.

Answer objected to as irresponsive, and the witness is requested to give a direct answer to the question .

XQ226. I now repeated XQ222 and XQ223, and XQ224 which you have entirely failed to answer; and which embody the same question.

"XQ222. Can you state any better or more accurate way of determining what is actually taking place as to pressure within the engine cylinders in actual operation, and the actual thermic cycle on which they are operating, than by obtaining card diagrams?"

A. I desire to bring to the attention of the honorable attorney for the complainant that question 224 comprises two ~~phrx~~ sentences. Each one of them constitute one question and that both questions cannot be linked together. The relation between the two questions will be better explained by this comparison.

Can you indicate to me better means for painting the surface other than the use of a brush and color and tell me who is the manufacturer of the color. This comparison will perhaps be sufficient to explain why I am compelled to separate my answer in two parts in order to give two precise answers.

Answer objected to as entirely irresponsive and volumteered.

XQ227. As you insist that there are two separate questions involved in my XQs 222, 223 and 224, in your opinion, although you have not answered either one of them I will now ask you first, "Can you state any better or more accurate way of determining what is actually taking place as to pressure within the engine cylinders in actual operation than by obtaining card diagrams?"

I call your attention to the fact that we are considering internal combustion engines and also to the fact that I am not asking what is the most accurate apparatus to obtain diagrams but I am asking just what the question states?

A. The question has not been modified and I believe that I have given to questions 222, 223 and 224 the answer that they require. I will sum up now all my answers as follows: It is not possible to require a diagram to indicate more than it can actually indicate. By asking any more from a diagram, one runs the risk to give to its appearance a misconstrued interpretation, and I will add that I do not know of any apparatus which can give better results than the indicators which are actually in existence. Above answer except the last sentence objected to as irresponsive.

XQ228. In your last answer do you mean better results in ascertaining what is actually taking place as to pressure within the engine cylinders in actual operation?

A. Yes; the expression "better results" can only be applied to that since I have stated that examination of a diagram and I will add no matter how well it is taken cannot permit to determine the type of motor from which the diagram has been obtained.

XQ229. What do you mean by the expression "type of motor" in the above answer, do you mean cycle of operation within the cylinder?

A. No; I mean to define by this expression a motor operated by steam or compressed air or by internal combustion, etc.

XQ230. Confining your answer to internal combustion engines, will not an ensemble card diagram well taken by the apparatus you have mentioned in your testimony, indicate to you as a picture whether the cycle of operation within the cylinder at the time such diagram is taken is more nearly of a constant volume character, or more nearly of a constant pressure character?

A. I answer no, basing my answer on the various reasons that I have previously given in my answer to the preceding questions.

XQ231. Do card diagrams taken as set forth in the last question indicate nothing to you as to whether the cycle of operation within the cylinder at the time such diagrams are taken is more nearly of a constant volume character or more nearly of a constant pressure character.

A. A diagram is not a puzzle. I never examine a diagram unless I can see written on the diagram the following indications which are necessary and indispensable for its reading: 1st. Type of motor under examination. 2nd. Number of revolutions. 3rd. Particularity of the ignition. 4th. What results was it proposed to obtain. An examination such as is proposed by the

honorable attorney will never come to the mind of any one wishing to speak seriously.

~~X9232x~~

Adjourned to Friday, November 16th, 1906, at 10 A. M., same time and place.

Met pursuant to adjournment, same place, same parties present.

CROSS-EXAMINATION OF ARTHUR CONSTANTIN KREBS CONTINUED BY MR. BETTS.

XQ232. Do not card diagrams taken as set forth in the previous questions show you variations of pressure within the engine cylinders, and supposing you are given the four points of information stated in your answer 231?

A. Before answering this question I must be permitted to state that in ~~this~~ the insistence shown in trying to oblige me to state that the examination of a diagram permits the determination of the type of motor ~~which~~ from which the diagram has been taken, seems to bring confusion in a question which ~~is~~ can be so easily settled since we possess all necessary elements to form our opinion.

I will now answer directly to this question by simply repeating what I have stated in my answer to question 221. No, the curve shown on the diagram does not exactly reproduce what is going on inside the cylinder where the pressures varies.

Answer objected to as not responsive to the question. The witness is politely requested to pay close attention to the questions and to give direct answers thereto. For example, there was

reproduce" which the witness has dragged into his answer expressly for the purpose of evading the question. Complainant's counsel now repeats the question and insists on a direct and fair answer.

XQ233. XQ232 repeated.

A. I will then modify my answer which the statement which I have made previously about this question rendered very clear, I thought.

The diagrams give information about the variations of pressure in a cylinder, but this information is inexact.

XQ234. To what is this inexactness due?

A. In my answer 221 I gave the reason.

XQ235. Did you ever see or obtain card diagrams from Panhard automobile engines which diagrams approximated more closely to constant pressure diagrams than any other kind of diagram in appearance or character?

A. I do not remember ever having made such comparison.

XQ236. When Panhard automobile engines are running well-throttled and with ignition advanced only (Contact), or you may consider any other under-load actual running conditions as in City streets, do not the card diagrams under such conditions show a closer approximation to constant pressure diagrams than to constant volume diagrams in appearance and charac-

A. The answer to this question has already been made in answer to question 218. I have not taken diagrams under the conditions which have just been mentioned. The diagrams that I have examined and taken under the conditions stated in my answer 218 permit any interpretation that one may choose.

XQ237. The same answer would apply to the case of diagrams taken according to the conditions stipulated in question 236.

XQ237. Then you do not know really what variations of pressure occur in the Panhard automobile engine cylinders when the engine is running under the conditions prevailing in actual traffic in city streets, do you?

A. No, I do not know, and I will add that under such conditions of operation no two successive piston strokes are alike.

XQ238. How do you know that fact you state in the last answer?

A. By trials made under similar conditions by means of a brake in a laboratory.

XQ239. Referring to your direct testimony (answers 2 and 13) you mention your work on dirigible balloons and on internal combustion engines in connection therewith? Is it not a fact that the result of your work in the endeavor to

was a failure and that practically you abandoned then this effort to utilize the internal combustion motor for balloons? and did in fact adopt an electric motor operated by a very light battery which electric motor was used to equip the dirigible balloon "La France" which you mention?

Defendants counsel objects to the question om the ground that it is irrelevant and immaterial and on the further ground that answer to the question has already been fully stated in the witness' direct examination.

A. There was in this matter a xxxxxxx question of opportunity which led me to select the electric motor in preference to the petrol/xx engine.

XQ240. But in fact did you succeed during this period from 1877 to 1885 in producing an internal combustion engine which was operative and of sufficient lightness in proportion to power to enable you to actually apply it to the work you then had in hand?

A. By reason"of the question of opportunity" which I have mentioned in my preceding answer, I did not follow xxxxxxxxxxxxxxxxxxxx the dx study of a motor which I did not need to use any longer.

XQ241. Well, then you in fact did not during this period produce an internal combustion engine which was operative and sufficiently light in proportion to power to be actually applied to the work you then had in hand, is that not so?

Same objection.

A. The only possible answer to this question is the one that I have made in the preceding answer. I have stopped the studies on the internal combustion motor which I had begun in view of applying to the balloon for reasons which were independent of my own will. Had it been necessary for me to continue these studies for the same purpose I would have not hesitated to follow the path indicated by Otto and followed by Daimler, It is what I have done as soon as I have had to deal with automobile vehicles.

But since the honorable attorney is so very anxious to know my thoughts about this matter, I will repeat, if this may please him, what I have already said before, when I began to study a combustion motor for balloons, I had made a mistake.

Complainants' counsel objects to the answer as entirely irresponsive and volunteered. The question is absolutely direct, plain and simple, does not inquire into the witness' thoughts, merely asks a response to an absolute question of fact, readily answered.

Complainants' counsel on the record now calls the attention of the witness to the statement and instruction but on this record on November 13, 1906, after

answer to XQ172 by the Examiner, Mr. John A. Shields, before whom this testimony is being taken, and at the request of complainants' counsel, and in the following words:

"The Examiner instructs the witness that he must answer the questions directly and in response to the question put, and in accordance with his view of the matter."

Complainants' counsel earnestly requests defendants' counsel to explain this matter to the witness so that responsive answers may be made, no matter what the views of the witness may be and that some progress may be made towards terminating this deposition, which under the methods of answering adopted by the witness very possibly in ignorance of the methods prevailing in answering questions under our practice in this country, is being unduly and unnecessarily prolonged.

Adjourned to meet at two P. M. at the same place.

Met pursuant to adjournment.

Counsel for defendant states that if the cross-examination has been unduly prolonged, the fault rests with complainants' counsel and not with the witness.

Counsel for complainants ~~xxx~~ as a matter of fact has not devoted one day of ~~xx~~ cross examination to the subject matter of the direct examination. What is more counsel for complainants has wasted a lot of time in a fruitless endeavor to have the witness give an answer from which an inference could be drawn that the type of motor can be determined by a diagram, when as he and every one who has any knowledge on the subject knows that diagrams differing greatly in appearance can be obtained from the same engine, and also that engines of different types can be manipulated so as to produce diagrams closely resembling each other.

Counsel for defendants again takes this occasion to warn the counsel for complainant that he will insist that as to all matters not relating to the direct examination, Commandant Krebs is a witness for the complainants.

Complainants counsel does not accept the statements of fact above made by defendants counsel as correct.

XQ242x Complainants' counsel regrets to note on the record that defendants' counsel has just had translated to the witness by the interpreter the statement made on the record by defendants' counsel after the previous question, because that statement read to the witness can only result in encouraging him in his conduct in not answering questions, and is also on its face leading and suggestive to the witness as to the character and kind of testimony he should give on the subject which has been inquired about, and is an absolutely incorrect statement as to the subject matter of the cross examination, and what complainants' counsel has endeavored to show thereby.

XQ242. I now repeat XQ241 which is an absolutely plain, simple question of fact, capable of being answered "yes" or "no" and request you to give a direct answer to the question as to what the fact was:

"Well, then you in fact did not during this period produce an internal combustion engine which was operative and sufficiently light in proportion to power to be actually applied to the work you then had in hand, is that not so?"

Same objection.

A. I have had no occasion of constructing this motor which had merely been studied because I received orders xxxxxxxxxxxxxxxxxxxxxxxxx on the subject. I cannot answer either xx yes or no to the question asked if I want to give an ans-

Answer objected to as not responsive.

XQ243. Well, then you did not in fact in the period from 1877 to 1885 construct the motor referred to in the last questions Nos. 241 and 242, did you?

A. The answer follows from what I have said before. No, I have not constructed such motor because I did not have to construct it.

XQ244. What was the weight per horse power actually developed, of the electrical outfit embodied by you in the balloon "La France", considering the weight of the entire electric plant carried by the balloon?

A. I cannot remember it.

XQ245. Give the weight per horse power actually developed approximately, as near as you can recollect it?

A. I cannot give you any information whatever on this subject.

XQ246. What horse power, as near as you can state, was developed by this electrical outfit put by you in "La France" balloon?

A. About ten horse power.

XQ247. Can you give me the weight per horse power actually developed of the electrical outfit which was put into the sub-marine boat "Gymnote" in the period from 1886 to 1889?

A. I cannot even approximately remember it.

The question of weight has no importance im this case.

XQ248. When you say the question of weight has no importance "in this case", do you refer to the engine for the boat "Gymnote", and if so, why has it no importance?

A. This results from the very conditions of operation of a sub-marine boat. It becomes sometimes necessary to put ballast in the boat and the weight of the latter may be replaced by the weight of the engine.

XQ249. Is not the same true in regard to other boats, not sub-marines?

A. I do not know, There may be different cases.

XQ250. During the period from 1877 to 1885, at whose expense were conducted your investigations in your endeavors to obtain or produce a motor light enough in weight in proportion to power to be utilized upon balloons?

A. The shops of Chalais Meudon where these experiments were conducted is a military arsenal, placed under the control of the War Ministry, All the expenses were paid out of its budget.

XQ251. Referring to answer second of your testimony, you have stated that "in 1889 the first application of this Daimler ~~motor~~ engine was made to a vehicle by the firm Panhard-Levassor".

Please state as nearly as you can what was the weight of this entire vehicle including its motor thereon?

3615

A. I absolutely know nothing about it.

XQ252. What was the horse power of this Daimler motor you refer to as applied to a vehicle by the firm Panhard-Levassor in 1889?

A. About 2 H. P., I believe.

XQ253. What was the weight of this Daimler motor of 1889 referred to, complete with its motor equipment?

A. I absolutely do not know what the weight was.

XQ254. Is there any way you can suggest for me to learn the weight of this Daimler motor of 1889 referred to. For example, is it matter of record anywhere, or published anywhere, to your knowledge?

A. You might find information in the catalogues of the firm of Panhard-Levassor. Several of these catalogues having been offered as exhibits in this case.

XQ255. Do you know where such information exists in the Panhard-Levassor catalogues?

A. I do not know anything about it.

XQ256. When did you personally first see a Daimler engine in operation?

A. In 1889.

XQ257. Was this the Daimler motor which was first applied to a vehicle by the firm Panhard-Levassor in 1889?

A. No.

XQ258. When was it that you first did see a Daimler

A. About 1894, I believe.

XQ258. From 1889 when you say you first saw a Daimler motor until 1894 when you say you first saw a Daimler motor mounted on a vehicle, what work did you yourself do toward developing or adapting the Daimler motor so as to be used on a vehicle?

A. I did not do any special work on the subject. I was merely a spectator.

XQ260. In view of your last answer I call your attention to a statement you made in answer No. 13, as follows:

> "About 1890 I was instructed to study for the Fire Brigade of Paris vehicles for salvage apparatus, and at that time I attempted to follow up the work that was being done to adopt the small petrol engine of Daimler to automobile vehicles."

How do you reconcile this statement with that of your last answer No. 259 that you were "merely a spectator"? from 1889 to 1894?

A. Both my answers agree perfectly. The period elapsing between 1890 up to 1894, about, was one of expectation, that is to say a period of incubation or study and it is about in 1894, as it is said at the end of the sentence referred to by you, that I began to materialize my studies. As a matter of fact I wish to state that those dates are rather distant from the present time and that I have cited them in an approximative manner.

XQ261. In your answer No. 2 you state:

"In 1889 the first application of this Daimler engine was made to a vehicle by the firm Panhard-Levassor".

But in answer No. 14 you state

"In 1891 the firm Panhard-Levassor made the first vehicle equipped with its Daimler engine".

How do you reconcile these two statements.

A I have stated in answer 2 that in 1889 the Daimler motor was for the first time mounted on a vehicle, This is an experiment which begins, which is followed up and it is only in 1891 (answer 14) that the arrangement studied and tried since 1889 permit the construction of the first vehicle which was offered for sale.

XQ262. Is it not the fact that the use of electric motors for dirigible balloons which you attempted in the period between 1887 and 1885, was abandoned and that the motors now in use for dirigible balloons are petrol motors of the same general construction as your Panhard automobile motors?

A. I have not occupied myself with the question of dirigible balloons since 1885. I cannot, therefore, answer the question.

Adjourned until Saturday, November 17, 1906 at the same time and place.

November 17, 1906.
Met pursuant to adjournment. Parties present as before.

CROSS-EXAMINATION OF ARTHUR CONSTANTIN KREBS, CONTINUED BY MR. BETTS.

XQ263. In your answer No. 13 you state that:

"At present I am still constructing petrol engines of the same power for dirigible balloons for the War Department, which are still lighter than those for the sub-marines."

How do you reconcile this statement with your answer to XQ262 where you say you have not occupied yourself with the question of dirigible balloons since 1885?

A. My answer is absolutely exact. I have received orders for engines of a certain power and certain weight which I admit are to be mounted on dirigible balloons, but the only part that I have taken in this question has merely been to deliver motors which would be built in accordance to the specification mentioned in the contract. I have nothing whatever to do as far as the balloons themselves are concerned.

XQ264. What is the power and weight of the engines to be mounted on dirigible balloons which you refer to in the last answer and are they of the same character as to construction and operation as your Panhard automobile engines?

A. I regret to be unable to answer this question. The order that I

strictly of a confidential nature. I find myself, therefore, compelled to ~~xxxxxxx~~ invoke ~~xxx~~ professional ~~xxxxxx~~ secrecy. I will add that I cannot understand very well how this question can be of any interest in the case.in which I am a witness.

Answer objected to as irresponsive.

XQ265. Leaving out of the question the details of these engines for dirigible balloons which you say are a professional secret, please answer the general question as to whether the engines are of the same general character as to construction and operation as your Panhard automobile engines?

A. These motors are analogous to the latter and belong consequently to the class of engines operating under constant volume.

XQ266. During the period from 1877 to 1885 when you were working on dirigible balloons in the way you have stated in your testimony, would not motors or engines of the kind you are now constructing for dirigible balloons have been a very desirable thing if then attainable?

A. But, certainly, since they are good now.

XQ267. What was the horse power and weight of the engine Daimler ~~xxxxx~~ which you referred to in answer to 258 as the first one you saw mounted upon a vehicle about 1894, as you believed?

A. I do not know. Catalogues shown as exhibits might

XQ268. State the horse power and weight of the earliest Daimler engine of which you can state those details and identify that engine as to time when you first saw it and first knew its weight and horse power?

A. As My memory about this motor is not very distinct, I take the catalogues shown in the case and I find that they contain the following informations as I have stated before.

I take the catalogue of 1892 and I find that the first motor that I have handled is a motor indicated on the catalogue as being a two-cylinder engine having a "nominal power" of two horse, Its indicated weight being given as 150 kilograms (330 pounds approximatively).

XQ269. State what is the horse power and weight of the first Daimler motor you saw applied to a vehicle and of which you knew or can state the horse power and weight and please identify that motor and vehicle by time and catalogue?

A. It is the one of which I have spoken in the preceding answer.

XQ270. Does not this same catalogue to which you are referring and which is marked defendants exhibit 183, Nov. 3,1906, show or give descriptions of single cylinder motors of one-half horse power, weighing 132 pounds, also of single cylinder motors of one horse power

horse power, weighing 485 pounds?

A. This catalogue shows drawings of single cylinder engines and a brief description of these engines. The table gives for a given power information relating to the weight, the space occupied and the type.

Answer objected to as not responsive to the question.

XQ271. Do you not find on the catalogue defendants exhibit No. 183, of Nov. 3, 1906, and on page two thereof, a tabular statement in which is mentioned single cylinder engines of one-half horse power weighing 132 pounds, also single cylinder engines of one horse power weighing 242 pounds, also of single cylinder engines of two horse power, weighing 485 pounds, offered for sale by Panhard & Levassor, the weights given being without including the base?

A. Yes. The weight of the base varies according to the application which is made of the motor and becomes zero in the case of an automobile.

XQ272. Do the weights of the en gines given in the tabular statement of defendants' exhibit No. 183, referred to in the last answer exclude any parts which are necessary for the operation of the engines on the vehicles, and if so, name such parts excluded?

A. I know nothing about it, but it is very unlikely that the weight given does not comprise all the weight of the organs necessary for its operation.

XQ273. Please specify what you understand is included under the column in which is given the weight of the engines excepting their base on this catalogue, defendants' exhibit No. 183, as included in the engine when weighed?

A. Exactly what is shown in the pictures in the catalogue. I cannot give you more information on the subject because as I have stated before I do not wish to commit any error.

XQ274. What was the weight of the vehicle including the engine, which you say in answer to XQ268 and XQ269 was the vehicle on which was put the first Daimler motor of which you could state the horse power and weight, the engine being a two cylinder engine having a nominal power as you say of two horse and as mentioned in the table in catalogue exhibit No. 183?

A. I cannot tell.

XQ275. Did you actually see operate the vehicle referred to in the last question and in answers 268 and 269?

A. I have seen automobiles operated by motors having the power mentioned.

A. The first automobile that I saw was equipped with the first motor that I ever saw mounted on a carriage.

XQ276. Did this first automobile vehicle you saw equipped with the first Daimler motor that you saw mounted on a carriage, and which I understand to be the vehicle you have referred to in your answers 268 and 269, run or operate in a satisfactory manner?

A. A distinction must be established between the vehicle equipped with a motor which vehicle I saw operating for the first time and the first automobile motor that I have had in hand (reponse 168).

All the vehicles which I have seen in operation equipped with Daimler motors did run perfectly well.

XQ277. Was that true of the first vehicle equipped with a Daimler motor of two horse power which you saw in operation? Did it run perfectly well?

A. Yes.

XQ278. Please state whether any of these Panhard & Levassor vehicles with the engines originally in them and referred to in this catalogue, defendants' exhibit No. 183 are still in existence in the same form or condition, or substantially the same, as they were about 1892, and if so, where are they or any of them?

A. I know nothing about it, If such a vehicle exists, which is possible, parts worn out by use may have been replaced.

XQ279. What is the existing vehicle of the Panhard &

ing in substantially the same construction and condition of vehicle and engine, subject, of course, to necessary repairs having been made, and which dates furthest back as to time of its manufacture and first operation or sale? Where is that vehicle and in whose possession or under whose control at present?

A. [illegible] I know of the existence of such vehicle dating from 1892, but I do not know where it is.

Adjourned until Monday, Novemb er 19th, 1906, at 10 A. M.

November 19th, 1906.
Met pursuant to adjournment,

Same parties present.

CROSS-EXAMINATION OF MR. ARTHUR CONSTANTIN KREBS CONTIN UED BY MR. B ETTS.

XQ280 . Looking at the picture of automobile on the 3rd page of the catalogue, defendants exhibit No. 183, does that correctly represent the appearance of the Panhard & Levassor vehicles they manufactured and you saw operating at that time?

A. Yes.

XQ281. How long did the Panhard-Levassor vehicles continue to be made in appearance practically like that picture on exhibit No. 183?

A.To About 1895 for the two-seated vehicles.

XQ282. Did the Panhard and Levassor Co. to your knowledge ever make an automobile driven by internal combustion engines in which the engine came directly under any portion of the vehicle in which the passengers were actually seated?

A. Yes.

XQ283. When was that?

A. Since about ten years.

XQ284. When did the Panhard & Levassor Co. first import any automobiles of their manufacture into the United States as near as you can give the time?

A. The Panhard-Levassor Co. has began to import au-

XQ285. Did not Panhard Levassor automobiles, which were imported into the United States, more than three years ago carry the name-plate &c. of that Company, showing that they were manufactured by that company?

A. The company's name-plate is placed on every automobile shipped by the factory.

XQ286. Through whom did the Panhard-Levassor Co. import automobiles into the United States more than three years ago and before it began the importation under its own name as you say in answer 284?

A. The Panhard & Levassor Co. did not have any authorized intermediary.

XQ287. When in fact was the first importation of Panhard & Levassor automobiles into the United States, ~~xxxxxxxxxx~~ in any way?

A. I cannot say.

XQ288. How many Panhard & Levassor automobiles have been imported into the United States down to the present time that you know of?

A. I cannot give a definite answer stating how many Panhard automobiles have been imported from the very beginning.

XQ289. Well give the statement of your knowledge in the matter, whatever it is?

A. About two hundred and fifty, by the Panhard & Levassor Co. itself.

XQ290. As ~~technical director~~ general manager of the Panhard & Levas-

sor Co., are you a member of the Board of Directors who determine the policy and conduct of that Company?

A. I am not a member of the Board of Directors but I am generally present at the meetings, and give an account of what is going on, asking the Board of Directors' authorization in my conduct of the most important business matters.

XQ291. Are you a stockholder in the Panhard & Levassor Co.?

A. Yes.

XQ292. Do you receive compensation from the Panhard & Levassor Co. for your services as general manager?

A. Yes.

XQ293. Do your duties as general manager of Panhard & Levassor Co. include your advising them or consulting with them with reference to this suit and the other suits brought in the United States on the Selden patent against purchasers and users of Panhard & Levassor automobiles?

A. As far as this actual suit is concerned, yes, but in the case of suits brought against third parties, no.

XQ294. Do you not know that instructions have been given by the Directors of the Panhard & Levassor Co. to the firm of Coudert Brothers in New York to appear and defend any suits brought on the Selden patent against customers of the Panhard & Levassor Co. who have bought in the United States or are using

A. I do not know.

~~This suit is~~ The handling of suits of this nature is wholly placed in the hands of a party ~~who~~ who has full charge of our litigation.

XQ295. Who is the party you refer to in the last answer?

A. Mr. ~~Prevost~~ Prevots, ~~living~~ residing at 4 Place St. Michel, Paris.

XQ296. Do you not know that the Panhard & Levassor Co. give a guarantee to persons buying their automobiles to defend them against suits brought against them on the Selden patent?

A. Yes, and it is the company's duty to do so.

XQ297. Various letters and catalogues have been put in evidence in connection with your testimony given. From what source did you obtain these?

A. These documents have been sent to the firm of Coudert Brothers by Mr. Prevots.

XQ298. These letters and catalogues are all of dates prior to 1897 when you became actively connected with the Panhard & Levassor Co. Do you rely on the statements made in these documents for your testimony as to what the Panhard & Levassor Co. did prior to the time you actively joined them, and in so far as those documents contain statements?

A. No. They merely corroborate what I knew myself about the matter.

XQ299. Did you yourself make any examination of the files of the Panhard & Levassor Co. before you came over here on this occasion in order to ascertain facts and find documents?

A. Personally I have not made any such searches but I have given orders to deliver to Mr. Prevost, all the documents for which he asked. Previous to my departure he furnished me with a list of all the documents sent by him to the firm of Coudert Brothers.

XQ300. Please let me inspect the list of documents you refer to in your last answer so that I may ascertain which of the documents found in the files of Panhard & Levassor Co. and sent by Mr. Prevost to Coudert Brothers they have thought it best to offer in evidence and which of those documents they have thought it best not to offer in evidence?

A. I have not the document with me and moreover I did not read it.

Counsel for defendants states that at the close of the examination to-day he will allow counsel for complainants to inspect at this office the documents produced from the files of the Panhard Co.

The only objection to producing them now is that the witness is very anxious to sail for Europe on Thursday.

make an additional ~~xxxxxxxxx~~ charge to customers when you give them the guarantee to defend them against suits brought on the Selden patent and beyond what you charged when you did not give them the guarantee?

A. I do not know what is done in this matter by parties who having bought vehicles from the Panhard & Levassor Co. to sell them afterwards, representing themselves as agents. I can say though that as far as the vehicles sold by the Panhard & Levassor Co. are concerned, we never ask from any one any additional charge whatever to insure them guarantee against any such a suit.

XQ302. In view of your attendance at meetings of the directors of the Panhard & Levassor Co. and in your capacity as general manager, do you not know that the defense of this suit against the Panhard & Levassor Co. and of the suit against H. & A. C. Neubauer on the Renault machines (in both of which suits you are now testifying by a single deposition), is being paid for not merely by the Panhard & Levassor Co. alone, but also in part by Renault Frères, and also by contributions from other Companies and firms established in Europe?

Counsel for defendants instructs the witness not to answer the question as it is not proper cross-examination.

~~Witness declines to answer.~~

A. I do not know, Mr. Prevost having full charge of all ~~xx~~ Panhard-Levassor interests.

XQ303. Do you not know that there is a combination of ~~xx~~ European manufacturers in which the Panhard & Levassor Co. is included and which combination through its members is contributing to a fund for the defense of the so-called test suits on the Selden patent against Panhard & Levassor Co. on their machines and against H. & A. C. Neubauer on the Renault machines?

A. I do not know what has been done about this matter.

XQ304. Who would know the facts about this?

A. I do not know who could give you an answer on such ~~hypothetical~~ a hypothetical questions.

XQ305. Please give a list of the present directors of the Panhard & Levassor Co.?

A. This list may be found anywhere. Here it is however: President, Menard Dorian, Vice President, Garnier, R. Panhard, H. Panhard, Holtzer, deKnyff, Pierron, Lavertujon, and Prevost.

Recess until 2 P. M.

XQ306. From the time you went actively with the Panhard & Levassor Co. in 1897, has not your personal work im connection with internal combustion engines and your practical experience thereom been exclusively in connection with the automobiles produced by that Company and efforts to improve them?

A. All of my efforts and personal work have been entirely directed towards the general managing of all the technical and commercial business of the Company Panhard & Levassor.

XQ307. Has not your actual practical experience with automobile construction and automobile engines been during that period from 1897 to the present day when you have been with the Panhard & Levassor Co.?

A. No.

XQ308. Has the Panhard-Levassor Co. ever made a three-cylinder internal combustion automobile engine? and if so, when?

A. Yes, about 1902 or 1903, I believe.

XQ309. Did those three-cylinder engines work in a satisfactory way?

A. Yes.

XQ310. When did you first see a three cylinder internal combustion engine?

A. I don't remember; the number of cylinders bears no

latter may be and are actually constructed according to the needs with one, two, three, four or six cylinders.

XQ311. I notice that the Panhard & Levassor Co. are manufacturing engines of six cylinders for the 1907 models or some of them. What is the advantage of six cylinders over one or two cylinders?

A. They have been built according to orders placed. in our Company.for some use of which I am ignorant. Personally I prefer a four cylinder engine.

XQ312. I asked you what were the advantages of a six cylinder engine beyond a one cylinder or two cylinder engine?

A. They are better balanced.

XQ313. Is this also true of a three cylinder engine as compared with a one cylinder engine?

A. No, it is not possible to absolutely balance a three cylinder engine, no more than it is possible to absolutely balance a one or two cylinder engine.

XQ314. How many three-cylinder automobile engines have the Panhard & Levassor Co. made?

A. About four or five hundred. These three-cylinder engines were built especially for England.

XQ315. What was the lowest horse power of any of these three-cylinder engines?

A. All were of the same power, nine horse power about.

XQ316. Have you not considered these three-cylinder

A. No. The three cylinder engine has been built by utilizing cylinders of the twelve horse power four-cylinder type. This was possible since the cylinders of our motors are independently built.

XQ317. But do you not consider the use of three cylinders in your engines as an improvement on the use of one or two cylinders?

A. No; it is above all a question of room taken by the engine and chiefly in our case is simplification in the manufacturing process, since by using one type of cylinder five different powers can be obtained.

XQ318. What was the weight of the Panhard Levassor three-cylinder engines of about nine horse power of which you have spoken?

A. About one hundred eighty kilograms (396 pounds) although I cannot recollect exactly.

XQ319. What is the weight of a Panhard engine of 24 H. P. of the present time?

A. I could not tell exactly; The weight of these motors, ~~that is,~~ varies according to the use. For instance, we have built motors which only weigh three kilograms (6.6 lbs.) per horse power, the water jackets containing no water.

XQ320. Were these last for use on automobiles?

A. Yes.

XQ321. How lately were these last engines built?

A. These results (three kilogram per H. P.) has been

obtained as early as 1901.

XQ321. Referring to the Panhard & Levassor catalogues which you produced on your direct testimohy, do you know as matter of fact that the weights given in those catalogues for engines stated to give two horse power, were the actual weights, of engines in fact made by that company and that such engines did im fact give practically in operation the two horse power attributed to them in the catalogue?

A. Their mechanical output was superior to the figure given by the catalogue.

All motors manufactured by the Panhard & Levassor Co. deliver as a matter of fact and effectively a power superior to the power indicated on the catalogues. As far as the weight is concerned I may say that it is always given as closely as possible, giving round figures however.

XQ322. Please note that I am asking you about the catalogues produced on your testimony and which are of a date before you entered the employment of the Panhard & Levassor Company. These catalogues give two horse power for certain engines as a catalogue statement, but the question is do you personally know, outside the catalogue, whether these engines of that time did give more or less than two horse power actually?

A. Yes, I know that these motors delivered a power superior to two horse power as I tried them on the brake

As a matter of fact the motor ~~xxdxxxxxx~~ mentioned in the catalogue as delivering two horse power gave actually on the brake 2 and 3/4 horse power.

XQ 323. Well, what was the weight of that engine to which you refer in your last answer?

A. I refer you to the catalogue.

XQ324. How is it you remember a different horse power from the c atalogue, but only remember the weight from the catalogue?

A. For the reason that I occupied myself above all with the power developed by the engine, and moreover, these engines which have been constructed until 1895, in large numbers, were known as giving two and three-quarter horse power.

XQ325. What date can you give as the first year in which you tested an engine manufactured by Panhard & Levassor and which developed more than 2 horse power?

A. In the year 1894.

XQ326. Is it not true that the internal combustion automobile engines of the present day with the large horse power obtained, which you have stated on your direct testimony, is substantially the same in mechanical construction and operation as the Daimler engines made by the Panhard Levassor Co. im 1895?

A. Yes; These large motors solely differ from the latter by dimensions, details of construction and the arrangement of parts.

XQ327. When and where did you first see a printed statement of the Beau de Rochas theory of the operation of four-cycle internal combustion engines?

A. Over thirty years ago, but I cannot state where and when I saw that statement printed for the first time. I have read in its entirety the Beau de Rochas patent.

XQ328. Do you not know that the printed statement of the theory of Beau de Rochas was first called to the attention of Otto when it was put in as a defense to Otto's suit upon his English patent brought in the English Courts? and as a defense against Otto's patent in the suit brought thereon in the German Courts?

A. No.

XQ329. As you remember did you know of the description of the Beau de Rochas theory during the period between 1877 and 1885 and particularly while you had and were working with your Otto four-cycle engine of 1878?

A. I have not occupied myself with these theories on account of this Otto motor. I have already said all I can say on this matter.

XQ330. You have already said that you had an Otto four-cycle motor in 1878, and you have said that you knew of the theory of Beau de Rochas about thirty years ago. Did you know of the Beau de Rochas theory while you had the Otto four-cycle motor you got in 1878?

A. I cannot recollect.

XQ331. From where did you first obtain the idea or knowledge that the Beau de Rochas theory was applicable to the Otto four-cycle internal combustion engine?

A. I know nothing about it. This patent was public property at that time.

XQ332. You certainly must at some time have learned or appreciated that the theory set forth by Beau de Rochas, was in practical application embodied in Otto four-cycle internal combustion engines? When did you first reach that appreciation or knowledge?

A? At this time ~~xxxxxx~~ this fact was public knowledge.

XQ333. State what you mean by this time, what period?

A. That same period referred to by the attorney.

XQ334. Well, what do you understand that period to be, give the years?

A. I refer you to ~~xxxxxxxxxx~~ the period cited in questions 328 and 329. I cannot ~~xxxxxx~~ give you any more precise information about it.

XQ335. Well, do you mean the period between 1877 and 1885 as mentioned in XQ329?

A. As you please.

~~XQ336x~~ Answer objected to as irresponsive.

XQ336. XQ335 repeated.

A. I cannot give you a more precise answer.

XQ337. Do you not know that in Otto's patent which he took for his internal combustion engine, he set forth a

in the terms of his patent as an object the securing of gradual combustion within the engine cylinder?

A. Yes, but it has been recognized that this theory was not correct. I refer you to my answer to Q100.

XQ338. In 1878 when you bought the Otto engine you have referred to, was it appreciated by you that this engine ran upon the Beau de Rochas theory or cycle?

A. There couldn't be the least doubt im my mind.

XQ339. When you bought this Otto engine of 1878 was any representation made to you by the builders or sellers as to whether it was an explosion engine or not?

A. I do not know. I did not need to ask them about it. It was generally known to be an explosion engine.

XQ340. Was not your Otto engine of 1878 supplied with gas from the ordinary street mains or a gas tank?

A. Yes, it was city gas.

XQ341. When did you first operate or see operated an Otto four cycle engine which was supplied with gas by means of a carburetor, deriving its liquid from a supply of liquid hydrocarbon and as distinguished from being supplied with City gas?

A. In 1889.

Adjourned until Tuesday, November 20, same time and place.

November 20, 1906.

Met pursuant to adjournment.

Parties present as before.

Counsel for Defendants states that the witness has arranged to sail for France on Thursday of this week, and that the interpreter cannot act after to-day, owing to his business engagements.

Counsel for defendants, therefore, requests that the cross-examination be closed to-day and that if necessary a session be held tonight in accordance with the suggestion of the Examiner, made some time ago.

[illegible]

Complainant's Counsel states that he is making and will make every effort to finish the cross-examination at the sessions of to-day and to-morrow and is willing to work extra time for that purpose if necessary.

(342)Q. Whose make or invention of carburettor was that which you saw operated on and Otto four cycle engine '89, as you say in answer 341?

A. I do not know.

Q. 343. Whose make andninvention was the first carburettor you ever saw operated in connection with a

a four cycle Otto engine?

A. I could not tell really as I have seen many of them

344 Q. Whose make and invention was the first carburettor you ever saw ~~xxxxxxxxxxxxxxxxxx~~ operated at all in conennection with an internal combustion engine?

A. I cannot give you any pr ecise information on this subject. This was too long ago.

Q. 345. Whose invention and manufacture of carburettors were put upon the Dambler engines which were first manufactured by the P. & L. Co., and put upon vehicles?

A. I cannot tell as every part of the motor, carb uretor included ~~xxx~~ was built by the Panhard, Levassor Company .

Q. 346. Whose invention of carburettors were those which were put upon the Pah nd Levassor vehicles like th ose sold in catalogues, Deft. Ex. 183?

A. I am absolutely unable to tell the name of the inventor.

XQ347. Are you ignorant of the name of ~~xxx~~ any inventor of carburetors for internal combustion engines, either those used by Panhard & Levassor, or any others, before you, yourself, invented your carburetor?

A. No. Among the many carburetors that I have seen none was considered as patentable.

Answer objected to as irresponsive.

XQ348. Tell me what carburetors were in use by the Panhard & Levassor Co. on their internal combustion engines

their construction? Were they attributed to any individual by name. Did they permit of the operation of the engine?

A. Several types of carburetors have been successfully used. The surface carburetor, the atomizing carburetor. The mode of operation of these carburetors is so well-known that it is hardly necessary to describe them. They did operate perfectly well when they were set to give their best efficiency for a determined speed of the motor. These carburetors came to the Panhard Levassor works with the patterns furnished by Daimler. I know nothing more on this subject.

XQ349. Did not these carburetors which were manufactured and used by Panhard & Levassor prior to their adoption of your carburetor operate so as to enable the automobile engines to run and to propel the vehicles?

A. Yes, very well.

XQ350. Have you not understood that the carburetors which came to the Panhard-Levassor works with the patterns furnished by Daimler were of Daimler's invention?

A. I know nothing about it.

XQ351. Did the Panhard & Levassor Co. to your knowledge ever employ a carburetting device in which the entire supply of gasolene or liquid hydrocarbon was boiled by or subjected to the heat of a furnace?

A. I know nothing about it.

XQ352. Have the Panhard & Levassor Co. to your knowledge ever operated their automobile engines deriving the supply from a tank of compressed gas carried on the vehicle as distinguished from a supply of liquid hydrocarbon carried on a vehicle and utilized in connection with a carburetor?

A. I have never heard about such idea.

XQ353. Have not the Panhard & Levassor Co. so far as you know always carried the supply of liquid fuel for their automobile engines in a suitable tank on the vehicle and withdrawn the liquid fuel therefrom and vaporized it at a rate to accord with the working of the engine?

A. The hydrocarbon liquid contained in a tank carried by the vehicle has always been brought to the motor by the intermediary of the carburetor having for function to regulate its supply to the motor.

XQ354. Referring to the carburetor you have mentioned on your direct examination as your invention, when and where and by whom was the first Krebs' carburetor, as referred to, constructed?

A. I cannot answer this question as I consider it as being wholly foreign to the case.

XQ355. Answer objected to as irresponsive.

XQ355. Have you taken out patents in the United States for your carburetor, and if so, give me the numbers and dates of them?

A. I do not recollect and I consider that it has nothing to do whatever in the case.

Answer objected to as irresponsive.

XQ356. You are not the judge of whether questions have something to do with the case or not. You must certainly know whether you have received any patent in the United States for your carburetor. I ask you whether you have or have not taken out or been granted any patents in the United States for your carburetor.

A. I know nothing about it. [illegible]

Counsel for defendants admits that Mr. Krebs has obtained Letters Patent of the United States, No.734, 421, dated July 21, 1903. [illegible]

These letters patent are in evidence, Defendants' exhibit No. 151 .

XQ357. Has any patent for your carburetor been granted to you in France, and if so, give date and number if you can.

A. Yes, a patent has been applied for in France but I cannot recollect the date or number.

XQ358. Did you yourself build the first carburetor of the kind you have described on your direct examination? as of your design, and if not, who did do it?

A. It was built at the Panhard-Levassor works.

XQ359. To your knowledge have any suits been brought either in Europe or the United States under any patents granted you or on your application for carburet[illegible]

parties alleged to copy or infringe such carburetor patents?

A. As far as I know, no such a suit has ever been brought about these patents.

XQ360. When was the earliest use of the carburetor which you refer to on your direct examination and which is generally known as the "Krebs carburetor", and where was that use?

A. At the Panhard & Levassor works. I cannot at the present time recollect the exact date of its first application. I will state, however, that this happened about five years ago.

XQ361. Did you ever hear of carburetors known by the name of "Butler" carburetors or "Maybach" carburetors, and did not carburetors so named exist prior to your own invention of the "Krebs" carburetor?

A. In a vague manner I heard of those names.

XQ362. Are you aware or did you ever learn that the English patent to Daimler for "Float Feed Aspirating Carburetor" was declared invalid in England because of the prior patent for carburetor to Butler of England?

A. Yes, in a vague manner.

XQ363. Are not "Float Feed Aspirating " features of construction embodied in the so-called "Krebs" carburetors, you have testified about on your direct?

A. I do not claim to have invented a carburetor. I merely brought important improvements to float feed carbu-

XQ364. Are you not aware that many other forms of carburetors are in practical and successful use on automobiles in connection with internal combustion engines, than the specific form of carburetor you have referred to as of your design and which is known as the "Krebs" carburetor?

A. I am aware of it.

XQ365. Do you know Mr. Aimé Witz of France as an authority or expert on the subject of internal combustion engines and has he published a book or books on the subject, and if so, have you ever read them?

A. My answer to the three above questions asked is : I know of Witz and his books, but I do not recognize anyone as an authority on these questions. See my answers to question 95, 96, 97, 98, 99, 100 and 101.

XQ366. Before you came over to this country on this occasion, did you receive any letter or letters from counsel or experts in the United States or from any one explaining to you in regard to giving testimony here in this case, and did you write any letter or letters on the subject, and if so, please produce all of such correspondence?

A. As I have already stated in a previous answer, I came here without having had previously any communication whatever, either verbal or written with any one relating to the manner in which I was to give testimony, I only

XQ367. Do you not know that Benz successfully ran in Germany a vehicle equipped with an internal combustion engine and before Daimler ran a vehicle equipped with his internal combustion engine?

A. Yes, I heard of this in a vague manner.

XQ368. Do you know or have you heard of an engine invention of in accordance with the ~~French patent granted to~~ Francois ~~Million~~ Million ? ~~dated~~

A. I do not remember of having heard such name.

XQ369. ~~Have~~ Have you ever heard of any French patent or patents to an inventor named Henri Menn, or of any internal combustion engines built or used under any such patents?

A. I do not remember.

XQ370. Did you ever hear or know of any patents ~~to~~ granted to or engines made under the inventions of persons named Carre or Brothier?

A. I don't remember.

XQ371. Did you ever hear or know of the practical use ~~of~~ an automobile of what I term an external combustion engine, that is an engine in which the charge is burned in a chamber outside of the working cylinder and the expansible gases resulting from the combustion, conducted from the said chamber to the working cylinder by means of pipes?

A. No.

Recess until 2 P. M.

9657

XQ372. Do you know or have you ever heard of an automobile which was propelled by a hot air engine such as the Ericcson engine or by a compressed air engine employing a tank containing a supply of compressed air under heavy pressure or by an ammonia engine?

A. I do not remember of it.

XQ373. In fact did you ever hear or know prior to 1895 of an automobile constructed in accordance with what is shown in the Rosenwald patent No. 116,871 of 1877, defendants' exhibit No. 108, being actually constructed and operated?

A. No.

XQ374. Did you ever know or hear of the free piston type or construction of engine like that of Otto & Langen or Hallowell, or Barsanti & Matteucci, being actually used on an automobile to propel it prior to the year 1895?

A. No.

XQ375. Did the Panhard-Levassor Co. ever use for automobiles a slow speed internal combustion engine which required to be geared up instead of being geared down, so as to give a higher instead of a slower speed to the axle?

A. I do not know as far as I am concerned.

XQ376. Do you know of the Panhard & Levassor Co. ever constructing an automobile which was actually and successfully operated by a gas engine of the free-piston type?

A. Not to my knowledge.

XQ377. Referring to the Lotz vehicle of 1867 and the Bolle vehicle of 1878 which you have mentioned in your direct evidence, were not both of these driven by steam engines?

A. Yes.

XQ378. Did not the manufacture of these vehicles stop at that time so far as you know?

A. I know nothing about it.

XQ379. Have you ever heard of them since the times you mention in your testimony?

A. I don't remember.

XQ380. Has the Panhard & Levassor Co. ever manufactured automobiles driven by steam engines?

A. No.

XQ381. Why have not the Panhard Co. made steam automobiles?

A. I do not know the reason of it.

XQ382. As an engineer and expert in the art of automobile construction is your preference for internal combustion engines as the motive power of automobiles as compared with steam engines for the same purpose.

A. I do not know whether one type is preferable to the other. It is chiefly a question of opportunity.

XQ383. But as matter of fact you prefer yourself the internal combustion engine for automobiles because you con-

sider it better and more perfected and more applicable to such vehicles, is that not so?

A. No, judging from what I see every day.

XQ384. What percentage of automobiles manufactured in France are driven by internal combustion engines as compared with automobiles which are driven by steam engines?

A. No, I could not say what the proportion is.

XQ385. Is not very much the larger proportion, now manufactured and which has been manufactured in France to your knowledge, of automobiles driven by internal combustion engines, than those driven by steam engines?

A. I do not know. That may be.

XQ386. Have the Panhard & Levassor Co. ever made experiments with steam engines for propelling automobiles?

A. I do not know whether it did or not.

XQ387. You never heard of their making such experiments, did you?

A. No, I never heard of it.

XQ388. Have you any knowledge of steam traction engines haveing been used in France?

A. I believe that they have.

XQ389. Were not these very heavy and slow-speed vehicles?

A. I have no exact figure present in my mind at the present time, but of course the weight of these tractors and their speed were depending upon the use for which

XQ 390What were the uses for which these steam traction engines were designed and to which they were actually applied in your knowledge?

A. I could not tell you.

XQ391. In the efforts made by yourself and others to adapt the internal combustion engine for the propulsion of road vehicles or automobiles, were you aided, or was any one aided to your knowledge by what had been done in connection with steam traction engines and steam driven xxxx vehicles?

A. I do not know. I cannot remember of anything.

XQ392. Can you now set forth any way in which your knowledge of steam traction engines has helped you in what you have done in the development of the internal combustion motor and its application as a driving engine for Panhard & Levassor automobiles?

A. I cannot answer. I know nothing about this.

XQ393. Then, you cannot point out any way in which steam traction engines or steam driven automobiles have helped you in developing internal combustion engines and adapting them for the automobiles of the Panhard & Levassor Co., is that the fact?

A. No.

XQ394. Can, you state when gasolene was first used in France as fuel for internal combustion engines on automobiles?

A. No. I cannot.

XQ395. Did the pneumatic tires for automobiles originate with the Panhard & Levassor Co., and if not, with whom did it originate?

A. The firm of Panhard never occupied itself with this question. The first pneumatic tires actually mounted on the wheels of automobiles its, were mounted at the expense of the customers who bought the vehicles.

XQ396. Then it was from the customers who bought the vehicles that at the first suggestion of pneumatic tires on Panhard automobiles came, and they were only put on the Panhard machines at the special request and expense of the customer?

A. I understand that this question requires two answers. To the first, I would answer yes. Answering the second, I must say that I do not know whether the pneumatic tires were placed on the wheels at their expense or not.

XQ397. Have the original Daimler engines constructed by the Panhard & Levassor Co. with cylinders at a V angle with each other or the double track side groove cams of those engines, remained in use or has that construction been abandoned?

A. No. This construction has been abandoned since 1894.

XQ398. Do you not know that a number of Panhard-Levassor automobiles were sold having irom tires, and before pneumatic tires came into general use for automobiles?

A. I am aware of it.

XQ399. In your answer to direct question 46 you say in giving the changes made year by year, in Panhard & Levassor automobile construction, that in 1904 you changed from cone to multiple disc clutch, was not the multiple disc clutch used by other automobile manufacturers before the Panhard & Levassor Co. and taken by your designers from previous users in Italy or England?

A. No, it is precisely the contrary which happened.

XQ400. Do you mean to testify that the use of multiple disc clutch by Panhard & Levassor Co. in 1904 was the first use of that form of clutch in connection with automobile construction?

A. Yes, to the best of my knowledge. I will add that I attach but a very small importance to this fact. This type of clutches having become at that time, public property.

XQ401. Referring again to your answer No. 46, ~~xxxx~~ had ~~xxxxxxxxx~~ not the "direct drive" on high speed been used in connection with automobiles by other constructors, and more particularly by Monsieur Renault previous to the adoption of that mechanism by the panhard & Levassor Co.?

A. Yes, but the Renault ~~The Panhard~~ Co. ~~xxx~~ employs a special type of direct drive which differs from the type employed on the Panhard ~~xxxxxx~~ automobile. This "direct drive" has long been public property.

~~XQ402xxxXQ403xxxxxxxxx~~.

~~Axxx Yes xxxxx~~

XQ402. Referring again to answer 46, had not the ~~xxxxxxx~~

Co. changed in 1901 been used practically prior to that date by other automobile manufacturers and adopted by your Company after it had been proved satisfactory?

A. No. As in the case of the friction clutch, the contary took place; at any rate this device has become public property.

XQ403. When did that reversing gear device become public property, if you know?

A. ~~No, xxkxxkxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx~~ No, I could not tell when this device became public property, but I am certain that it is public property.

XQ404. Was not this reversing gear public property when it was first put by the Panhard Co. into the construction of its automobiles?

A. It is quite possible.

XQ405. Did not the Panhard & Levassor Co. have to make many trials and do a large amount of work, covering several years, to reach the result of adapting the Daimler engine to actually, successfully drive a rodd vehicle or automobile?

A. Not that I know of. As the motor was working very well the success was certain inasmuch as automobile vehicles were already in existence.

XQ406. How many years was it after the Panhard & Levassor Co. secured the license or rights under the Daimler patent or engine before that Company sold an automobile equipped with that engine?

A. I do not know.

XQ407. In your answer No. 46 you have said that in 1901, the Panhard & Levassor Co. cast engine cylinder and head in one piece. Had not this been done by other manufacturers, including some other French firms, before the Panhard Company, did it?

A. It is quite possible.

XQ408. In your answer to question 46, you say that in 1901 the Panhard & Levassor Co. changed its engine control on Panhard automobiles from "hit and miss" to throttle control of mixture. Had not throttle control of mixture been employed on automobile engines before Panhard & Levassor Co. made this change in 1901?

A. Not that I know of.

XQ409. Do you remember a time when Monsieur Clement was President of the Panhard & Levassor Co. and whether there was not received at that period and after you actively went with the Company, various drawings of automobile vehicles and parts made by the Pope Manufacturing Co., motor carriage department, of the United States, which drawings were open to examination by yourself and certain others of the designers of the Panhard Company, and were in fact examined or seen?

A. I remember perfectly well that I saw at the date mentioned at the factory of M. Clement at Levallois Perret, Pope vehicles, but I never saw or had drawings of these vehicles

XQ410. Do you not remember that a vehicle made by the Pope Mfg. Co., which you saw at M. Clement's factory at the date mentioned, had its engine control by throttle control of mixture?

A. The only Pope vehicles which I saw at M. Clement's factory, towards the end of the year 1898, were only electric vehicles.

XQ411. In your answer No. ~~42~~ 46, you have said that in 1898 the steering mechanism in the Panhard & Levassor automobiles was changed. You have also stated that Mr. Levassor died in 1897 in an automobile accident. Is it not a fact that this latter circumstance influenced a change of steering mechanism on the Panhard & Levassor automobiles and the adoption of a system of steering mechanism which at that time was known under the name of "Pope-Columbia direction" and had been illustrated in trade papers as the "Pope-Columbia direction?"

A. I answer no to the question asked, and I do add this: The question of steering is one that I have taken up towards the ~~xxxx~~ end of 1897, as soon as I had acquired a sufficient knowledge of the operation and of the organization of the Panhard & Levassor business. This steering device was not anything else but an adaptation of means already known and used since a very long time for the same object.

~~XQ412~~

Adjourned until Wednesday, November 21, 1906, same time and place.

November 21, 1906.
Met pursuant to adjournment.
Parties present as before.

CROSS-EXAMINATION OF ARTHUR CONSTANTIN KREBS RESUMED BY MR. BETTS.

XQ412. State when M. Clement was President of the Panhard & Levassor Co.?

A. As far as I can remember M. Clement was President of the Panhard Co. from 1899 to 1901.

XQ413. Did you during that period hear or know of a system of steering mechanism under the name of "Columbia direction"?

A. I do not recollect.

XQ414. Did you examine the steering mechanism on the Pope vehicles you say you saw at M. Clemen t's factory towards the end of the year 1898?

A. I have looked at the automobile all over and it is quite possible that I saw the steering mechanism.

XQ415. Was not the death of Mr. Levassor in an automobile accident due to some failure or accident connected with the steering gear of a Panhard & Levassor automobile which he was driving?

A. No. I cannot say that positively.

XQ416. But did you not hear and understand at the time that such was the fact?

A. It is quite possible, but personally I do not know

XQ417. Did not the Panhard & Levassor Co. have at their factory, to your knowledge, at some time the Pope electric vehicle or vehicles which you say in answer 410 you saw at Mr. Clement's factory?

A. The Panhard Co. never had such vehicle at its factory for any length of time. It is quite, possible, however, that the electric vehicle referred to were brought to the Panhard factory as many other vehicles were brought there.

XQ418. Did not you at about that time say, yourself or was it not said to you by some one connected with the Panhard Co. that the steering mechanism of that Pope electric automobile was a good feature and worth introducing while other features of the machine were too expensive?

A. I do not remember.

XQ419. Is it not a fact that the change in the steering mechanism on the Panhard & Levassor automobiles which you have described in your testimony was made at or about the time that this Pope electric automobile was in the possession of M. Clement and was seen by you?

A. No. I have said in my answer 411 that a study of such modification in the steering mechanism had begun at the end of the year 1897. Mr. Clement introduced in his factory at Levallois Perret the Pope vehicles at the end of 1898. The Panhard-Levassor racing car of May, 1898, Paris-Amsterdam race, were already equipped with the new steering mechanism. As a matter of fact and as I have stated in my

which had been employed for a long time for similar purposes.

XQ420. Do you know of any internal combustion engines which were described or which existed prior to the Brayton engine as that is described in the Brayton U. S. patents of 1872 or 1874 and which you would classify as constant pressure engines?

A. I do not know anything about it.

XQ421. Do you mean th at you do not know of any?

A. I do not know of any.

XQ422. Is it not a fact that prior to the year 1900 almost all automobiles propelled by internal combustion engines had motors of not more th an 8 H. P. so far as you know?

A. No.

XQ423. How was it prior to 1899 whether a large proportion of automobiles driven by internal combustion engines were not of 8 H. P. or less?

A. No.

XQ424. Please look at the two original letters now shown you and which I have received from defendants' counsel, Mr. Murray, and which are dated February 15,1890 and August 7, 1890, respectively and state if you recognize the signature thereto as that of Mr. Armand Peugeot?

A. No, I cannot ce tify the signature, not knowing Armand Peugeot's signature.

XQ425. Are not these two letters referred to and shown you from the files of the Panhard & Levassor Co.?

A. I consider them as belonging to the files of the Panhard & Levassor Co.

XQ428. Complainants' counsel asks that the two original letters produced and referred to above be marked for identification by the Examiner, and they are so marked.

XQ426. You never have seen the Selden engines, either the three cylinder engine or the one cylinder engine which you inspected at the garage in New York on October 29th and 30th, actually running or operating have you?

A. I have already answered no.

XQ427. Have you not been informed by any of the counsel in this case or by any of the defendants' experts, such as Mr. Jesse Smith or Prof. Carpenter, or by any one, that these Selden engines of three cylinders and one cylinder had been actually run and seen running by defendants' counsel and experts?

A. No.

XQ428. Can you tell me when the word "automobile" was first used in connection with vehicles driven by internal combustion motors, or about when. When did it come into nomenclature of the art in France?

A. No, I could not tell you.

XQ429. Please look at the printed French publication

shown you, and state whether you do not find in the upper figure of the drawing on page 389 of the Brayton engine, that there is shown a restricted opening into the cylinder owing to a baffle-plate and which opening is relatively small compared with the size of the chamber for combustion marked D on the drawing?

A. This drawing is too crude to permit me of giving my opinion on the relation between volumes.

It is not, however, in this document that I have noticed the arrangement mentioned in the question, but in the United States patent 151,468, which was shown to me to enable me to say whether the drawing in La Nature represented fairly well an arrangement similar to the one described in the patent.

XQ430. Does not the drawing of Brayton United States patent No. 151,468 referring specially to figure 3, show in fact a carburetor for the Brayton engine?

A. It is certainly what Brayton intended to build.for a carburetor.

XQ431. Referring to your answers to questions 55 and 56 and also to the printed copy of the Selden patent No.549,160 now shown you, is that the printed copy you examined in giving answer No.56?

A. Yes.

Counsel stipulate that the copy referred to is an ordinary printed copy of which the size of

which copy is one of the regular printed copies of patents issued by the United States Patent office.

XQ432. Please look at the printed or lithographed sheet of drawings now shown you and of which the field within the rectangular border lines measures about 8 in. x 13 in., and which on its face has the printed statement G. B. Selden road engine, No. 549,160, Patented Nov. 5, 1895, 2 Sheets--Sheets 2, &c. Please look at fig. 3 of this drawing and particularly at the portion thereof marked T' and the small chamber to the left thereof, and the lines which appear on said drawing between the chamber T' and this smaller chamber to the left, and state in the first place what you understand to be indicated by the vertical dotted lines there shown? and you are requested to use a magnifying glass which I now hand you.

A. These dotted lines mentioned cannot in my mind represent anything except if the drawing is supplemented by description.

XQ433. Do you say that these dotted lines on this drawing referred to do not represent to you as accustomed to read and understand drawings wire gauze fabric or sheets between the large chamber T' and the smaller chamber to the left?

A. No. These lines do not represent anything to me.

XQ434. Looking now at the curved black line on Fig. 3 of this Selden drawing, immediately to the left of the dotted lines just referred to and to the short black lines immediately to the left of this curved black line, near the top and the bottom thereof, do those lines on that drawing represent or indicate anything at all to you as to construction shown?

A. These lines do not represent anything to me.

XQ435. But now that you have seen the Selden engines as actually constructed as you saw them at the garage, do those lines referred to on the Selden drawing indicate anything to you as to what they represent in the construction actually put into the Selden engine?

A. Now that I have seen a motor constructed, I understand that these lines are meant to represent the springs of the valve shown, and which is also represented by the black lines which separates chamber T' from the small chamber at the left. But, while I am aware of this, I do not see a point of rest for these springs since the dotted lines which are supposed to represent the wire gauze do not indicate anything to me in the drawing.

Complainants' counsel offers in evidence the full size lithographed copy of sheet 2 of the drawing of Selden patent No. 549,160 which has just been examined and referred to by the witness and the same is marked

XQ436. I now show you a copy of ~~the~~ Fig. 1, Fig. 2 and Fig. 3 from the English patent to Maybach, No. 16,072, dated August 25, 1893, and contained on page 33 of a printed pamphlet entitled "Bulletin No. 8 of Association of Licensed Automobile Manufacturers"? and ask you what you call the part marked g in each of those figures 1, 2 and 3?

A. A valve with its stem and the spring shown in dotted lines The spring rests on one end on the frame, on the other end on a nut ~~xxxxxxxx~~ screwed at the end of the valve stem.

XQ437. Is there not shown in these drawings, Figs. 1, 2 and 3 a chamber just outside of the valve g into which a liquid fuel pipe leads close to the cylinder?

A. Yes, very clearly.

XQ438. Do not these drawings shown you represent the first form of that float feed aspirating carburetor, and which is very generally used in automobile engines to-day?

A. These drawings are very clear drawings intended to represent ~~a~~ float feed aspirating carburetors, but I have not seen carburetors built exactly as shown. Carburetors could be constructed with these drawings.

XQ439. Do you not know that the Lenoir engine was constructed, double ~~ex~~ acting, with electric ignition from a single source?

A. Yes, vaguely.

XQ440. Was there not used on such a Lenoir engine a distributor in connection with a source of electricity

A. Yes, I believe that was the case.

XQ441. Did not the French electrician, M. DuMoncel, describe electric batteries of the dry or semi-dry type prior to 1879?

A I have no recollection about it.

XQ442. Is it not a fact that the Panhard & Levassor Co. continued until the year 1900 to use hot-tube ignition?

A. Yes, it is a fact, but not an absolute fact.

XQ443. Did not the Panhard & Levassor Co. ever sell machines for use in the United States which were fitted with both hot-tube and electric ignition?

A. I c annot say.

XQ444. Did not the Panhard & Levassor Co. ever manufacture automobile engines which were fitted with both hot-tube and electric ignition, and if so, down to what time?

A. Yes; this double ignition was provided upon request from a purchaser and the double system may yet be asked by customers.

XQ445. In fact was not the Panhard & Levassor Co. obliged to change from hot-tube ignition to electric ignition for their engines by the demands of customers for electric ignition?

A. No. This change has been made when electric ignition became practical reliable and positive by the reliability of its operation and at least equal to hot-tube ignition

XQ446. ,Do you not know that electric ignition was used

prior to its adoption practically by the Panhard & Levassor Co. for its engines?

A. I was aware of it, but electric ignition did not give satisfactory results except in the case of single cylinder engines.

XQ447. Is not the chamber marked with the letter T' in ~~the~~ Fig. 3 of the drawing of the Selden patent now shown you, entirely unobstructed from the black lines shown on that drawing to the left of the dotted line and which indicate the clap-valve of the Selden engine you saw, ~~xxxxxxx~~ unobstructed, I mean, to the cylinder pump, and in a similar way to the clear chamber shown in Fig. 3 of the Maybach patent drawing referred to in XQ436?

A. I cannot say anything about it. ~~This~~ drawing is too incomplete to permit me to look upon it as being comparable to the construction shown by the drawing illustrative of the Maybach patent.

XQ448. In the Selden drawing Fig. 3 do you see or can you point out any constriction or contraction of the space running from the black line to left of the dotted line and towards and into the combustion chamber marked T^1?

A. I again state that this part in the drawing of the Selden motor is ~~so~~ confused that the lines do not represent anything very precisely. The drawing of an engine must be so made that its reading cannot ~~xxixxx~~ give rise to ~~xxxxxxxx~~ ~~xxxxxxxxxxxxxxxxxxxxx~~ doubtful interpretations. I see lines which certainly cannot extend to define what the draftsman

XQ449. Do you understand or have you been informed that under the law applicable in the United States, the Letters Patent to Selden on which this suit is brought, No.549,160, dated Nov. 5, 1895, and for which his application was actually filed in the U. S. Patent office on May 8, 1879 carry back the date of Selden's invention as to everything which was described and shown in his application as filed to at least the date of May 8, 1879? and that it is only matters which existed prior to that date and indeed prior to the date on which you actually invented what he set forth in his filed application that can act to anticipate or limit his patent as finally granted, Nov. 5, 1895?

A. Yes, of course, but our vehicles operate by means of quite different methods and the results are also different.

Corss-examination closed, at 2:30 P. M.
Adjournment taken to 3:30, P. M.

Re-direct examination by Mr. Murray.

RDQ450. Have you arranged to sail for France tomorrow morning?

A. Yes.

RDQ451. Is the date of your departure later than you expected and if so, why?

A. I engage passage to sail on November 8th, and again on November 15th. These two postponements were due to this deposition.

RDQ452. Have you made any study of the patents and publications in this case?

A. No.

RDQ453. Do you know where the Lenoir shop was in Paris?

A. Not exactly.

RDQ454. State if you know the distance between Paris and Joinville-le-Pont?

A. About 12 kilometres, that is about 7 2/10 miles.

RDQ455. In answer to XQ191 you referred to a charge in an Otto 4-cycle engine where after the compression stroke the pressure is less than atmospheric. Briefly explain if you can why the pressure is less than atmospheric?

A. In such conditions of operation, the cylinder walls are cold, because the power developed is nearly zero and because there is a circulation of water sufficient to prevent the cylinder walls from reaching the temperature of vaporization of water. It follows, therefore, that the residual burned gases left in the clearance space and containing themselves a large amount of steam, becomes largely condensed; moreover the admission of gas takes place under a comparatively large degree of vacuum. Besides the very active vaporization of the light hydrocarbon liquid taken in the charge produces a further considerable lowering of temperature. It can be, therefore, conceived that the temperature of the gases (both residual and newly introduced) being very low, the volume of these gases becomes con-

RX by Mr. Betts.

RXQ456. Referring to your answer to RDQ455, why would the cylinder walls be cold if the engine had been running?

A. In the case referred to I have assumed that the motor had not been running, was cold and the circulation of the water also cold, and in making this statement I merely meant to allude to conditions which may happen in a laboratory.

RXQ457. Then the conditions you have supposed in giving answer 455 are not conditions of actual practical operation delivering large power for unit of weight, are they?

A. No.

Re-Cross closed.

It is stipulated that the witness may read over and sign his deposition before the stenographer and that questions and answers 1 to 172 inclusive are subject to correction as to translation, corrections, if any, to be agreed upon between counsel and all points as to which they do not agree to be decided by a translator to be appointed by the Commissioner.