

A CASE STUDY OF PRIOR CONTRACTING IN INNOVATIONS:

U. S. v. HARTFORD-EMPIRE REVISITED

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The purpose of this paper is to examine the extent and the consequences of contracts for future developments in patent licenses. Important innovations are usually a sequential process, i.e. the early results can be incorporated in subsequent results. Even though the innovations may be patentable, patent infringement suits are often a timely process. With these assertions, I argued in previous papers that a manufacturer will be unlikely to contract with a patent holder who does no continuous research, partly because he anticipates another major idea displacing the existing one and partly because the incentive for the existing patent holder to fight an infringement suit will be less, and thus the probability of the manufacturer escaping the infringement charge is higher. This implies that, on the average, the ratio of patent infringement suits to patent licenses ought to be higher in relatively stagnant industries where the state of the art requires no drastic changes. Furthermore, in industries where important innovations are anticipated, and if the dominant inventor can be identified, patent licenses are likely to include the granting of future patents on improvement. The reason for the latter is that once a

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licensee has decided to contract (rather than to fight) with the patent holder, he would gain by contracting early rather than late. If negotiation with the patent holder can be conducted before his patent position has been strengthened, competition among potential inventor becomes viable and the package price of the innovation can be lowered. Such an arrangement has been called prior contracting. Stated succinctly, a manufacturer may either fight or contract with a patent holder; but if he chooses to contract, he would rather prior contract than to sign up late.¹

An ideal test for the above theory perhaps requires inter-industry comparisons. Lacking the data (and the resources) to conduct this task, I examine a case study where innovation is known to be important. The Hartford Empire case has been selected because of my relative familiarity with the case,² but as it turns out, the case may not be that ideal because the driving force behind prior contracting, namely, competition among inventors, has been reduced by an enforceable collusion in this particular case. Still, there were outsiders to any collusive scheme. Even though some implications cannot be tested because of inappropriate circumstances or insufficient data, a discussion on the relevant variables that require examination hopefully can provide guidelines for future studies of other cases. This is not a complete case study in the sense that many aspects of the case are deliberately left out so that one can concentrate on the issue of prior contracting alone.

The paper will be divided into two sections. The first summarizes the implications relevant to the issue of prior contracting. The rationale behind

¹Patent licenses without future improvement clause do exist, but the implication is that they should, on the average, be less frequently observed in industries where important innovations are anticipated.

²The main sources of references are (a) the transcript of U. S. v. Hartford-Empire Co., 323 U. S. 386 (1945), hereafter called Transcript, (b) U. S. Congress, Temporary National Economic Committee Hearing (1939), Part 2, hereafter called T.N.E.C., and (c) Past studies of the case, see Bishop (1950), Brown (1966), Beck (1976).

the implications has been explained in the other papers. Section II examines the Hartford Empire case between 1916 and 1940. I argue that much of Hartford's conduct in the glass manufacturing industry has to do with their intention of doing additional research work in the field. This aspect of the case has not been fully addressed to in past studies of the case.

I.

Prior contract involves the licensor making a commitment to future development which the licensee will commit to accept. Two types of transaction costs are crucial in determining the extent and the form of a prior contract. First, there is the information cost of identifying and evaluating the potential abilities of different inventors. Variation of such cost over time as well as across manufacturers generates refutable propositions regarding the behaviors of the licensor and the licensees. Second, there is an enforcement cost to the future commitment. Without an appropriate incentive system, an inventor may not actually deliver the committed development once he has gotten the commitment from the manufacturers. If patent licenses are partially development contracts, we ought to observe some enforcement mechanisms specified in such license. Consideration of these two types of transactions cost generates the following implications.

(a) Implications regarding the behavior of the licensor

Before the relative superiority among inventors (or models) is known, a licensor would price his innovation as if he is a monopolist. Information on the relative superiority among inventors may only be revealed after a period of price cutting surviving only the superior inventor. This implication is often taken for granted. But without considering the commitment of future development in prior contracts, there is no reason to determine a priori whether price cutting or quality (development) improving would be chosen as a method to gain patronages.

Prior contracting can be more clearly tested when information concerning the relative superiority of various inventors are known. The effect of prior contracting is potential competition among inventors, which implies that changes in the market shares of alternative models (or inventors) would not affect the price of the surviving model. As explained elsewhere, this suggests a regression analysis with royalty per machine as the dependent variable, and time and the interaction of time and changes in the market shares of the models as dependent variables. The theory predicts that the coefficient of the interaction term to be insignificant. However, actual testing of the implication may require a model of simultaneous equations because price cutting among different models when inventors superiority is unknown would result in changes in the market shares as well.

(b) Implications regarding the behavior of licensees

Prior contracting implies the licensees take on an active role in determining the terms of the license rather than reacting passively to whatever licensing policy imposed on them by the patent holder. The more efficient licensees with lower search cost will prior contract early, leaving the inefficient licensees who sign up late with a lower or negative profit. This line of reasoning implies that the early licensees ought to have larger output and a faster growth rate than the late licensees. The reason for the larger output is based on the theory of search--larger manufacturers search more. The faster growth rate is based on Stigler's survival principle.

(c) Implications regarding the enforcement mechanisms

A running royalty rate based on the output of a consumer product has been hypothesized as an inducement mechanism for future development of innovation. This implies royalty per machine ought to increase as improvements were added on to the machines. Furthermore, since precommitment of certain expected future development is the essence of prior contract, one expects the royalty rate

(bonus for the future development) to remain the same even if there is a "price war." A lowering of the "price" of the innovation is likely to come in other forms such as lump sum reduction.

11.

A mechanical process of glass manufacturing around 1920 concerns with the mechanical process of feeding molten glass into formers; and from there, charges of glass are blown or pressed into different shapes. Initial research work on the feeding technique allegedly began in 1912 by a research organization called Hartford-Empire,³ but the first commercialized feeder of the company did not appear until 1916 under the name of Paddle Feeder (later called P. N. Feeder). From 1916 to 1923, the feeding technique had been constantly improved, based on the principle of the P. N. Feeder as well as on a different principle called plunger. Starting from 1923, the plunger principle gradually took over. Modelled under the name of Single Feeder, 15 of such machine were installed in its first year. This number grew rapidly, and by 1941, 410 were in use compared to 214 for the next popular feeder.⁴ There were other feeding techniques besides the mentioned ones. They were the air feeder, the stream feeder, the pneumatic air feeder. The feeding technique also competes with a pre-1912 principle known as the suction process. The alternative feeding techniques, owned by different individual concerns, mushroomed during the early history of the feeder's development but gradually disappeared from 1925 onward.

The events between 1923 and 1940 have been well recorded in previous studies.⁴ Most widely publicized are (a) a series of patent acquisitions and

³The company was called Hartford-Faimont in 1912. It's name changed to Hartford-Empire when it merged with Empire Machine Co. in 1916.

⁴Ex. H-5749, Transcript, showed that the market shares of alternative machines declining while the single feeder gained considerable grounds.

⁵The glass container industry has been studied by a number of scholars in the past. This section will not duplicate their findings. Only evidence relevant to the issue in this paper will be presented. For other issues in the case, see Robert Bishop (1950), James A. Brown, Jr. (1966), Roger Beck (1976)

cross licensing arrangements which enabled Hartford to threaten numerous manufacturers using "competing machines" with infringements suits, and (b) Hartford's restrictive licensing practices of leasing feeders to manufacturers on limited types of glass wares, sometimes with quantity and geographical restrictions. Both are some forms of contractual arrangements, but the first type is formed among competing inventors (or research organizations) whereas the second type is formed between the inventor and the manufacturers in the industry.

The contracts among inventors (i. e. acquisitions and cross licenses) belong to a separate issue which is treated elsewhere. Most relevant to the subject matter on hand is the question concerning the extent of prior contracting (i. e. the second type of contracts) and its enforcement mechanism. However, this question may not be answered totally independent from the first. If the driving force behind prior contracting is competition among manufacturers and inventors, a collusive agreement among competing inventors would eliminate much competitive conduct. Still, there are always outsiders to any collusive arrangements, and the effect of competition, though greatly reduced, should be revealed to some extent. In the following paragraphs, I argue that Hartford's dominance has much to do with its continuous research effort. While much of these efforts were prior contracted, the precommitment of future research in patent licenses was reduced as Hartford's patent position was strengthened. This is a direct implication of the prior contracting view. In addition, certain contractual provisions in Hartford's patent licenses can be demonstrated to serve as enforcement mechanisms in such prior contracts.

To illustrate the type of improvements that can be made on a feeder, it helps to describe the basic components of a Single Feeder. It consists of (a) a forehearth, a channel where proper temperature of the molten glass can be adjusted, (b) a plunger, the reciprocating movement of which controls the

shape of individual charges of molten glass, (c) an orifice ring, a hole through which gobs are fed, and (d) a pair of shears, which servers the suspended gob at the proper time. The co-ordination of these components is self-explanatory in Figure 1.

The functioning and the coordination of individual components of a Single Feeder have great variations. It was improvement on these components that constituted much of Hartford's post contractual development. Take the quality of glass wares as one desired dimension, it is largely a function of proper temperature, viscosity, and size of the discharged molten glass in a feeder; and different wares have different optimal temperatures and "gob" sizes.⁶ A versatile feeder is therefore needed by manufacturers serving multi product lines. This was accomplished by improvements on the foreheath and on the controlling mechanism of "gob" sizes.⁷ Take the quantity of glass wares as another desired dimension, it is largely a function of the speed of the feeder which is controlled by the coordination of the plunger and the shearing mechanism. Again, a great deal of improvements were performed on the

⁶ Different glasses have different temperature and viscosity relationship and different machine cycles, see the testimony of Peiler, p. 7910. Improper temperature results in streaks and cords in the glass wears see also C. J. Phillips, GLASS: The Miracle Maker, (New York: Pitman Publishing Co., 1941), p. 238.

⁷ One problem in the forehearth was "channeling." The phenomena refers to hot glass coming from the melting tank, instead of gradually distributing throughout the nose of the furnace and coming out even to different feeders, it makes a bee-line between islands of stagnant glass. The result is that the temperature of the glass charge reaching the forming molds cannot be controlled with great accuracy. The solution to the problem involved the addition of revolving tube or sleeve around the plunger to air the glass in the feed bowl, the strengthening of the refractories, the homogenizing of the glasses in a soaking section of the feeder, all these were added improvements after 1923 and continued up to the date of the trial. (See court transcript, p. 8052 to 8059) Gob size is controlled by adjustment in the plunger and the sleeve surrounds the plunger. In particular, a device known as "phase change" shifts the time of occurrence of the shear-cut so that the length of time in which the glass is suspended may be varied or controlled. This will change the stretch and therefore the ratio of length to diameter of the charge. i.e. the shape of the gob, p. 4494.

FIGURE I

ACTION OF HARTFORD SINGLE FEEDER

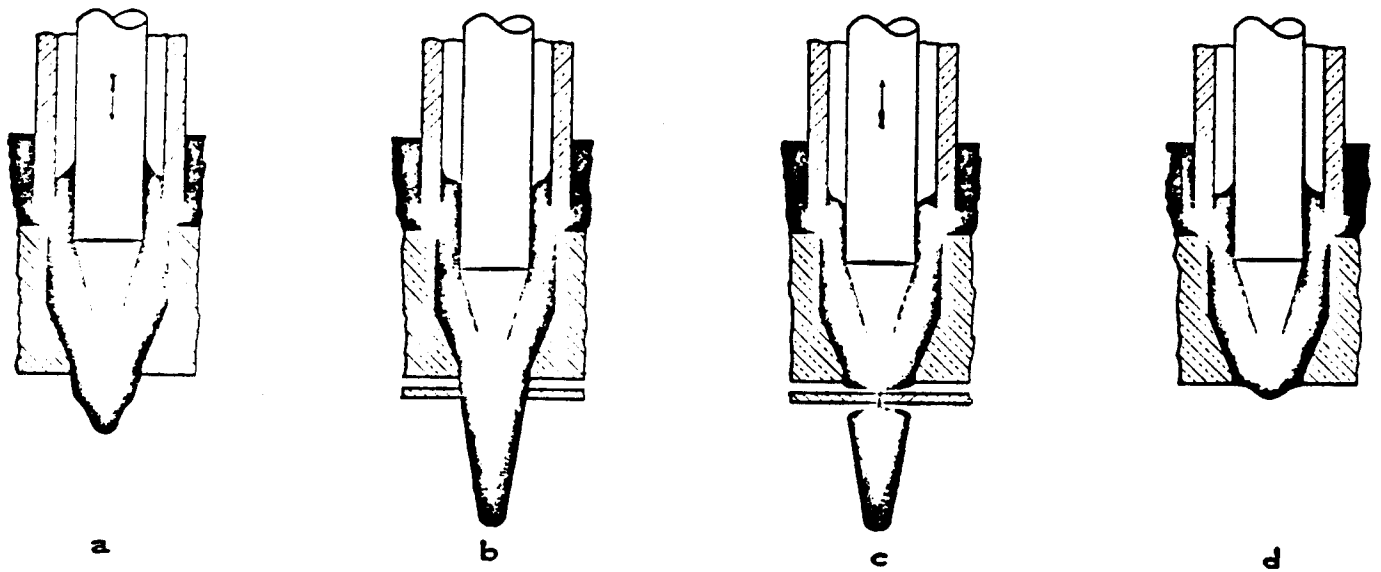


FIGURE 6 - Diagram of operation of feeder, which delivers gobs of glass from the tank to the molds of the forming machine, in the gob fed process.

coordination and the composition of the two components, resulting in significant increase of production.⁸

Besides improving particular components of Single Feeder, Hartford is also known to have experimented with alternative feeding principles used in other machines. Moreover, such development works continued even after the patents covering these methods were acquired--an unlikely event if patent acquisitions is purely for the sake of monopolization. As late as 1940, Hartford was still experimenting with the "double gob feeding technique," i.e. feeding two mold charges instead of one to a double cavity mold. This would double the speed of the Single Feeder (p. 8061). Another experimental venture has to do with the combination of an entirely different technique (the suction method) with the feeding technique. The suction method and the feeding method each has its own advantages and disadvantages, depending on the type of glass wares and the quantity of the order. In 1930, roughly 30% of the glass containers were produced by suction with the rest utilizing some forms of feeding technique (T.N.E.C. p, 443 and p. 772). But as early as 1915, Hartford had been experimenting with the so-called "suction gob feeding" technique, and judging from the issue dates of patents covering this method, the work continued until sometime around 1937 (Transcript, p. 4476). As the chief engineer of Hartford, Karl E. Peiler, testified, the original intention of Hartford, was to aim at a universal feeder that can handle all types of wares. Unfortunately, this approach turned out to be unattractive after the trial runs around 1933, (ibid, p. 4479). The dominance of the Single Feeder appears to emerge from repeated challenges from alternative devices.

⁸Besides experimenting different plunger (e.g. cam-operated vs. pneumatic-operated), a stronger shearing mechanism must be built to stand the high speeds without vibration, to avoid throwing the glass and keeping the blades together to make a clean cut, p. 8061. Roughly speaking, there had been a steady increase in capacity of 50% between 1928 and 1939 in the quantity of glass obtainable from a tank of given size, T.N.E.C., Hearings, Part 2, p. 817.

The dominance of the Single Feeder must not be viewed as resulting from Hartford's patent acquisitions alone. There is no doubt that the patent positions covering the art of feeding was strengthened through acquisitions, but the proponents of this viewpoint should further ask: what explains who acquired whose patents? The testimony by Peiler gave convincing reasons on why it was Hartford who acquired others and not the other way around. What Hartford had repeatedly demonstrated is the fact that they have the comparative advantages in all feeding related techniques. Without such demonstration, it would be difficult to explain why a competitor would easily sell out his patent rights to Hartford. Competitors would not sell out, or might even acquire Hartford's patents, if each believe that his method will be most superior in the long run. They sold out because Hartford valued the continuous development of the competitors' methods more than competitors themselves--a necessary condition of any trades. As a matter of fact, many patents holders who sold out their patents rights winded up working for Hartford afterwards.⁹

The preceding arguement has been largely neglected in the court and in past studies. This was a point the defense attorney for Hartford came close to saying. In his direct examination of Peiler, the court and the plaintiffs' attorney became impatient on the tedious questioning about the technical details of various techniques. The defense attorney tried to explain,

"I want to show Your Honor the essential identity of the feeders which were developed and which were put on the market by various parties whom we are accused of suppressing, and so on...I want to show what that was in that was in controversy between those parties, and I want to show that there was a similarity of method or of apparatus, and I can show it within an hour's time--It is not a patent infringement suit at all..." (emphasis mine) (p. 4496)

Further elaboration on this point were never explicit. However, he came close to the point in the following page,

⁹The two notable ones were George E. Howard and W. J. Miller, the former sold out his patent rights in 1923, the latter sold out his rights in 1925. Their acquisition contracts with Hartford also specified transfer of future patents.

"Now, I have shown partly of what the (Miller) feeder consists; has many parts..., and when you say "Miller Feeder" you mean only a feeder put out by Miller and not a feeder developed by Miller entirely. This single feeder here is not, in all aspects and all features, the work of a Hartford inventor, and we claim that a feeder can not be properly referred to us, say a Miller, or Tucker, Reeves & Beatty Feeder. Although the word is descriptive, it doesn't describe what the feeder really was, what the contribution or central thought of Miller, or Tucker & Reeves was, what they produced and gave to the art, which was more than just a box, or forehearth, or cams, that anybody could pick up on the market..."

The defense was clearly referring to the continuity of ideas. The impression was that the acquisitions have something to do with the sequential nature of idea, but not quite a patent infringement issue. But what exactly is the reason for the contract,¹⁰ and the question of who acquires whose patents have not been addressed to at all.

Hartford's continuous research, which I just argued as the factor leading to its dominance, also explains their enormous patent expenditure. If future developments were not anticipated, there would be less incentive to set up an elaborate patent department specializing in patent applications and infringement suits, both of which involved large set up cost. The general impression in past studies seems to believe that Hartford's dominance was caused by their enormous patent expenditure. It is particularly easy to develop this type of sympathy by listening to the testimony of a small disgruntled licensee.¹¹

At the TNEC hearing, the President of Knape-Coleman Co. describes how he gave up fighting with Hartford vividly,

"(Hartford) brought us unto court in April of 1935, as I recall. Well, when I arrived in San Angelo and met them there in the hotel, I can conservatively say there was a half train load of attorneys

¹⁰ I attempted to answer this question in my doctoral dissertation (1978), summary argument is in Yu (1981)

¹¹ The predecessor of Knape-Coleman was the Three Rivers Glass Co. who took out a license from Hartford in 1929, but cancelled in 1932 because of nonpayment, (see the record in Exhibit-5750, p. 15436 Court Transcript).

and equipment. There were motion picture projectors and attorneys all over the place. I don't know anyone of the Hartford legal staff that was not there. They were prepared to give us a nice battle. Well, I had only one attorney and he was considerable lost in that crowd. I wish you might have seen his face that morning. So I promptly asked for a recess until the afternoon, in order to see if we couldn't settle the case out of court.¹²

The "tyranny" of a patent owner, however can be viewed differently. Consider the following question: Why didn't Knappe-Coleman, or the owner of their machines, or Miller, or Howard, or any other competitors build the same patent department and thus be able to compete with Hartford's "tyranny?" It is almost a universal practice for a patent licensor to hold his licensees harmless against damages recovered in suits brought against the licensees by other patent holders.¹³

The lacking of such commitment is like selling a product without warranty, and can be easily inferred by the buyers as the sign of a fly-by-night.¹⁴ Conversely, the existence of such commitment must be backed up by a strong patent department which in turn signals future inventive potentials. Thus, uneven strengths of patent litigation power could reflect just uneven future inventive potentials. Throughout the testimonies in T.N.E.C. and the court transcript, Hartford had emphasized that his licensees demanded strict enforcement of all infringers. Indeed, this may be explained in terms of licensees demand for monopoly protection. But how is this different from a buyer of a product demanding warranty? How is this conceptually different from buying from firms that have large advertisement budgets and thick flushy carpet? Viewed this way, it is conceivable that the large litigation expenditure of Hartford is some sort of "brand name capital investment" required in situations where there is an honesty premium.¹⁵

¹²T.N.E.C. Part 2, p. 611, Knappe-Coleman was formed around 1934. They took out a license from Hartford in 1935, but was recorded as a "financial failure" in 1936, see Ex-5750, ibid.

¹³See the general study of patent licenses in Cheung (1976)

¹⁴This line of reasoning is similar to the one by Nelson (1974)

¹⁵See Klein and Leffler (1980)

One way to differentiate our view from the "tyranny" view of patent licensing is by observing the behaviors of the licensees. A totally passive glass manufacturer who started out using alternative machines would sign up with Hartford only if the latter exercised strong litigation threats and the patent owners covering such alternative machines gave up fighting with Hartford. On the other hand, prior contracting views the licensees actively searching and comparing the future potentials of different machines. Thus, one should expect some manufacturers using alternative machines to switch to Hartford even in the absence of the litigation threat and before the patent holders of such machines sold out to Hartford. In other words, it can be the behavior of the licensees that determine the extent of the licensor's research effort rather than the other way around, (see section I, implication a and b). Machine installation records in the transcript suggested some of these cases (Transcript, Ex. H-6152, p. 8572). For example, the Carr-Lowrey Glass Co. had been using the Miller feeder prior to 1924. They switched to Hartford's single feeder before Miller sold out his patent rights to Hartford in 1925.

The behaviors of the licensees can also be examined in terms of their sizes and growth rates (see section I, implication (b)). Prior contracting predicts that the earlier licensees have larger firm sizes and faster growth rates. However, this test is inappropriate in this case for the following two reasons: (a) For any risky activity, the relative superiority of an individual can only be determined from numerous trials. The winner in a single race could be just lucky. This remark applies in the evaluation of inventors's superiority as well as the evaluation of the licensee's efficiency in his price searching behaviors. For the time period under investigation in this case, there were only one major innovation in the

industry. Thus, classifying licensees based on the timing of their contracts with Hartford and inferring from this about their efficiency in price searching may have a high degree of error. (b) The case under investigation also involves collusion among inventors. Behaving like a cartel, the superior inventor (Hartford) may hold firm to a high royalty rate and the licensees would lose their incentives to make prior commitments as the theory would predict. In fact, in such circumstances, collusion among competing inventors should provide a reverse incentive for the licensees to wait rather than contract earlier. The testing of prior contracting thus requires data before the date of collusion. But this set of data would also be difficult to obtain since the court tends to overlook detail evidence before collusion. A search among the exhibits in the court transcript discovered only market information after 1928. Classifying firms who took out licenses from Hartford prior to 1932 as "early" and those signed up after 1932 as "late," comparisons of firm sizes and growth rates among these two groups did not reveal significant differences (see Table I).

We now examine the contractual forms adopted in Hartford's patent licenses. The framework of prior contracting provides the following guidelines: (a) How much of Hartford's research were prior contracted? What changes in prior commitments are to be expected as the patent position of Hartford was strengthened? (b) What penalties a late licensee has to bear? Is there price discrimination over time? i.e. were the early licensees successful in getting a lower royalty rate while the late licensees were forced to pay a higher rate? (c) What enforcement mechanisms were used to encourage post contractual development? We examine these questions separately under the following headings:

(a) Prior commitment of future development

In earlier paragraphs, we have described the research and development of various aspects of glass feeding techniques by Hartford. How much of such research were prior contracted is a crucial issue in our framework to analyse

Table 1

		Early Licensees			Late Licensee			t-value of the differ- ence
		\bar{x}	σ_x	n	\bar{y}	σ_y	n	
Firm Size	Small	111,424.6	46,896.1	10	109,251.3	51,053.1	7	.085
	All	1,138,209.4	2,874,568.7	19	638,566.8	1,270.651.8	16	.626
Rate of Growth (Mkt Share)	28 - 32 Small	-.03339	.1650	10	.0977	.1216	7	-1.680
	28 - 32 All	-.0057	.1308	19	.0784	.0937	16	-2.088
	34 - 38 Small	.1512	.2240	8	.0121	.0692	6	1.360
	34 - 38 All	.0722	.17726	17	.0480	.0719	17	.517
	28 - 38 Small	.0197	.1718	10	.0270	.0785	7	-.098
	28 - 38 All	.0199	.1297	19	.0670	.1151	18	-1.134

*Calculations based on Ex. G.C.A. 6088, Transcript, (1928-1939). Small firms are defined as those that shipped less than 200,000 gross in 1928 on the East Coast. West Coast firms were not included because economic conditions and development of the market were different. The "small firms" are manufacturers who did little or no research. "All firms" include medium and large size companies who did research and development to various extents.

patent licenses. Recall the Single Feeder and its predecessor P. N. Feeder, the patent licenses of the two machines look quite different. The Single Feeder licenses have a standard form for all licensees, each license differs only in terms of the type (and sometimes quantity) of glass wares permitted under the license. The P. N. Feeder license contains slightly different contractual clauses and its royalty rate differs from that of the Single Feeder. It also stipulates permitted types of glass wares.

The precommitment of future research were specified in both the Single and the P. N. Feeder licenses, but the scope of the precommitment seems narrower in the former than in the later license. In a P. N. Feeder license granted to Thatcher Co. in 1920, Section 11 states,

The Thatcher Co. shall during the term of such licenses be given the benefit of any/and all improvements upon the machines comprising said leased units which may be devised, developed or acquired by the Hartford...¹⁶

The term "improvement" had not been further specified. By contrast, the improvement clause in a typical Single Feeder license states,

The word "improvements" when used in this license and lease, shall be held to mean only (1) substitution of new parts for old parts of said leased machinery, or (2) changing old parts thereof, or (3) addition of new devices which are intended and adapted to become integral portions of such machinery, and not otherwise.¹⁷

The narrowing of the precommitment of future research as Hartford progressed from the P. N. Feeder to the Single Feeder is perfectly consistent with the prior contracting view. Hartford's patent position on feeding techniques was much stronger during the Single Feeder era because the validity of their patents have survived the testing in successive infringement suits and because extensive patent acquisitions have reduced competition among potential inventors. Based on our reasonings, the incentive to prior

¹⁶ Transcript, Ex. 231, p. 8907

¹⁷ Hearing before T.N.E.C., Part 2, Exhibit 120, Section 8. See also license from Hartford-Empire to Florida Glass Mfg. Co. (1935), T.N.E.C., Part 2, Exhibit 118.

contract is the strongest when the licensor's patent position is the weakest, for only then would the licensees be able to exert competitive pressure on the licensor in lowering his royalty price. This implies that the extent of precommitment of future development ought to be inversely related to the strength of the licensor's patent position. It is difficult to demonstrate this quantitatively in a case study. But one could easily imagine what would have happened had Hartford been able to contract with all the potential inventors. Our analysis predicts that the improvement clause in the patent licenses would be totally deleted in such situation.

An expected result which I have not observed among the data source has to do with the transitional stage when Hartford switched from the P. N. Feeder to the Single Feeder. According to the wording of the P. N. Feeder license, the Single Feeder may be interpreted as covered by the improvement clause as well. In fact, this was the interpretation of the Thatcher Mfg. Co., who had an exclusive right to produce milk bottles under the P. N. Feeder license.¹⁸ When the Single Feeder first appeared, this interpretation became controversial. Hartford did not want the exclusive right to carry over to the single feeder license. However, the fact that Thatcher did possess negotiation power and the fact that additional milk bottles licenses were very difficult for other glass manufacturers to obtain suggested that Hartford must honor Thatcher's interpretation to some degree. Other P. N. Feeder licensees' relationships with Hartford were not fully documented in the transcript. Based on the little evidence on hand, it was not known that any preferential treatment or discount had been given to the P. N. Feeder licensees when they switched to the single feeder.¹⁹

¹⁸ Testimony by Smith, pp. 2046 (or 1028). Transcript. See also Exhibit 231, 234, and 237 in the transcript.

¹⁹ An example of an early licensee switching from the P. N. Feeder to Single Feeder is the Carr-Lowrey Co. The officer in this company has not been called

to testify and its P. N. Feeder license was not included as an exhibit in the transcript. However, part of the single feeder license they obtained from Hartford was included as exhibit 1913 in the transcript which only gave the specification of wares allowed under the contract. I interpret this to mean that the rest of the contract were exactly identical to other single feeder licenses. The lack of the expected preferential treatment at the early licensees may have different reasons: Hartford may have reneged on their prior commitments because of the collusion scheme they have with other potential inventors. Alternatively, Hartford could have considered the invention of the single feeder as too drastic a departure from the P. N. feeding technique, see the distinction between anticipated and unanticipated innovations in Yu (1981) section II. Both explanations are suggestive and no further tests can be provided at this stage of my research.

(b) Penalty of Late licensees

The proposition that the early licensees can lower innovation price before the licensor has patented his innovation implies that the late licensees have to pay a higher price if they sign up after the licensor has strengthened his patent position. This implication is again difficult to be tested directly. The license fees of both the P. N. and the Single Feeder certainly exhibited a time path exactly opposite to the prediction. Namely, both the lump sum and the running royalty rates in the two feeders licenses were noted to have decreased rather than increased over time. (See Table II on the year a particular price component was cut). However, in analyzing the time paths, one must bear in mind that time is a proxy for more than one thing. Besides its use as an indication of the increasing strength of the patent position of the licensor, it also represents a gradual accumulation of information about potential inventors' (or models) superiority. Without such information, prior contracting will be infeasible as one might wind up signing up with an overly optimistic inventor. As pointed out in section I implication (a), it is not unusual that under such a situation, the necessary information have to be sorted out by price cutting among various potentials inventors (or models). I suspect that was what happened during the P. N. Feeder era when the art of feeding was most crowded.

The time path of the single feeder is more difficult to explain. When Hartford successfully marketed the machine and when competing inventors (alternative models) gradually surrendered (sold out) after 1923, information concerning the superiority of inventor (model) should be better known and prior contracting should be in force. This implies that the late licensees of single feeder should be paying a higher lump sum and/or royalty rate. However, evidences suggested the contrary, Hartford had maintained the same lump sum and the running royalty of single feeder from 1923 to 1935, with only a decrease in the lump sum around 1935, probably caused by a decrease in the cost of building

Table II

Types of Feeder	Year	License Fee (i.e. lump sum)	Royalty
P. N. Feeder	1916	\$5500	1st year \$2250. Thereafter standard sliding scale depending on bottles size starting at 8¢
	1918	6000	
	1920	4473	
	1926	4250	
Single Feeder	1923	\$2500	Sliding scale starting at 10¢ for bottles 2 oz. weight and under Rates on bottles over 2 oz. were the same, but add a sliding scale for bottles less than 2 oz. starting at 7.5¢ for bottles under 1/2 oz. wt. Same royalty rate
	1936	2500	
	1937	2000	

Based on Antitrust Transcript. Ex. H-5800

the Single Feeder.²⁰ The only late penalty I can detect is the infringement settlement a late licensees often have to pay. The magnitude of the penalty cannot be directly estimated because the settlement often included a transfer of the physical machinery of the alternative model from the licensees to the licensor. Since there were no information on the value of the physical machines transferred, the nominal amount specified in the settlement contract should be interpreted only as net figure. It ranges from \$150,000 (in the case of Ball Brothers Co.) to a negative \$22,000 (i.e. licensee got paid by selling the physical machineries to Hartford) in the case of Lamb Glass Co.²¹

Aside from the accounting difficulties in figuring the late penalty, our analysis of late penalties is subject to another caveat. Patent acquisitions and cross licensing arrangements of Hartford no doubt have signalled the comparative advantages of Hartford, and through a lowering of such information cost, the effect of prior contracting should be more obvious. But the same arrangements of Hartford also have the ill-effects of decreasing the underlying motive of prior contracting because competition among inventors would be reduced. In other words, while the transaction cost of prior contracting is lowered, the gain of prior contracting is also lowered. If the relative magnitudes of the two cannot be determined a priori, no prediction on the extent of late penalty can be made.

One puzzling aspect of the feeder licenses deserves some attention, and perhaps it reveals to some extent the intent of Hartford in charging a late penalty. Each feeder license specified the type (and sometimes quantity) of wares allowed to be produced by the licensees. The conventional interpretation of price discrimination does not seem to apply as Hartford has not charged

²⁰The construction cost of a feeder can be found in the Transcript.

²¹Exhibits 199 and 152, 153. Transcript.

different licensing fees for different glass wares. Furthermore, this practice was used in P. N. Feeder license as well as in Single Feeder license. The P. N. Feeder era, recalled from previous discussion, is one when Hartford had not yet completely dominated the field of feeding. The inclusion of such restrictions during this period of time suggested its motivation is probably not related to collusion.

An alternative explanation of the restrictive provision described has to do with Hartford's motive of charging a late penalty, i.e. price discrimination over time. If the early licensee have no limitation on the type and quantity of wares produced, a late licensee can avoid the late penalty by contracting with an early licensee through a merger agreement and the ability to charge a higher demand price to the late licensees will be destroyed. With types of wares specified into the contract, Hartford can refuse to extend a licensee's product line when evasion of the late penalty is the underlying motive. Testimonies in T.N.E.C. as well as the court transcript also suggested that the type wares specified is not truly "restrictive;" namely a licensee can request for additional wares or quantity, and they were usually granted.²³ It appeared that Hartford was using the restrictive clause as merely a safty-value.²⁴

c. Enforcement mechanisms for the inducement of future development

The single feeder license has a sump sum license fee of \$2500 (changed to \$2000 in 1936) and a "Standard royalty rate schedule" as shown in Table III. Obviously, the total royalty payment is a function of the size and the quantity

²³Milk bottles and fruit jars were the two exceptions.

²⁴See the testimony of Smith in T.N.E.C. pp. 401-415. Describing the policy as to what type of wares were allowed, he said, "But as a general licensing policy, when a manufacturer came to us for a license, we said, what have you been making? What would you like to license for?" And we would give him the license to make the particular glassware that he was manufacturing, selling, and marketing," p. 407. Elsewhere he described the general condition of the glass industry, "Now there are very few of the companies that make all kinds of ware. Many of the companies do a national business from coast to coast. Many are quite satisfied if they get a license from us to make three or four kinds of wares which is in a business that they know...and that is the license we give them..." p. 412.

Table III

RATES OF ROYALTY.

The weights below specified are the weights of the finished articles.

	<i>Blown or Pressed and Blown</i>	<i>Purely Pressed*</i>
	<i>Per Gross</i>	<i>Per Gross</i>
½ oz. wt. and under	7½ Cents	7½ Cents
Over ½ oz. wt. and not exceeding 1 oz. wt.	8 Cents	7½ Cents
Over 1 oz. wt. and not exceeding 1½ oz. wt.	9 Cents	7½ Cents
Over 1½ oz. wt. and not exceeding 2 oz. wt.	10 Cents	7½ Cents
Over 2 oz. wt. and not exceeding 4 oz. wt.	11 Cents	8¼ Cents
Over 4 oz. wt. and not exceeding 8 oz. wt.	12 Cents	9 Cents
Over 8 oz. wt. and not exceeding 12 oz. wt.	13 Cents	9¾ Cents
Over 12 oz. wt. and not exceeding 13 oz. wt.	14 Cents	10½ Cents
Over 13 oz. wt. and not exceeding 16 oz. wt.	15 Cents	11¼ Cents
Over 16 oz. wt. and not exceeding 20 oz. wt.	16 Cents	12 Cents
Over 20 oz. wt. and not exceeding 26 oz. wt.	18 Cents	13½ Cents
Over 26 oz. wt. and not exceeding 30 oz. wt.	21 Cents	15¼ Cents
	<i>Per Pound</i>	<i>Per Pound</i>
Over 30 oz. wt. and not exceeding 96 oz. wt.	¼ of a Cent	⅓ of a Cent
Over 96 oz. wt. and not exceeding 128 oz. wt.	⅓ of a Cent	¼ of a Cent

* — Purely Pressed, that is, produced by an operation which consists solely of pressing without the intervention of any air in the mold for the purpose of changing the shape of the article to be produced.

of glass bottles produced. As explained in early paragraphs, much of Hartford's post contractual development has the effect of increasing the speed of the feeder. The royalty rate is thus an incentive bonus--the licensor would be paid more if he made the machine to run faster.

The incentive function of the running royalty is not a pure conjecture. A study of the license of the single feeder's predecessor provides useful information on what the lump sum and the royalty supposed to represent. In the contract between Hartford and Thatcher in 1920, Section 3 stipulates the licensee fee (i.e. the lump sum),

The Thatcher Company agrees to pay to the Hartford Co. a license fee for each unit equal to the cost of the leased unit plus fifteen percent (15%) of said cost. Such cost shall be the actual and ordinary manufacturing cost incurred by the Hartford Company, including a reasonable overhead charge on that part of the cost incurred in the shop of the Hartford Company, but shall not include experimental or development cost as such, or the cost of designs and drawings. (emphasis added)²⁵

The P. N. Feeder also has a running royalty rate based on the quantity and sizes of the bottle produced. It appeared that the royalty was the only way by which Hartford can recoup its research and development expenditure. In the single feeder license, the same wording cannot be found, but it is likely that the underlying motive behind its payment structure was the same as that in the P. N. Feeder license.

The incentive role of a running royalty also implies its relative rigidity when the licensor competes with other inventors (or models) in cutting the overall package price of the license. As shown on Table II, the license fee of the P. N. Feeder varied over time and in general decreased while the royalty rate has remained the same during the period. In other words, the licensor has committed to a "quantity" of future development (and thus requiring

²⁵Exhibit 231, Transcript, (p. 17287 or 8907)

the same bonus payment), but competed to gain patronage by cutting "lump sum prices."

The incentive role of a running royalty also implies that the total royalty per feeder machine ought to increase over time as the machine becomes more and more efficient. An estimate of the total royalty per P. N. Feeder over time confirms the prediction, (see Table IV). Unfortunately, calculations cannot be made regarding the Single Feeder because royalty figures reported in the Transcript included all other feeders since 1923, and it is not possible to segregate the figure for the single feeder alone.

The leasing arrangement of Hartford's feeder provides still another clue to the enforcement mechanism adopted to induce future development. Unlike the owners of some other feeders, Hartford had never sold their feeders outright to the licensees. Such behaviors were considered by the Justice Department as most objectionable.²⁶ However, it is entirely possible that it is the licensees rather than the licensor who prefer the leasing arrangement. When a prior contract is signed, the licensee only gets a crude model with a promise by the licensor to further improve on it. If the licensee owns the machine outright, the licensor would have less incentive to honor the commitment since they have permanently parted with the machine. On the other hand, a leasing arrangement implies that the licensor retains partial ownership on the machine. Failure to deliver the expected improvement would decrease the value of the machine and thus provides the needed inducement for the committed future development.²⁷

²⁶The same arrangement was adopted by U. S. Machinery Corp. in the manufacturing of shoe and the IBM in the manufacturing of computer. Both were prohibited by the Justice Department. See *United States v. United Shoe Machinery Corp.* by Carl Kaysen (1956), the 1956 IBM Consent Decree in *U.S. v. IBM Corp.*, U. S. District Court, New York, Civil Action No. 72-344. In the *Hartford-Empire Case*, the consent decree requires Hartford to sell the machine outright to anyone at "reasonable prices."

²⁷The relationship between the leasing arrangement in conjunction with the unit royalty rate and R & D was also mentioned in Kaysen, *Ibid.*, pp. 190-91.

Table IV

(1) Year	(2) P. N. Feeders *	(3) Royalty **	(4) = (3)/(2) Royalty/Machine
1916	4		
1917	20	11,393	569.7
1918	39	81,689	2094.6
1919	46	135,964	2955.7
1920	64	237,901	3717.2
1921	73	288,576	3953.1
1922	74	330.438	4465.4

* From Ex H-5749 (or 15435)

** From Ex. 415 (p. 15088 or 7928A)

An alternative explanation to the leasing arrangement is the licensees' risk aversiveness towards the obsolescence of the machine. But this explanation is not totally independent from the one provided in the above paragraph. The risk of owning an obsolete machine increases if there are continuous improvements done on the machine. Since the licensor is the one that is doing the improvement, they must have better information about the probability distribution of future improvement than the licensees. Competitive free trade would thus result in the licensor (the more informed) bearing the risk even though both the contracting parties may have identical risk preference.

Conclusion

In this paper, I have demonstrated a case where the licensor of a patent license performed much post-contractual development. The glass industry between 1916 and 1940 has utilized sequentially and predominately two glass feeding principles--the P. N. Feeder and the Single Feeder. While considerable development on each machine were prior contracted, the Single Feeder did not appear to be covered by the license of his predecessor, the P. N. Feeder.

For the type of post-contractual development prior contracted, I have demonstrated the necessity of certain contractual provisions in patent licenses for its inducement. The analyses suggested an alternative way of viewing patent infringement prosecutions, the importance of examining the behaviors of the licensees, and the intention of the licensor to price discriminate over time. These considerations are uniquely implied by the theory of prior contracting, but have been hitherto neglected in past studies.

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