disclosure of such a remote act is, therefore, indirectly but effectually a disclosure of the criminal act itself. Since the Counselman case, it is admitted law that every person is protected by the Fifth Amendment against self-disclosures in any proceeding, civil or criminal, of such of his own acts as would subject either the actor or any connected with him to the dangers of incrimination. The constitutional guarantee puts a seal upon his personal knowledge that no legislative or judicial hand can break. The Judge says:

What was the real purpose of the Fifth Amendment? Did it intend to guarantee immunity thereby against compulsory self-accusation of crime so far as it might bring to the witness law-inflicted pains and penalties? Or was it to make the secrets of memory, so far as they brought one's former acts within the definitions of crime, inviolate as against judicial probe or disclosure? The Counselman case leaves this question undecided. So far as the Supreme Court of the United States is concerned I regard the opinion as an open one.

The case at bar inspires no wish in the Court to protect the witnesses. The Interstate Commerce act is a law of the land, and the witnesses ask for protection under the amendment under circumstances which in the case that, having violated it before, they had no intention to cease violating it now. It is the contest of people who disbelieve in the expediency of the law against the attempt to enforce it. Judged by this specific instance, the Fifth Amendment, if construed broadly enough to afford the witnesses immunity against testifying, is an obstruction in the path of the administration of law. . . . In my opinion, the privilege of silence against a criminal accusation guaranteed by the Fifth Amendment was meant to extend to all the consequences of disclosure.

The defectiveness of the statute of Feb. 11, 1893, might well be questioned on other ground. It is a statute of pardon. Until the witness makes his disclosure he is chargeable with the offence without his personal knowledge. The pardon becomes effective only at the moment and upon condition of disclosure. But pardon is not necessarily unilateral. No person is compelled to accept the legislative or executive grace.

In the case at bar it must be assumed that the witness is guilty of some offence. In the absence of the statute of Feb. 11, 1893, he has the undoubted constitutional right of silence. It is said that that right is taken away by the immunity of pardon extended by the statute. But he chooses not to accept such immunity, or pardon. He prefers to stand upon his constitutional rights, and take his chances of conviction, rather than expose himself to the civil liabilities and the odium of self-confessed crime.

Illinois Railroad Inspectors' Report.

Messrs. R. P. Morgan & Son, the engineers of the Illinois State Railroad & Warehouse Commission, have made their report, to be incorporated in the annual report of the commission which will soon be issued. A copy of the engineers' report has been sent to us, from which it appears that Messrs. Morgan have done a good service for the state, making a general inspection of the physical condition of all the railroads, though their report does not contain detailed facts concerning each road, like the inspector's report in New York state. Their inspection occupied four months, or from Aug. 1 to Dec. 6. The roads furnished them with quite full engineers' notes before they started, thus greatly facilitating their work. Reference is made to the roads which have been complained of as dangerous. Some of these have been referred to heretofore in the *Railroad Gazette*, and the special report of the engineers on them is merely referred to here. In several cases "immediate improvement was found necessary" and orders to that effect were complied with by the roads interested.

It is found that the roads in the northern part of the state have good ballast because gravel is abundant there, while in the southern part gravel is scarce, but sleepers are cheaper, so that the differences in condition partially offset each other. The length of railroads in Illinois now is 10,427 miles, of which 94 per cent. is laid with steel rails, 55 per cent. well ballasted and a considerable percentage in addition is partially ballasted.

The condition of signal structures, crossing signs, mile posts, etc., is found so shabby that sharp emphasis is laid on the necessity of taking more energetic measures to punish the malicious and mischievous defacement and destruction of such property. On some roads it is only with the greatest difficulty that the officers keep these fixtures in good order. The natural life of posts, outdoor signs, etc., is 10 or 12 years, but as a rule they have to be renewed every two or three years. The letter of a prominent railroad manager is quoted in which it is said that both repair men and detectives are kept busy on this matter. This manager has arrested 18 offenders in Illinois during the past year, for interfering with block signals, and he thinks there are many more who ought to be arrested.

The engineers discuss and commend block signaling. There are now over 400 miles of track (not miles of road) in Illinois equipped with block signals, and besides this there is a large mileage on which trains are blocked a station apart by the regular telegraph operators. Block signal apparatus is contemplated on 900 miles of track in the immediate future. The following statistics are given:

Block Signals in Illinois.

Style of signal.	Road.	No. of blocks.	Miles of track.
Hall	C., R. I. & P.	9	14
	C. & N. W.	206	180
	I. C.	138	91
Westinghouse electro-pneumatic	C., B. & Q.	17	10
	C. & N. P.	26	10
	C. & N. W.	38	18
Manual	C., B. & Q.	......	72
	C. & W. I.	......	16
	C., C., C. & St. L., St. Louis Div.	......	18
			429

To the 106 miles shown in the last three items should be added the large mileage blocked by telegraph operators, but it has been impossible to obtain complete information as to this mileage.

Laws requiring interlocked signals at crossings of one railroad with another were passed in Illinois in 1887 and 1891, and considerable progress has resulted. The engineers have held conferences with the chief engineers of railroads during the past year, with a view to revising the rules of the state concerning interlocking. Among the new rules adopted is one under which railroads present their plans for interlocking to the Commission previous to the commencement of work. The interlocking devices approved by the Commission are tabulated as follows:

Year approved.	No. of plants.	No. of working levers.
1889	7	66
1890	16	186
1891	8	145
1892	23	418
1893	39	1,182
Total	93	1,997

Eleven interlocking plants were reconstructed in 1893 and their capacity enlarged 110 levers. Many of these interlocking plants are at terminals and other places where the law does not require them, showing that the railroads fully appreciate the value of interlocking, aside from the action of the state. Plans have been approved for numerous interlocking machines to be constructed during the coming year, among which is one larger than any now in use in the state.

Rate of Combustion as Affecting Evaporation in Locomotive Boilers.*

In some sections of the United States there are large amounts of fine coal and slack that cannot be burned in the ordinary locomotive; and in such places here, as in Belgium, one finds a peculiar construction of locomotive fireboxes. In this country the most common type for fine coal is the Wootten. A new form, having a Belpaire top, has been proposed. It is not unlike that used in Belgium. The Wootten type of boiler has been

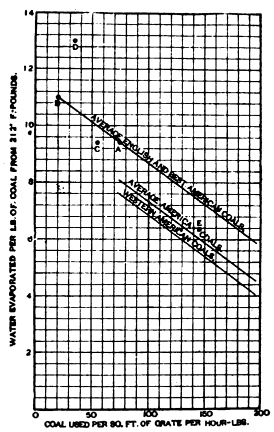

Fig. 1.

NOTE—A to B = English practice.
C = English coal as determined by Rankin.
D = English coal as determined by Kennedy and Donkin shop tests of a locomotive.
E = American coal — Brazil block — Indiana— Goss, at Purdue University shop tests.

very successful where there is a sufficient quantity of fine coal; but on some Western roads in the United States, where it has been tried, there has not been enough fuel to keep the engines supplied. Add this to the disadvantage of having to keep in stock two classes of fuel for engines at the same terminal, and the difficulties experienced with the large crown sheets, and the reasons are found for the infrequency of this type of firebox. . . . An increase in grate area, which is, of course, followed by a decrease in the rate of combustion of coal per square foot of grate per hour, is conducive to economy; but there is a limit to this increase, which cannot be exceeded without loss from incomplete combustion and excess of air supply through the grates. Large grates are difficult to cover properly, and if the fuel is free burning it is impossible to regulate the fire accurately, and much heat is lost by the blowing of the safety valves when the train is at a station or while descending grades.

The forcing of American locomotives, which results from the necessary policy of hauling heavy trainloads, is perhaps best illustrated by fig. 1, which shows the decrease of the evaporation of water per pound of coal in a locomotive boiler which accompanies an increase in the coal "used" per square foot of grate per hour. The term "used" is perhaps better than "burned," because much of the coal that is thrown into a locomotive firebox is not burned, but goes through the tubes in the form of cinder and smoke. This diagram is taken from many results obtained within the last three years on American railroads, during locomotive tests, where the coal used per square foot of grate per hour has varied from about 60 to nearly 200 lbs. That there is the marked decrease in evaporation accompanying an increase in the rate of coal used that is shown by the diagram is becoming well known here, and has recently led to a stronger conviction about the advantage of using large grate areas. In some recent tests of three locomotives, having different areas, it was found that the coal used per square foot of grate varied almost in an inverse proportion to the total area of the grates, and the water evaporated per pound of coal decreased with the increase of coal used almost exactly as shown on the diagram. This led to the conclusion at the time that the larger grate that could be put on a locomotive the greater would be the evaporation per pound of coal used, provided always that the grate does not exceed in size that which can be properly handled by the firemen. In some cases we have made the grates too large, but as a rule a good fireman can properly fire a furnace with a grate not exceeding 10½ ft. in length, and up to this length it is practicable to go. On roads where a deep firebox with a comparatively small grate has been used for a long time, the firemen object strongly to the introduction of a shallow firebox and a larger grate, as it requires more skill and attention.

On the coal diagram, there are three lines—one showing the evaporative power of Western American coal, such as is commonly used in the vicinity of Chicago and farther west; the next line gives a fair average of the coal used throughout the United States; the upper line shows the better quality of the best American and the average English coal. Perhaps the difference in the English and American coals is better illustrated by the points representing individual tests by Kennedy and Donkin, and the results obtained by Mr. Webb with the compound locomotive "Greater Britain." These points are considerably above the highest results from American locomotives using the best American coal (see the result obtained by Professor Goss during the Purdue University shop tests of a locomotive). The continuation of the upper line on the diagram from *A* to *B* illustrates the difference in the way in which locomotives are worked here and in foreign countries. It is not common, except in the United States, to use over 70 lbs. of coal per square foot of grade per hour. The difference between the evaporation per pound of coal used from *A* to *B* and that given on the line representing the average American coal, shows how much greater is the efficiency of boilers operated without forcing than under the American plan of operation. The average evaporation per pound of coal used throughout the United States is not over 5½ lbs. of water from and at 212 deg., while that in foreign countries, when operated between the limits *A* and *B* on the diagram, and which is taken to be the average work, is nearly 10 lbs. These figures correspond to a considerable difference in coal used per square foot of grade per hour; namely, 150 lbs. for the American and about 50 for the foreign.

There is such a wide difference in the evaporating power of the coals found in various parts of the earth that a comparison of the performance of locomotives using different fuels is well-nigh impossible without a full knowledge of the chemical composition of the fuel used and a practical knowledge of its mechanical action in a locomotive firebox. Coals having much moisture and a large percentage of ash made up of fusible silicates do not give results in evaporation that would be expected from an examination of the chemical composition; and coals having the same percentage of hydrogen, carbon, oxygen, etc., do not necessarily give the same results in evaporation; hence, a practical knowledge of the value of various fuels in locomotive boilers is absolutely necessary before a fair comparison can be made of the relative performance of different engines under otherwise equal conditions.

The varieties of coal in common use and the wide difference in composition may be seen from Table C, but, unfortunately, the real value of the fuels in practical operation cannot be learned from this table, owing to the lack of data recorded by the different experimenters. What is lacking is the real evaporative power of the fuel under equal conditions, and there is much merit in the proposition recently made by one of our engineering societies, to establish a central testing station, with a standard boiler operated under standard conditions, for the purpose of dertermining the relative value of various fuels.

Perhaps fig. 1 illustrates as well as need be the reason for the greater economy of foreign locomotives under the conditions of average operations. Of course, if the foreign engines were to be forced so much that the coal used per square foot of grate would increase from 50 to 150, the evaporation would drop from 10 to 7½; and if the coal used on English engines were no better than that used here, the evaporation would certainly drop to less than 6 lbs. of water per pound of coal, the same as for the American locomotive. Although there is evidently a waste of coal on the American plan of operating locomotives, yet, as has been shown, there is a gain by doing this. Perhaps the following approximate estimate made up for such accurate data as is now available will give a sufficiently close comparison of the coal used in the best foreign and the best American passenger train service, average coal being taken in both cases:

Country.	Total train. Weight, tons.	Coal per ton-mile of total train.	Coal used per square foot grate per hour.	Water evaporated per pound of coal from 212° Fahr.	Coal per ton-mile of passenger cars.
Foreign	220	.12 lbs.	60 lbs.	9½ lbs.	.182 lbs.
United States	400	.15 "	110 "	6½ "	.191 "

This comparison shows how little is the difference in the weight of coal used per useful ton-mile here and abroad, under about the same conditions even when no allowance is made for the difference in the quality of the coal. What this difference in quality amounts to can be seen by an inspection of fig. 1, on which lines are drawn for the average American and average English coals. With the same coal for both typical locomotives, the American practice of heavy train loads would result in less coal per useful ton-mile. In the United States, wages and train expenses other than for coal are so comparatively great as to leave no choice in train practice, and railroads are compelled to condense the passenger traffic into heavily loaded passenger trains run at long intervals in order to pay expenses. There are a few cases here where lighter trains than the average can be run with profit, such as between New York City and Philadelphia; but even there the trains must be heavier than the average foreign train, as more passengers must be carried per train to pay the greater cost of wages and other train expenses. Where parlor and sleeping cars are run, the greater weight of train per passenger also causes heavier train loads.

There are many other conditions in this country that compel heavy passenger as well as heavy freight trains, and particularly is this true for through trains where the distances are long and the trains cannot be run fre

* Extract from a paper by D. L. Barnes on "Distinctive Features and Advantages of American Locomotive Practice," before Civil Engineering Section World's Engineering Congress, August, 1893.