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M. F. WALSH, *Director*
DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief, Urbana*

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PRELIMINARY SUMMARY OF RESULTS OBTAINED FROM A SURVEY OF REPRESSURING OPERATIONS IN THE SOUTHEASTERN ILLINOIS OILFIELD

By Alfred H. Bell and Frederick Squires

Introduction

As a first step in a program of studies looking toward increased recovery of oil in producing fields, the Illinois State Geological Survey, at the request of the Illinois-Indiana Petroleum Association, undertook an investigation of the air and gas repressuring operations already under way in the Southeastern Illinois oilfield. In view of the probability that repressuring operations will be given much attention by operators and engineers, this preliminary summary is being issued before the detailed studies are completed. The geologic, engineering, and economic aspects of repressuring will be discussed in a later more detailed report.

The Survey is indebted to many oil companies for their generous cooperation in supplying data used in this report. The field data on repressuring have been collected by Mr. Frederick Squires. Dr. R. J. Piersol, Physicist of the Survey staff, has been consulted frequently during the course of the investigation and has contributed valuable suggestions in the preparation of the manuscript. Assistance in assembling some of the data for the report was given by Messrs. Perry S. McClure and Walter B. Roe, both of the Survey staff.

Location and Extent of Repressuring

Repressuring has been tried on more than 107 leases in the Southeastern Illinois oilfield (Table 1, Figs. 1 and 2) of which 77 have yielded increased production for one year or more. The repressured leases have a total area of 11,049 acres, of which it is estimated that 3,488 acres have been affected by repressuring. This represents only about 3.6 per cent of the total productive area of the field. Out of the 3,488 acres, increases in production for one year or more were obtained on 2,548 acres or 73 per cent. The total number of input wells was 126, of which 93 were on leases that yielded increased production. Out of 613 pumping wells which were affected, 458 wells or 75 per cent yielded increased production.

TABLE I *Index of Repressured Properties in Southeastern Illinois Oilfield*
(See Figs. 1 and 2)

Lease Index No.	Sec.	T-N	R-W	Township	County	Company	Lease	Acres Total	Acres Affected	No. Pressure wells	Pumping wells Total	Pumping wells Affected	Years re-pressured
						SAND REPRESSURED—"WESTFIELD LIME"							
1	5	11	14	Parker	Clark	Ohio Oil Co.	Drake Heirs	160	20	1	12	6	'22-'22
2	7	11	14	Parker	Clark	Associated Producers	Dorsey	200	30	1	25	6	'28-'30
3	20	11	14	Parker	Clark	Dinsmoor Oil Co.	J. T. Linn	80	20	1	16	6	'22-'23
						Total for Westfield lime		440	70	3	53	18	
						SAND REPRESSURED—"SIGGINS"							
4	13	10	10 E	Union	Cumberland	Bell Bros.	Queen	80	20	1	39	6	'28-'30
4 A	25	10	10 E	Union	Cumberland	Dinsmoor	Arney	50	10	1	15	3	'27-'27
5	13	10	10 E	Union	Cumberland	Ohio	Chrystler	30	30	1	5	5	
6	18	10	14	Casey	Clark	Dinsmoor	Fuqua	100	80	2	15	15	'22-'32
						Total for Siggins sand		260	140	5	74	29	
						SAND REPRESSURED—"CASEY"							
7	22-23	10	14	Casey	Clark	Kewanee Oil & Gas Co.	McDaniels	80	40	1	16	9	'31-
8	22-23	10	14	Casey	Clark	W. C. McBride, Inc.	Short	120	90	3	13	9	'28-
9	25-26	10	14	Casey	Clark	W. C. McBride, Inc.	Rush	240	35	1	7	4	'21-'21
10 A	26	10	14	Casey	Clark	Dinsmoor	Mumford	40	40	1	11	11	'21-
B	2	9	14	Casey	Clark	Dinsmoor	English	40	40	2	16	16	'25-
C	2	9	14	Casey	Clark	Dinsmoor	Smith	80	80	6	16	16	'22-
D	3	9	14	Casey	Clark	Dinsmoor	Heim	80	70	1	9	9	'22-
E	2	9	14	Casey	Clark	Dinsmoor	Phillips	13	13	1	2	2	'22-
10 (B-E)				Casey	Clark	Dinsmoor		213	203	10	43	43	
11 A	7-18	9	13	Orange	Clark	Ohio-Remlik	Seaton	40	5	0	3	2	
B	7-18	9	13	Orange	Clark	Ohio-Remlik	Phillips	20	15	1	2	2	
C	7-18	9	13	Orange	Clark	Ohio-Remlik	Newlin	80	15	1	5	4	
11 (total)								140	35	2	10	8	'25-'29
12	34	9	14	Johnson	Clark	Remlik Oil Co.	Snearly	80	30	2	10	10	'23-
13 A	11	8	14	Licking	Crawford	Ohio-Dinsmoor	S. Smith	30	20	0	14	9	
B	11	8	14	Licking	Crawford	Ohio-Dinsmoor	J. A. Smith	20	20	1	6	6	
C	11	8	14	Licking	Crawford	Ohio-Dinsmoor	E. Wyman	20	20	1	7	5	
D	11	8	14	Licking	Crawford	Ohio-Dinsmoor	J. Payne	20	10	0	11	3	
13 (total)								90	70	2	38	23	'24-
						Total for Casey sand		1,003	543	22	148	117	
						SAND REPRESSURED—"ROBINSON"							
14	17-20	8	12	Prairie	Crawford	Associated	Newlin & Cox	280	70	2	22	11	'28-'30
15 A	23-24	8	13	Prairie	Crawford	Bell Bros.	Hill	160	15	1	11	5	'28-
B	24	8	13	Prairie	Crawford	Bell Bros.	Johnson	80	20	1	9	3	'29-'30
15 (total)								240	35	2	20	8	

16	1	7	14	Licking	Crawford	Remlik	Kraft-Rhine	120	20	3	9	5	'22-	
17 A	13	7	14	Oblong	Crawford	Charles Grace	M. C. Lefever	15	15	1	4	3		
B	13	7	14	Oblong	Crawford	Associated	Lefever & Stifle	110	15	0	13	3		
17 (total)								125	30	1	17	6	'29-	
18 A	3	7	13	Prairie	Crawford	Arkansas Fuel Oil Co.	J. V. McClane	40	3	0	3	1		
B	3	7	13	Prairie	Crawford	Arkansas Fuel Oil Co.	I. Ikemire	80	6	1	8	1		
C	3	7	13	Prairie	Crawford	Arkansas Fuel Oil Co.	W. Evans	40	6	0	5	1		
18 (total)								160	15	1	16	3	'29-	
19	7	7	13	Oblong	Crawford	Brenneman & McDonnel	Condry	240	5	1	23	1	'28-	
20	8	7	13	Oblong	Crawford	Stranahan & Cheuvront	N. Reed	40	20	1	6	3	'29-'31	
21 A	4	7	13	Licking	Crawford	Dinsmoor	S. Wilkin	40	30	1	2	2	'24-	
B	8	7	13	Oblong	Crawford	Kewanee	C. Headley	153	30	1	26	7	'30-	
C	9	7	13	Oblong	Crawford	Dinsmoor	Grogan	40	40	1	7	7	'22-	
D	8	7	13	Oblong	Crawford	Kewanee	S. P. Headley	60	20	1	13	4	'30-	
E	8	7	13	Oblong	Crawford	Associated	C. M. Stifle	150	20	1	31	5	'32-	
F	9	7	13	Oblong	Crawford	Dinsmoor	S. Henry	40	40	1	6	6	'22-	
G	9	7	13	Oblong	Crawford	Dinsmoor	Ed. Henry	63	10	0	3	2	'23-	
H	9	7	13	Oblong	Crawford	Dinsmoor	T. Randolph	10	10	0	2	2	'24-	
I	9	7	13	Oblong	Crawford	Dinsmoor	J. E. Wilson	40	20	1	7	4	'22-	
21 A-I (total)								596	220	7	97	39		
J	16-17	7	13	Oblong	Crawford	Associated	C. & J. J. Wilkin	160	55	3	21	9	'29-'30	
K	17	7	13	Oblong	Crawford	Associated	M. Drake	80	30	1	15	4	'29-'30	
L	21	7	13	Oblong	Crawford	Dinsmoor	H. M. Wilson	40	20	1	7	3	'22-	
22	13	7	13	Robinson	Crawford	Bell Bros.	Eaton	40	40	1	7	3	'29-	
23	18	7	13	Oblong	Crawford	Associated	Clark	80	15	1	11	2	'32-	
24 A	28	7	13	Oblong	Crawford	Associated	Viola Dees	220	110	2	22	13	'28-	
B	28	7	13	Oblong	Crawford	Dinsmoor	Charles E. Henry	40	20	2	5	5	'22-	
C	28	7	13	Oblong	Crawford	Niagara Oil Co.	L. Newlin	28	20	2	4	2	'23-	
D	27	7	13	Oblong	Crawford	Niagara Oil Co.	Barrick	160	5	0	5	1	'25-	
24 (total)								448	155	6	36	21		
25	29-30	7	13	Oblong	Crawford	Niagara	Dennis-Frazer	160	20	1	42	3	'28-	
26	31-32	7	13	Oblong	Crawford	Mallory & Crawford	Dee	40	10	1	8	1	'27-	
27	33-34-27	7	13	Oblong	Crawford	Ohio	Woodworth	1,160	135	3	74	11	'28-	
28 A	7	7	12	Robinson	Crawford	Dinsmoor	Hall	80	55	2	16	10		
B	1	7	13	Robinson	Crawford	Dinsmoor	Barlow	90	50	1	8	6		
28 (total)								170	105	3	24	16	'23-	
29 A	9	7	12	Robinson	Crawford	Associated	Meserve	350	220	6	41	32		
B	9	7	12	Robinson	Crawford	Associated	S. M. Lloyd	120	10	0	8	7		
C	9	7	12	Robinson	Crawford	Associated	Crowley	30	10	0	3	2		
D	9	7	12	Robinson	Crawford	Ohio	Jones	40	20	1	6	4		
E	9-10	7	12	Robinson	Crawford	Associated & Wilson	Conrad	100	70	2	20	19		
F	10	7	12	Robinson	Crawford	Associated & Wilson	Sankey	60	30	1	9	9		
G	10	7	12	Robinson	Crawford	Associated & Wilson	Austin	140	80	5	15	12		
H	10	7	12	Robinson	Crawford	Associated	L. Newlin	80	30	1	4	4		
I	10	7	12	Robinson	Crawford	Associated	J. D. Lloyd	20	2	0	1	1		
J	10	7	12	Robinson	Crawford	Associated & Wilson	M. Newlin	36	28	1	5	5		
K	10	7	12	Robinson	Crawford	Associated	Cox	18	5	0	2	2		
L	10	7	12	Robinson	Crawford	Associated	Simpson	120	20	0	3	3		
M	11	7	12	Robinson	Crawford	Associated	Correll	120	80	4	11	11		
N	11	7	12	Robinson	Crawford	Associated	Jordan	27	5	0	2	2		
O	11	7	12	Robinson	Crawford	Associated	Conrad	13	5	0	1	1		
P	2-3	7	12	Robinson	Crawford	Associated	A. Correll	80	5	0	2	2		
29 (total)								1,354	620	21	133	116	'26-	
30	18	7	12	Robinson	Crawford	Ohio	Wilson	120	30	1	28	8	'28-	
31	30-31	6	11											
	36	6	12	Honey Creek	Crawford	Selby-Cisler Producing Co.	Ewing group	630	120	3	65	18	'27-'27	
	1	5	12											
	6	5	11											

TABLE 1—*Index of Repressured Properties in Southeastern Illinois Oilfield—Continued*

Lease Index No.	Sec.	T-N	R-W	Township	County	Company	Lease	Acres Total	Acres Affected	No. Pressure wells	Pumping wells Total	Pumping wells Affected	Years re-pressured
32	6	6	12	Honey Creek	Crawford	Warner-Caldwell	Jones group	540	40	2	52	8	'30-'31
33 A	20	6	12	Honey Creek	Crawford	Toomey & Bryan	Mills	80	15	1	2	2	
B	20	6	12	Honey Creek	Crawford	Toomey & Bryan	Highsmith	40	35	1	6	6	
33 (total)								120	50	2	8	8	'22-
34 A	5	6	13	Oblong	Crawford	Brenneman & McDonnel	O. B. Kirtland	100	65	1	20	11	'27-
B	5	6	13	Oblong	Crawford	Brenneman & McDonnel	D. P. Kirtland	20	5	0	6	2	'24-
C	5	6	13	Oblong	Crawford	Brenneman & McDonnel	O. Dee	40	20	0	10	4	'27-
D	5-6	6	13	Oblong	Crawford	Brenneman & McDonnel	Ziegler	40	30	1	11	7	'25-
E	6	6	13	Oblong	Crawford	Brenneman & McDonnel	Sarah Dee	40	10	0	9	2	'27-
F	5-6	6	13	Oblong	Crawford	Brenneman & McDonnel	Weigkenman	40	30	1	8	5	'27-
34 (total)								280	160	3	64	31	
35	8	6	13	Oblong	Crawford	Kewanee	Shilts	80	60	1	11	9	'29-
36 A	8-9	6	13	Oblong	Crawford	Dinsmoor	O. B. Kirtland	80	20	1	5	3	
B	9	6	13	Oblong	Crawford	Dinsmoor	Rhodes	20	10	1	1	1	
C	9	6	13	Oblong	Crawford	Dinsmoor	Wilson Heirs	40	15	0	6	4	
36 (total)								140	45	2	12	8	'28-
37	16	6	13	Oblong	Crawford	Dinsmoor	Dewey	60	60	2	9	9	'22-
38	17-20	6	13	Oblong	Crawford	Kewanee	Baldwin	120	40	1	8	8	'29-
39 A	27	6	13	Martin	Crawford	Dinsmoor-Ohio	Hughes	80	55	1	21	12	'22-
B	27	6	13	Martin	Crawford	Ohio	C. Dennis	100	20	½	24	5	'27-
C	27-34	6	13	Martin	Crawford	Ohio	J. Dennis	80	20	½	15	3	'29-
D	27-34	6	13	Martin	Crawford	Associated	Dennis (No. 1)	80	20	1	18	7	'32-
E	28	6	13	Martin	Crawford	Dinsmoor-Ohio	Tohill	60	20	½	9	3	'28-
F	28-33	6	13	Martin	Crawford	Dinsmoor-Ohio	Linsey	160	15	½	12	3	'29-
G	34	6	13	Martin	Crawford	Dinsmoor-Ohio	Thomas	80	40	1	9	6	'28-
39 (total)								640	190	5	108	39	
40	2	5	13	Martin	Crawford	Associated	Joe Due	40	25	1	7	3	'32-
41	9	5	12	Honey Creek	Crawford	Bell Bros.	Darone	160	35	1	6	5	'30-
42-A	10-15	5	11	Montgomery	Crawford	Remlik	P. Ford	113	30	2	7	7	'22-
B	10-15	5	11	Montgomery	Crawford	Remlik	Dickenson	45	20	2	3	3	'23-
42 (total)								158	50	4	10	10	
43	20	5	11	Montgomery	Crawford	Ohio	A. Montgomery	120	35	1	19	4	'22-
44	7	5	10	Montgomery	Crawford	Remlik	Goodwin	220	50	3	3	3	'26-
45	29	4	11	Bond	Lawrence	Remlik	Ford Heirs	80	10	1	3	1	'29-'30
46	30	4	11	Bond	Lawrence	Dinsmoor	Gillen	45	10	1	7	1	'28-'30
						Total for Robinson sand		9,086	2,630	94	1,008	438	
						SAND REPRESSURED—"KIRKWOOD" AND "TRACEY"							
47	36	3	12	Dennison	Lawrence	Bruner & Abbott	Gee-Dining	160	40	1	16	4	'31-
						SAND REPRESSURED—"BIEHL"							
48	3	1	12		Wabash	Jas. Toomey	L. Courter	100	65	1	9	7	'27-
						Total for all sands		11,049	3,488	126	1,308	613	

According to reports recently received, repressuring has been in operation on a few leases in the Southeastern Illinois oilfield in addition to those listed in Table 1, but data concerning them have not yet been collected. These include the following:

Lease	*Sec.*	*T.*	*R.*	*Twp.*	*County*
Lennox	22-23	10 N.	4 W.	Casey	Clark
Swenke	23	7 N.	13 W.	Oblong	Crawford
Spawn	28	8 N.	13 W.	Prairie	Crawford
Smith	3	1 N.	12 W.	Wabash	Wabash
Montgomery No. 1	21	5 N.	11 W.	Montgomery	Crawford

Repressuring Equipment

The equipment used for repressuring in the Southeastern Illinois oilfield is described in Tables 2 and 3. In most cases it was not designed for this particular work but has been adapted from existing machinery and plants. Many of the compressors (Table 2) were originally used for the extraction of natural-gas gasoline but were later used for repressuring by connecting them with certain wells which were chosen as input wells. In some cases compressors have been used at the same time for the extraction of gasoline and for forcing gas into the oil sand; in others the extraction of gasoline was discontinued when the compressor began to be used for repressuring.

Because many of the compressors were originally designed for other uses, it is quite probable that some of them are not adequate or are not suitable for the particular repressuring operation for which they are now used. Many of them however have given satisfactory results. Many additional gasoline plant compressors in the Southeastern Illinois oilfield might at some future time be used for repressuring, or at least for experimentation before new equipment is purchased.

Many of the engines (Table 3) which drive the compressors also drive other equipment and therefore the estimated horse power used by each compressor has been listed (Table 2).

The concensus of opinion among engineers and operators of repressuring plants is that, for several reasons, natural gas is superior to air as a repressuring medium, and it therefore seems advisable to use gas in preference to air wherever it is available. This is being done in the Southeastern Illinois oilfield (Table 2).

For the purpose of obtaining the greatest ultimate recovery of oil, careful conservation of natural gas is very important. Thus, the practice of returning the excess tail gases from gasoline plants to the oil sand rather than burning them is to be commended. Even though the immediate rate of oil production may not be materially increased, there is little doubt that a greater ultimate recovery of oil will be made possible. A further and obvious reason for conserving gas is for use as fuel in engines.

TABLE 2—*Data on Compressors used on Repres-*

(Leases are de-

Lease Index No. (Table 1)	Manufacturer	Bore and Stroke P = Portable D = Direct E = Oil-engine driven S = Single acting	Piston Displacement in cu. in. per one way stroke	Observed R. P. M.	Calculated delivery in cu. ft. per minute	Rated delivery in cu. ft. per minute
1	Ingersoll-Rand, Inc.	8½ & 4½×10	567.	190	124.6	123.
2	Ingersoll-Rand, Inc.	5½ & 2¾× 5 (P)	118.6	875	60.	60.
	Ingersoll-Rand, Inc.	8½ & 4½×10 (P)	567.	190	124.6	123.
3	Pattin Brothers Co.	8 & 4×14 (D)	703.7	180	146.5	117.2
4	Gardner-Denver Co.	6 & 3× 6	169.6	240	47.1	36.
5	Kite Gasoline Plant					
6	Gardner-Denver Co.	8 & 4× 6	301.5	150	52.3	40.
7	Ingersoll-Rand, Inc.	5½ & 2¾×5 (P)	118.6	875	60.	60.
8	Ingersoll-Rand, Inc.	4½ & 2×4½	71.50	348	28.7	
9						
10	Pattin Brothers Co.	9½ & 5×14 (D)	992.18	180	208.1	166.4
	Ingersoll-Rand, Inc.	10½×12 (E)	1,036.6	160	191.9	192.
11	Ingersoll-Rand, Inc.	6 & 3½×6	169.6	300	58.8	56.
12	Bessemer Gas Engine Co.	8×16 (D)	804.2	180	167.5	75.3
13	Ingersoll-Rand, Inc.	8½×10	567.	190	124.6	123.5
	Ingersoll-Rand, Inc.	8½×10	567.	190	124.6	123.5
14	Ingersoll-Rand, Inc.	5½ & 2¾×5 (P)	118.6	875	60.	60.
15	Gardner-Denver Co.	6 & 3×6	169.6	240	47.1	36.
16	Gardner-Denver Co.	6 & 3×6	169.6	100	19.5	15.
17	Gardner-Denver Co.	6 & 3×6	169.6	200	39.2	30.
18	Bessemer Gas Engine Co.	11 & 5½×18 (D)	1,710.5	180	356.3	
19		4×4 (S)	50.26	100	2.9	
20	Gardner-Denver Co.	6 & 3×6	169.6	200	39.2	28.
21B	Ingersoll-Rand, Inc.	8½ & 4½×10	567			
E	Ingersoll-Rand, Inc.	8½ & 4½×10	567.	220	144.3	143.
F	Pattin Brothers Co.	11 & 6½×14 (D)	1,330.4	180	277.1	221.6
	Pattin Brothers Co.	10½ & 6½×14 (D)	1,208.1	180	251.6	200.8
J	Ingersoll-Rand, Inc.	8½ & 4½×10	567.	220	144.3	143.
22	Gardner-Denver Co.	6 & 3×6	169.6	240	47.1	36.
23	Gardner-Denver Co.	6×6	169.6	265	52.	
24A	Gardner-Denver Co.	6×6	169.6	180	35.3	29.4
B	Gardner-Denver Co.	6 & 3×6	169.6	150	29.4	24.
	Gardner-Denver Co.	6 & 3×6	169.6	150	29.4	24.
C	Gardner-Denver Co.	6×6	169.6	250	49.	36.
25	Gardner-Denver Co.	6×6	169.6	250	49.	36.
26	Ingersoll-Rand, Inc.	8½×10	567.	220	144.3	143.
27	Gardner-Denver Co.	6 & 3× 6	169.6	200	39.2	28.
28	Pattin Brothers Co.	8 & 4×14 (D)	703.7	180	146.5	117.2
29	Clark Brothers Co.	15 & 6½×20	3,534.	180	736.2	368.1
	Clark Brothers Co.	15 & 6½×20	3,534.	180	736.2	368.1

sured Properties in Southeastern Illinois Oilfield

scribed in Table 1)

Ratio of rated to calculated delivery	Calculated vol. in cu. ft. per 24 hrs.	Rated vol. cu. ft. per 24 hrs.	Actual delivery[a], cu. ft. per 24 hrs. M=Measured E=Estimated	Pounds per sq. in. line pressure	Approximate H. P. for Compressor	Original purpose of plant P=Repressuring G=Gasoline	Pressure Medium A=Air G=Gas	No. input wells	No. producing wells affected
.987	179,424	177,091	125,000 E	60	15	P	G	1	6
1.00	86,400	86,400	Idle					1	6
.987	179,424	177,091	125,000 M	30	12	P	A-G	1	6
.80	210,960	168,768	90,000 M	200	60—	P	A	1	6
.76	67,824	51,546	20,000 E	160	15—	G	G	1	6
				130		G	G	1	5
.764	75,312	57,538	10,000 E	60	15—	G & P	A-G	2	15
1.00	86,400	86,400	30,000 M	80	16.5—	P	G	1	9
	41,457			40	5	P	A	3	9
								1	4
.80	299,664	239,731	Idle		60—				
1.00	276,336	276,480	200,000 E	60	24—	P & G	A-G	11	54
.952	84,662	80,598	52,000 M	180	11—	P	A	2	8
.45	241,200	108,540	80,000 M	125	20	P	A-G	2	10
.99	179,424	177,629	30,000 M	30	11.25	G	A-G	2	23
.99	179,424	177,629	Idle						
1.00	86,400	86,400	29,000 M	140	16.5—	P	G	2	11
.76	67,824	51,546	17,000 E	160	12	G	G	2	8
.769	28,080	21,593	20,000 M	180	12	P	A-G	3	5
.765	56,448	43,182	28,000 M	180	12	G	G	1	6
	513,072		20,000 M	65	15—	G	G	1	3
	4,176		2,000 E	10		G	G	1	1
.714	56,448	40,303	18,000 M	300	15	G	G	1	3
			19,000 M	120	30—	G	G	2	11
.99	207,792	205,715	30,000 M	100	40	G	G	1	4
.80	399,024	319,219	30,000 E	40	90—	P & G	G		
.80	362,304	289,843	90,000 E	100	90—	P & G	A	5	26
.99	207,792	205,714	36,000 M	220	40	G	G	4	13
.76	67,824	51,546	15,000 E	160	12	G	G	1	3
	74,880		33,000 M	75	12	G	A	1	2
.83	50,832	42,190	27,666 M	93	12	G	A-G	2	13
.816	42,336	34,709	30,000 E	115	12	G	A-G	2	5
.816	42,336	34,709	30,000 E	115	12	G	A-G		
.736	70,560	51,932	20,000 E	80	12	P	A-G; now A	2	3
.736	70,560	51,932	20,000 E	100	12	P	A	1	3
.99	207,792	205,714	40,000 E	10		G	A	1	1
.714	56,448	40,303	20,000 E	300	12	P	A	3	11
.80	210,960	168,768	80,000 E	75	60—	G & P	G	3	16
.471	1,060,128	500,000	475,000 M	227	190—	P	A	21	116
.471	1,060,128	500,000	Idle						

TABLE 2—*Data on Compressors used on Repressured*

(Leases are de-

Lease Index No. (Table 1)	Manufacturer	Bore and Stroke P=Portable D=Direct E=Oil-engine driven S=Single acting	Piston Displacement in cu. in. per one way stroke	Observed R. P. M.	Calculated delivery in cu. ft. per minute	Rated delivery in cu. ft. per minute
30	Ingersoll-Rand, Inc.	8½ & 4½×10	567.	140	91.8	91.
31	Pattin Brothers Co.	9½ & 5×14 (D)	992.18	180	206.6	165.28
32	Worthington	7½ & 3¾×6	264.8	250	76.6	
33	Gardner-Denver Co.	8 & 4×6	301.5	150	52.3	40.
34	Ingersoll-Rand, Inc.	10×10	785.	130	118.1	117.
35	Worthington	6½×6	198.8			
36	Bessemer Gas Engine Co.	7 & 3¾×10	384.8	100	44.5	35.
37	Kuntz & Smith Co.	6×12	339.2	120	47.1	
	Ingersoll-Rand, Inc.	10×10	785.4	120	109.	108.
38	Ingersoll-Rand, Inc.	5× 8	157.			
39A	Pattin Brothers Co.	10×14 (D)	1,099.5	180	229.	183.2
	[illegible]	8 & 4×14 (D)	703.7	180	146.5	117.2
D	Gardner-Denver Co.	8×6	301.5	200	69.7	
40	Gardner-Denver Co.	6×6	169.6	180	35.3	
41	Ingersoll-Rand, Inc.	6×6	169.6			
42	Gardner-Denver Co.	6 & 3×6	169.6	200	39.2	33.
43	Gardner-Denver Co.	6 & 3×6	169.6	200	39.2	33.
44	Ingersoll-Rand, Inc.	6 & 3½×6	169.6	200	39.2	37.2
45	Ingersoll-Rand, Inc.	6 & 3½×6	169.6	100	19.5	18.6
46	Gardner-Denver Co.	6 & 3×6	169.6	225	44.1	35.
47	Ingersoll-Rand, Inc.	8½ & 4½×10	567.	220	144.3	143.
48	Gardner-Denver Co.	8×8	402.1	160	74.4	74.

[a]Actual delivery regulated according to need.

Properties in Southeastern Illinois Oilfield—Continued

scribed in Table 1)

Ratio of rated to calculated delivery	Calculated vol. in cu. ft. per 24 hrs.	Rated vol. cu. ft. per 24 hrs.	Actual delivery*, cu. ft. per 24 hrs, M=Measured E=Estimated	Pounds per sq. in. line pressure	Approximate H. P. tor Compressor	Original purpose of plant P=Repressuring G=Gasoline	Pressure Medium A=Air G=Gas	No. input wells	No. producing wells affected
.99	132,192	130,870	90,000 M	50	20—	G	A	1	8
.80	297,504	238,003	118,944 E	60	60—	P	A	3	18
	110,304		30,000 M	250	20—	P	A	2	8
.764	75,312	57,538	30,000 E	125	12	G	G	2	8
.99	170,064	168,363	156,000 M	50	11	G	G	3	31
			36,000 M	23		G	A & G	1	9
.79	64,080	50,623	12,000 E	80		P	A & G	2	8
	67,824		50,000 E	175	75	P	A & G	2	9
.99	156,960	155,390	10,000 E	40	11.5		G		
			10,000 M	80		G	A & G	1	8
.80	329,760	263,808	10,000 E	10	90—	P	G	4	32
.80	210,960	168,768	42,000 E	125			A & G		
	100,368		24,000 M	20	21	P	G	1	7
	50,832		33,000 M	40	8	P	A	1	3
			20,000 M	70	8	P	A & G	1	5
.841	56,448	47,472	40,000 M	75	12	P	A	4	10
.841	56,448	47,472	10,000 M	70	12	P	A	1	4
.948	56,448	53,512	51,000 M	175	12	P	A	3	3
.953	28,080	26,760	20,000 M	180		P	A	1	1
.793	63,504	50,358	35,380 E	110	12	P	A	1	1
.99	207,792	205,714	40,000 E	250	44	G	A	1	4
.99	107,136	106,064	53,280 E	7		G	G	1	7

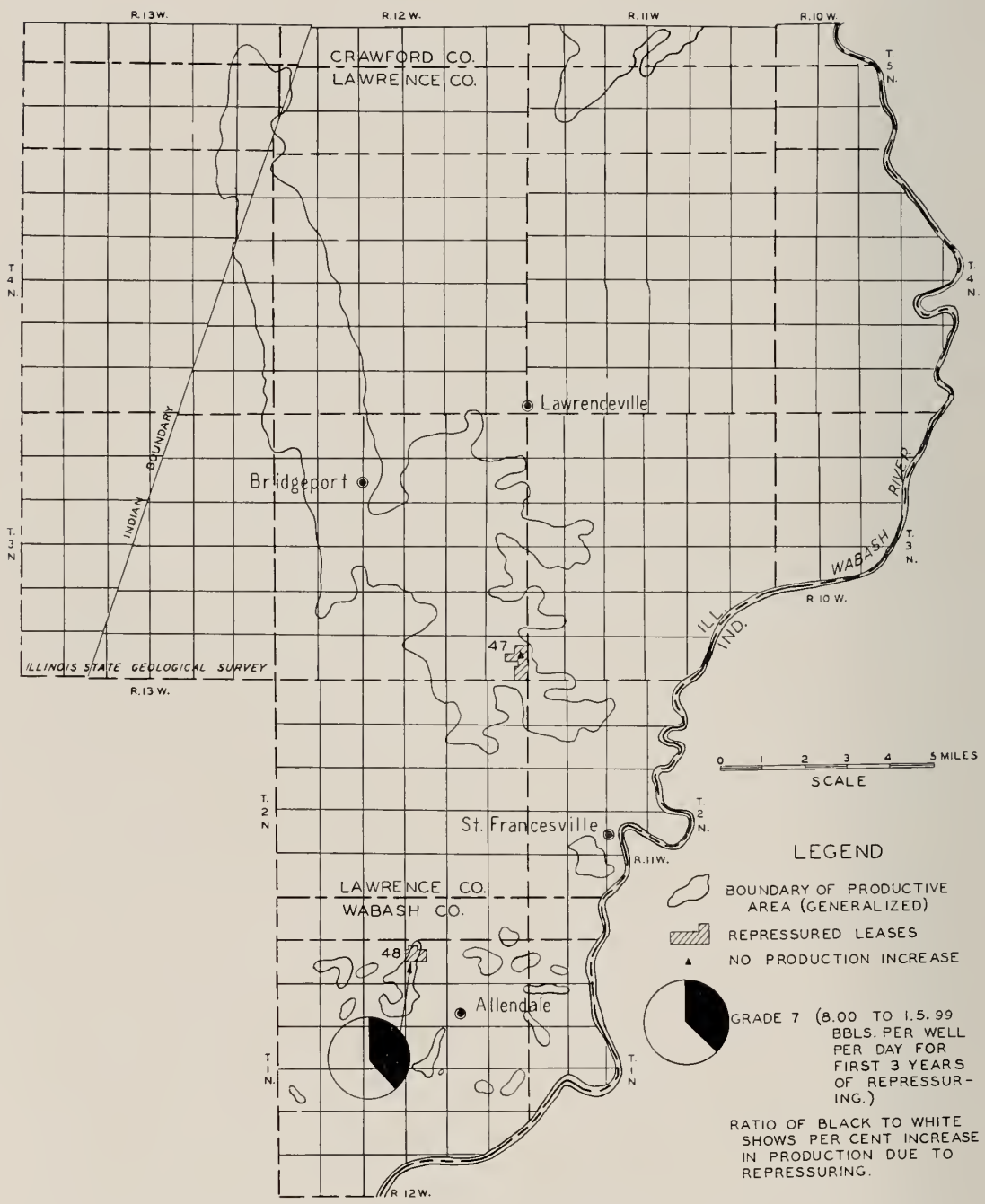
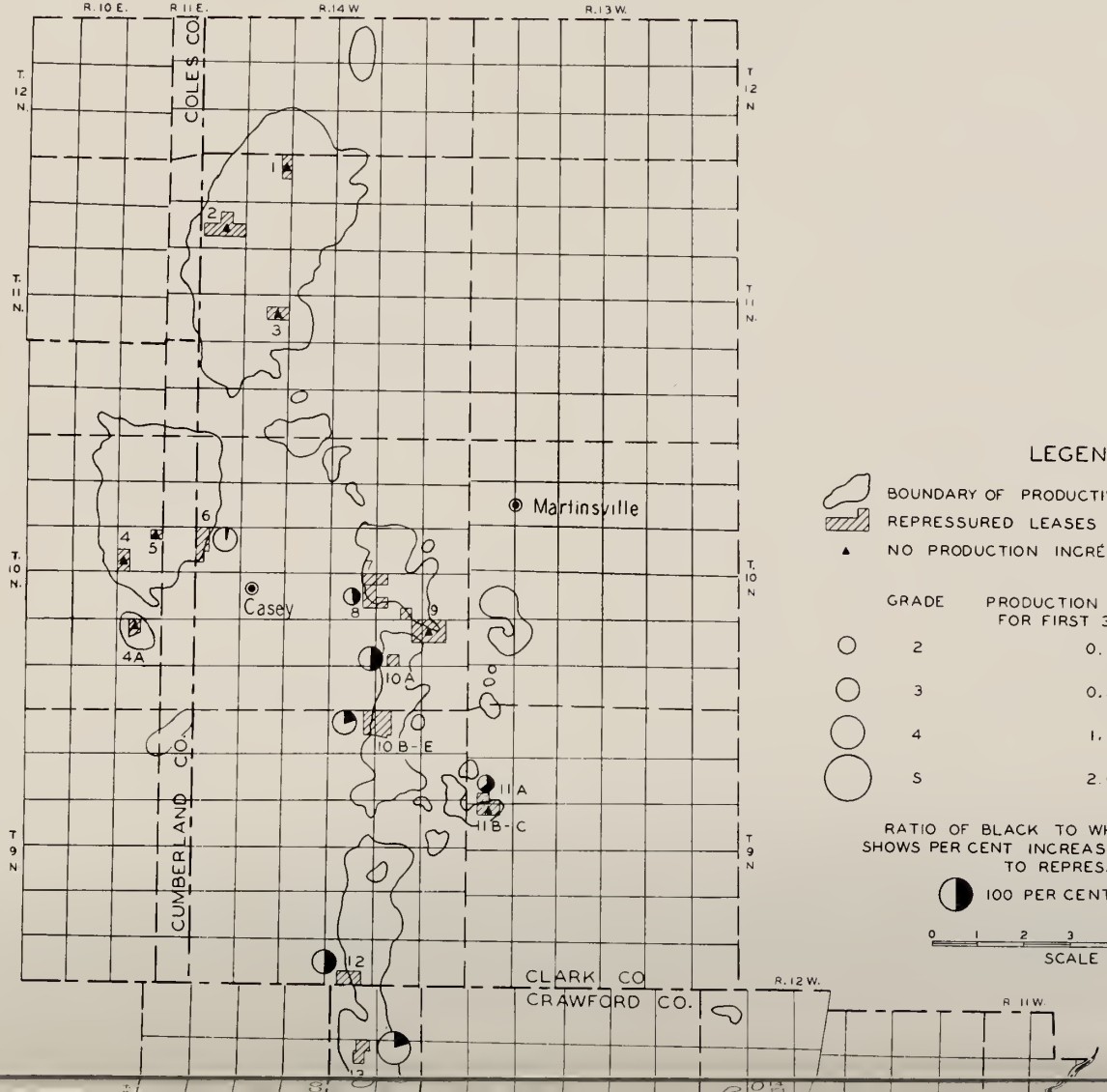


FIG. 2.—Map showing results of repressuring in Lawrence and Wabash counties, Illinois

TABLE 3—*Data on Power Engines used on Repressured Properties in Southeastern Illinois Oilfield*
(Leases are described in Table 1)

Lease Index No. (Table 1)	Manufacturer	Rated H. P.	At R. P. M.	Drive B=Belt D=Direct	Load in Addition to Compressor V= Vacuum pump P=Well pumping power
1	Superior Gas Engine Co.	40	150	B	
2	Ingersoll Rand, Inc.	20	875	D	
	Superior Gas Engine Co.	40	150	B	
3	Pattin Brothers Co.	60	180	D	
4	Superior Gas Engine Co.	35	150	B	V
5	Kite Plant Engine				
6	Superior Gas Engine Co.	25	150	B	V
7	Ingersoll-Rand, Inc.	20	875	D	
8	Superior Gas Engine Co.	25	150	B	V, P
9	Power from Gasoline Plant			B	V
10	Muncie Oil Engine Co.	60	260	B	V
	Pattin Brothers Co.	60	180	D	
11	Superior Gas Engine Co.	25	150	B	V, P
12	Bessemer Gas Engine Co.	20	180	D	
13	Superior Gas Engine Co.	40	150	B	
14	Ingersoll-Rand, Inc.	20	875	D	
15	Superior Gas Engine Co.	35	150	B	V
16	Superior Gas Engine Co.	25	150	B	V, P
17	Olin Gas Engine Co.	35	150	B	V
18	Bessemer Gas Engine Co.	50	180	D	
19	Power from Gasoline Plant				
20	Bessemer Gas Engine Co.	25	180	B	V, P
21 B	Superior Gas Engine Co.	40	150		
F	Pattin Brothers Co.	90	180	D	
	Pattin Brothers Co.	90	180	D	
E	Superior Gas Engine Co.	40	150	B	V
J	Superior Gas Engine Co.	40	150	B	
22	Superior Gas Engine Co.	35	150	B	V
23	Superior Gas Engine Co.	35	150	B	V
24 A	Superior Gas Engine Co.	25	150	B	V
B	Pattin Brothers Co.	40	150	B	V
C	Jones Engine Co. "Acme"	20	150	B	V
25	Superior Gas Engine Co.	30	150	B	V
26	Jones Engine Co. "Acme"	35	160	B	
27	Superior Gas Engine Co.	25	150	B	
28	Pattin Brothers Co.	60	180	D	
[a]29	Clark Brothers Co.	190	180	D	
	Clark Brothers Co.	190	180	D	
30	Superior Gas Engine Co.	35	150	B	
31	Pattin Brothers Co.	60	180	D	
32	Superior Gas Engine Co.	25	150	B	
33	Olin Gas Engine Co.	35	150	B	V, P
34	Superior Gas Engine Co.	35	150	B	V
35	Superior Gas Engine Co.	35	150	B	
36	Superior Gas Engine Co.	35	150	B	
37	Jones Engine Co. "Acme"	32	150	B	
38	Olin	35	150	B	V
39 A	Pattin Brothers Co.	90	180	D	
D	Superior Gas Engine Co.	25	150	B	V
40	Superior Gas Engine Co.	25	150	B	V
41	Olin Gas Engine Co.	25	150	B	P
42	Superior Gas Engine Co.	25	150	B	V
43	Superior Gas Engine Co.	25	150	B	
[a]44	Superior Gas Engine Co.	25	150	B	
[a]45	Superior Gas Engine Co.	25	150	B	V, P
46	Pattin Brothers Co.	33	165	B	V, P
47	Superior Gas Engine Co.	35	150	B	
48	Oil Well Supply Co. "Black Bear"	35	150	B	V

[a]Properties not gas-pumped



LEGEND

BOUNDARY OF PRODUCTIVE AREA (GENERALIZED)

REPRESSURED LEASES

▲ NO PRODUCTION INCREASE

GRADE	PRODUCTION BBLS. PER WELL PER DAY FOR FIRST 3 YEARS OF REPRESSURING
2	0.25 — 0.49
3	0.50 — 0.99
4	1.00 — 1.99
5	2.00 — 3.99

RATIO OF BLACK TO WHITE AREA IN CIRCLE SHOWS PER CENT INCREASE IN PRODUCTION DUE TO REPRESSURING

100 PER CENT INCREASE

0 1 2 3 4 5 6 MILES

SCALE

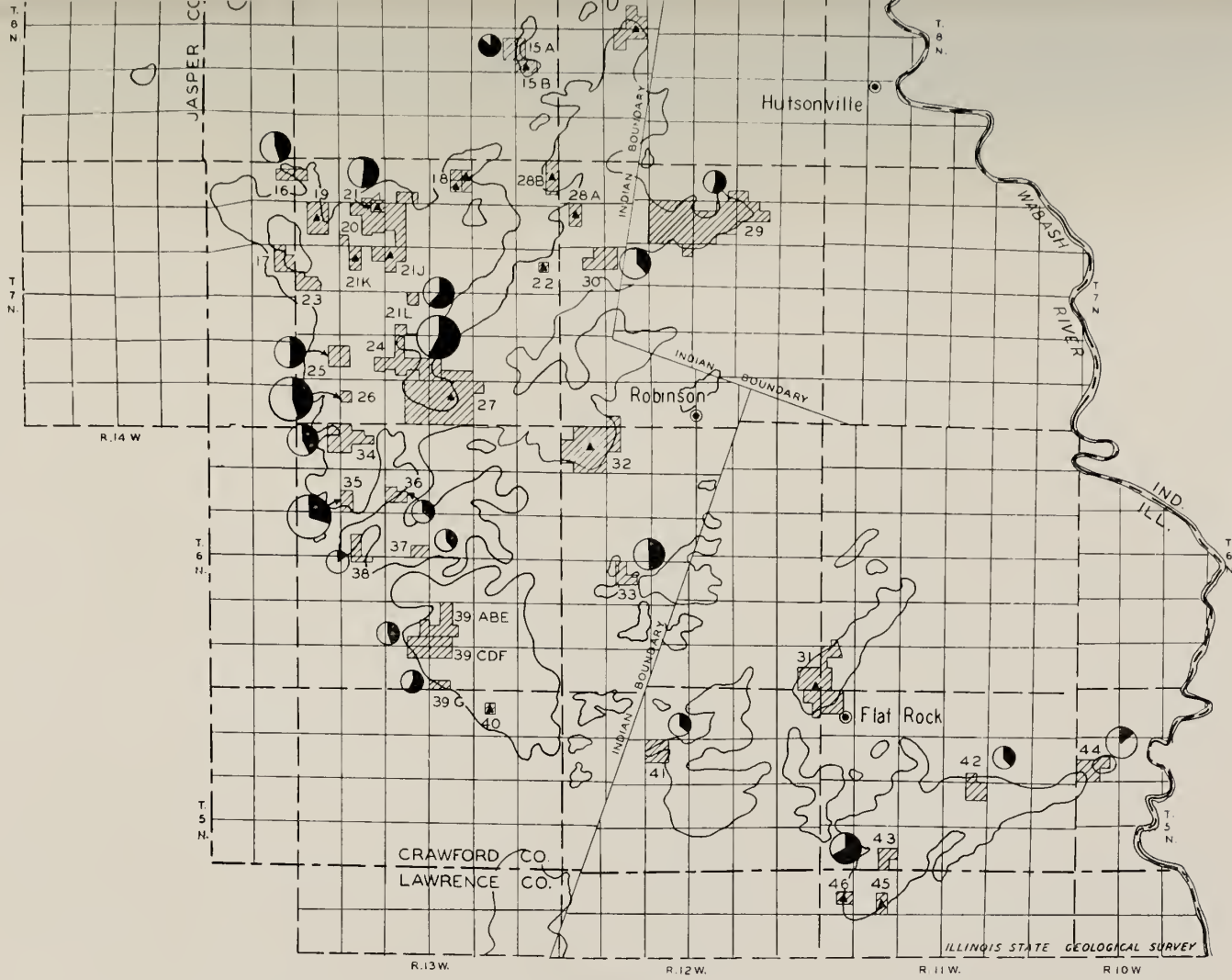


FIG. 1.—Map showing results of repressuring in Clark and Crawford counties, Illinois

Results of Repressuring

General.—The production of 458 wells having an average daily production per well of 0.73 barrel of oil before repressuring has been increased to 1.21 barrels per well per day for an average period of 5.5 years, an increase of 66 per cent. Stated in another way, the 458 wells have produced 1,111,392 barrels during the total period of repressuring; if these wells had continued to produce during this period at the same daily rate as during the year before repressuring was applied, they would have produced only 668,440 barrels. The difference, which amounts to 442,952 barrels, may fairly be said to have resulted from repressuring. Furthermore, the rate of production would no doubt have continued to decline slowly if repressuring had not been applied and therefore the increase due to repressuring was actually greater than the above mentioned figure.

In order to make a fair comparison between the results of repressuring from leases which have been repressured for varying periods of time, it is necessary to consider the results for a period of standard length. A period of 3 years was chosen as being long enough to give significant results and short enough to include the great majority of the leases (Figs. 1 and 2, and Table 4). The results in per cent increased production for a 5-year period are included in Table 4 and also for the total period of repressuring.

The relation between increased rate of production due to repressuring and the previous rate of production for wells of various sizes is shown graphically (Fig. 3). This graph shows that on the average the increase in production in barrels per well per day is not much greater for the larger than for the smaller wells, and accordingly the per cent increase in production is greater for the smaller wells.

Average results of repressuring for various sands.—The average results of repressuring by years for various sands are shown in figure 4 and Table 4.

The greatest per cent increase in oil production due to repressuring was obtained in the Robinson sand of Crawford County.[2] A noteworthy feature is the fact that numerous leases have been repressured for periods as long as 8 to 10 years and that the average rate of production during this long period has been held above the rate previous to repressuring. The average volume of air or gas used per barrel of increased production from the Robinson sand is 8,000 cubic feet.

One repressured lease producing from the Biehl sand[3] in the Allendale

[2] For descriptions of the Robinson sand, see:
Blatchley, R. S., The oil fields of Crawford and Lawrence Counties, Illinois State Geol. Survey Bull. 22, 1913, pp. 97-98.
Rich, John L., Oil and gas in the Birds quadrangle, Illinois State Geol. Survey Bull. 33, 1916, pp. 115-116.

[3] For description of the Biehl sand, see:
Rich, John L., The Allendale oil field, Illinois State Geol. Survey Bull. 31, 1915, pp. 64-65.
Moulton, Gail F., Further contributions to the geology of the Allendale oil field with a revised structure map, Illinois State Geol. Survey Report of Investigations No. 7, 1925, pp. 9-10.

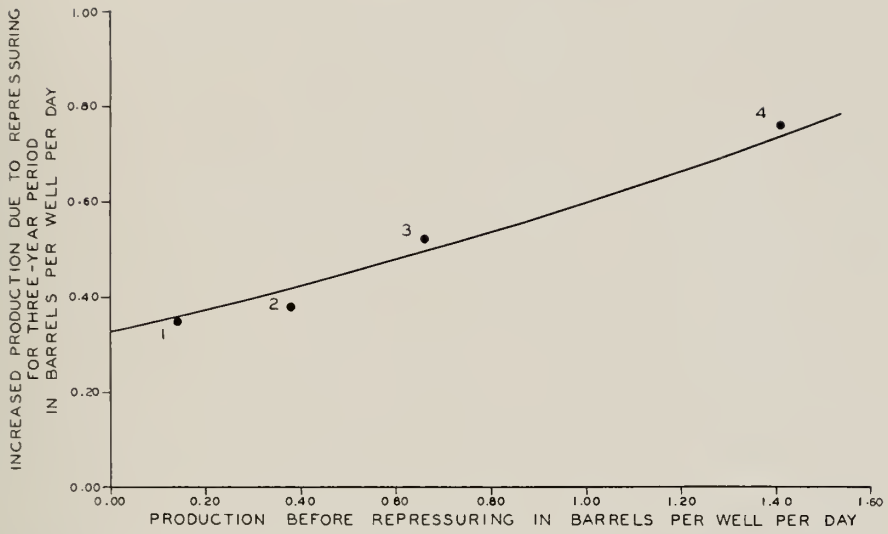


FIG. 3.—Curve showing relation between increased rate of production due to repressuring and previous rate of production for wells of production classes 1, 2, 3 and 4 (Table 4). Each point represents the average for the wells in a given class, not including those wells which gave no increased production.

field, Wabash County, gave 51 per cent increased production for a 3-year period. The volume of air or gas required per barrel of increased oil production was considerably less than the averages for the Robinson and Casey sands. This is probably because the Biehl sand has a more open texture and is richer in oil.

The average per cent increase in oil production from repressuring the Casey sand [4] has been considerably less than for the Robinson and Biehl sands (Table 4). The average volume of air or gas used per barrel of increased oil production is 15,000 cubic feet or nearly double that for the Robinson sand.

Of three attempts to repressure in the Siggins pool (Table 1, Nos. 4, 5, and 6) the first two failed to increase production and the third gave only a slight increase and that only during the first year (Table 4). This plant was continued in operation for 9 years but after the first year of repressuring the rate of production fell below that previous to repressuring. The failure of the Siggins sand to respond satisfactorily to repressuring is probably due to the fact that much of it is "tight" and that it contains many layers of interbedded shale.[5]

[4] For description of the Casey sand, see:
Mylius, L. A., Oil and gas development and possibilities in east-central Illinois, Illinois State Geol. Survey Bull. 54, 1927, pp. 144, 149, 156-157.

[5] For description of the Siggins sand, see:
Lamar, J. E., A study of the core of the Yanaway well No. 33 in the Siggins pool, Illinois State Geol. Survey Illinois Petroleum No. 15, May 12, 1928.

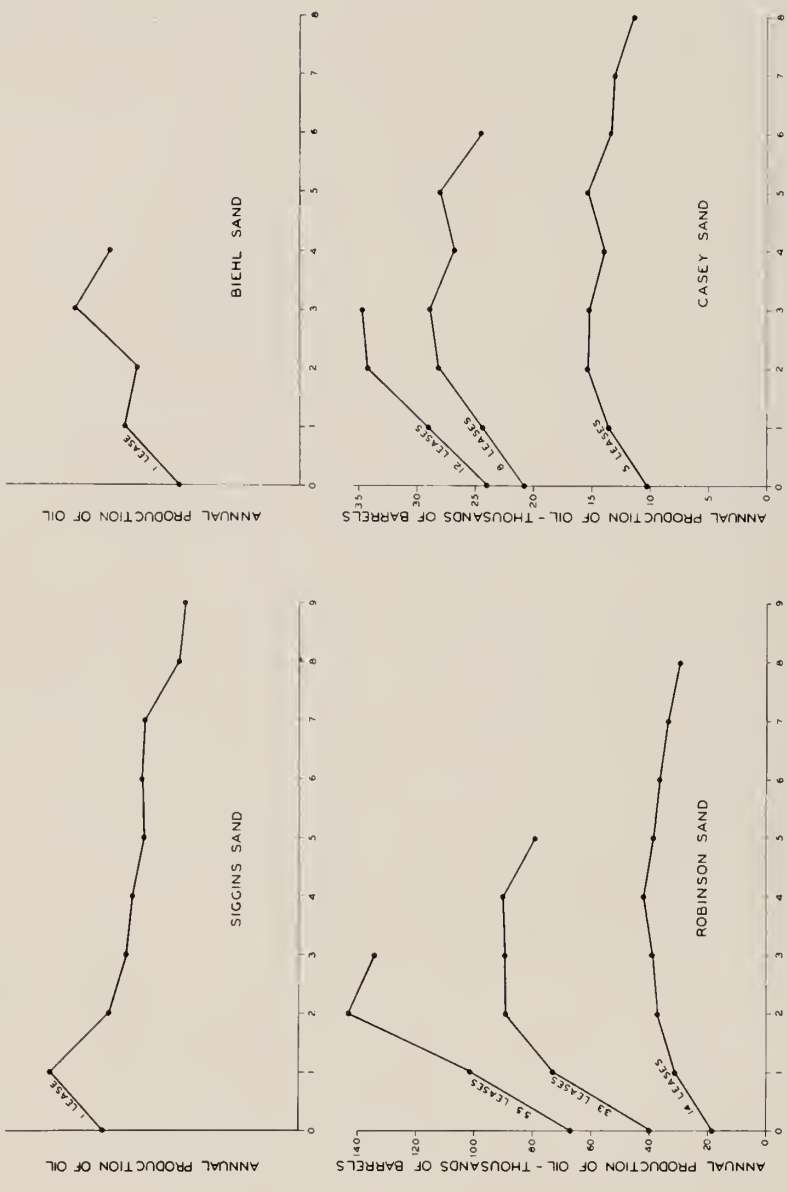


FIG. 4.—Production curves showing average results of repressuring for various sands. Vertical scales vary for Siggins and Biehl graphs.

Three attempts have been made to repressure the "Westfield lime"[6] (Table 1, Nos. 1, 2, 3) but all failed to increase production. It seems probable that fissures and joints in the limestone which is the producing formation of this pool permit the air to bypass without moving any oil.

Only one attempt to repressure the Kirkwood and Tracey sands (Table 1, No. 47) has come to the Survey's attention during this investigation and this failed to increase production. No repressuring appears to have been attempted on the Bridgeport, Buchanan, McClosky, "Gas" or "stray" sands in Lawrence County.

Opportunities for Further Repressuring

As mentioned above only about 3.6 per cent of the area of the Southeastern Illinois oilfield has been repressured. The sand which has given the greatest average per cent increase in production in the past, namely the Robinson sand of Crawford County, seems to offer considerable opportunity for successfully extending repressuring operations. However, in considering the advisability of undertaking repressuring in any given area due regard should be given to local conditions. Attention is called to the fact that certain leases which failed to give increased production are intermingled with others which gave good increases. Some of these failures may have been due to local sand conditions, others to the fact that the equipment used was inadequate.

The Bridgeport sand of Lawrence County is probably to be correlated with the Robinson sand of Crawford County.[7] This suggests that conditions in the Bridgeport sand may also be favorable to repressuring.

The excellent results from one repressured lease (No. 48, Fig. 2 and Tables 1 and 4) producing from the Biehl sand suggest that good results are to be expected from extending repressuring in the Allendale fields. However the extreme variability in the local sand conditions in these fields will no doubt cause great variation in the response to repressuring.

The results of all the attempts to repressure in the Westfield and Siggins pools do not encourage undertaking further attempts in these pools. The single attempt to repressure the Kirkwood and Tracey sands, however, should not be considered as condemning the possibilities of the repressuring of these sands in the large area in which they are productive.

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[6] For description of the Westfield lime, see:
Mylius, L. A., Op. cit., pp. 124-126.
[7] Blatchley, R. S., Op. cit., p. 83, Pl. III-B.

Method of Determining Per Cent Increase in Production Due to Repressuring

Production records by leases and by years were used as the basis for determining per cent increases in production due to repressuring (Table 4).

The majority of the production records received were gross, that is, they include both the working interest and the royalty interest. For those which were supplied in the form of working interest, the necessary calculation was made to obtain the gross production. Gross production is used throughout this report. The production records in most cases show a slow but steady decline for several years before the repressuring was applied, then a more or less sudden rise due to repressuring which may continue for some years.

The year before the first noticeable rise in annual production due to repressuring is here called the "zero" year of repressuring for the lease concerned (Table 4). As repressuring operations were usually not begun until well along in any given calendar year, the effects in increased annual production were usually not appreciable until the following calendar year because it ordinarily takes several months for the air or gas to travel through the sand from the input well to the nearest producing wells. In these cases the "zero" year is the year that repressuring was begun but in other cases it is the year previous to the beginning of repressuring.

On many of the repressured leases only part of the wells have been affected by repressuring. In order to approximate the production of the affected wells it was assumed (in the absence of production records by individual wells) that the wells were all equally productive. Errors introduced by this assumption would tend to be compensating rather than cumulative when large numbers of wells are considered. The production of the affected wells in the zero year was obtained by multiplying the total production of the lease by a fraction in which the numerator is the number of the affected wells and the denominator the total number of producing wells. Thus if a lease has 9 producing wells of which 5 were affected by repressuring, the production of the repressured wells for the zero year was taken as 5 9 of the total production of the lease.

The increase due to repressuring for any given year was found by subtracting the total production of the lease for the zero year from that for the year in question. The per cent increase was then obtained by dividing this number by the production of the affected wells for the zero year and multiplying by 100. The per cent increase due to repressuring for a period of years, for example 3 years, was obtained by adding the increases in barrels for the 3 years and dividing by 3 times the zero year production of the affected wells, then multiplying by 100. The increases for groups of leases and for all the leases producing from each sand were found by first adding the increases in barrels by years and making the same calculation as for the individual leases.

Classification of Leases According to Production

In order to avoid revealing individual production figures and at the same time to give sufficient information to permit the oil operator to distinguish between those leases whose production per well is above the economic limit and those which are obviously non-commercial, the leases have been classified according to average production per well per day (Table 4). Thus if a lease is classified as class 3 in the "zero" year it means that in that year the average production per well per day was somewhere between 0.50 and 0.99 barrels of oil. If the same lease is classified as class 4 for the first three years of repressuring it means that the average production per well per day for the three year period was between 1.00 and 1.99 barrels.

TABLE 4—*Results of Repressuring*[a]

Index to daily production per well, columns 2 and 3
Class 1—less than 0.25 barrels
Class 2—0.25- 0.49 barrels
Class 3—0.50- 0.99 barrels
Class 4—1.00- 1.99 barrels
Class 5—2.00- 3.99 barrels
Class 6—4.00- 7.99 barrels
Class 7—8.00-15.99 barrels

Index No. (See Table 1)	Class		Per cent increase			No. of yrs.	Percentage increase in production for each year of repressuring									
	"0"[b] year	1st 3 yrs.	1st 3 yrs.	1st 5 yrs.	Total Period		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
							SIGGINS SAND									
6	3	3	4	−3	−16	9	27	−3	−12	−14	−21	−20	−22	−39	−42	
							CASEY SAND									
7	2				94	1	94									
8	2	2	88		88	3	57	106	100							
10A	2	3	91	69	32	10	43	130	100	20	53	30	6	3	−23	−30
B	3	4	27	23	18	6	4	41	34	27	10	−7				
C	3	3	42	50	53	9	37	30	60	80	74	82	52	14		
D	3	3	4	5	−14	10	18	−2	−4	5	6	−10	−31	−26	−41	−50
E	4	4	10	8	−3	9	8	21	3	1	4	−7	−9	−22	−22	
B-E	3	3	25	26	19	8.1										
11A	1	2	163		163	3	215	190	85							
12	2	3	104	100	75	8	41	149	120	115	72	52	47	0		
13A	4	4	9	20	12	7	6	1	19	31	43	15	−10			
B	2	2	13	9	4	7	9	13	18	1	5	−7	−9			
C	3	4	48		53	4	14	48	83	69						
D	3	4	77		72	4	44	112	76	56						
13	3	4	24		22	6.1										
Total	3	3	36	32	26	7.1										

15A	1	3	750		750	3	620	847	711						
16	3	4	85	130	95	9	59	21	175	258	141	69	95	60	−28
17A	3				212	2	225	186							
B	3				250	2	296	202							
17	3				233	2									
18B	2				297	2	6	610							
20	2				53	2	21	84							
21A	3	5	383	403	346	7	212	490	443	477	390	226	184		
B	2				63	2	75	47							
C	2	3	99	244	237	9	44	90							
F	4	4	71	71	55	9	53	81	79	75	65	69	40	26	8
G	4	5	142	158	146	8	88	147	192	155	206	160	123	96	
H	3	4	61	74	67	7	30	83	70	91	92	68	38		
I	3	3	62	88	86	9	39	66	80	102	153	146	110	38	37
ACFGHI	3	4	106	137	118	7.6									
21L	3	4	176	166	126	6	99	211	201	200	102	−68			
24A	3	4	131		131	3	55	185	146						
B	4	5	166	138	87	10	148	230	120	92	101	56	48	31	41
C	3	3	33	28	33	8	29	17	53	37	3	−23	64	88	
D	2	4	290	103	67	6	20	430	422	−265	−92	−108			
24	3	5	140	120	93	6.1									
25	3	4	105		105	3	98	172	45						
26	4	5	80		66	4	100	66	72	23					
29A	2	3	117	121	121	5	69	138	146	138	115				
B	1	2	113	111	111	5	87	120	134	120	97				
C	3	4	44		40	4	40	58	36	28					
D	1	2	275	252	252	5	220	360	220	250	218				
E	3	3	65	75	75	5	45	64	86	110	71				
F	3	3	63	56	56	5	73	55	64	51	41				
G	3	5	207	167	167	5	223	210	188	142	72				
H	2	3	118	77	77	5	92	171	88	59	−29				
I	1	2	372		372	3	400	365	253						
J	3	4	97	97	97	5	20	160	110	117	78				
K	3	4	71	43	43	5	120	55	38	10	−9				
L	3	3	214	233	233	5	79	293	272	233	294				
M	2	3	190	179	179	5	129	232	210	177	142				
N	1	2	111		125	4	126	114	94	165					
O	1	3	392	440	440	5	450	338	394	455	650				
P	2	3	107		107	3	98	91	132						
29	2	3	119	116	114	4.9									

TABLE 4.—*Results of Repressuring*[a]*—Continued*

Index No. (See Table 1)	Class		Per cent increase			No. of yrs.	Percentage increase in production for each year of repressuring									
	"0"[b] year	1st 3 yrs.	1st 3 yrs.	1st 5 yrs.	Total Period		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
30	3	4	68		68	3	26	114	65							
33A	3	4	51	42	32	9	38	72	43	27	28	33	0	−3	53	
B	3	4	118	154	138	9	27	146	180	230	173	166	51	87		
33	3	4	98	122	108	9										
34A	3	4	28		42	4	19	38	26	12						
B	2	4	393	394	347	7	341	316	517	420	361	252	213			
C	3	4	101		98	4	91	97	117	89						
D	2	2	41	28	24	6	23	66	32	20	0	−2				
E	2	4	167		132	4	210	120	168	27						
F	2	4	150		136	4	178	145	126	92						
34	3	4	75		72	4.2										
35	4	5	43		43	3	47	64	19							
36A	2	3	29		29	3	92	−7	0							
B	3	4	225		225	3	76	292	310							
C	2	3	21		21	3	58	11	−4							
36	2	3	53		53	3										
37	3	3	53	95	133	9	20	23	115	177	141	238	212	158	102	
38	2	3	21		21	3	−3	51	17							
39A	3	4	93	81	62	9	76	109	94	73	55	24	26	54	23	
B	3	4	88		86	4	52	60	152	79						
C	4				115	2	114	116								
E	4	4	47		47	3	12	166	−38							
F	3				41	2	100	−19								
G	2	3	150		150	3	200	190	61							
39ABE	3	4	81		72	5.3										
41	3	3	55		55	3	8	114	42							
42A	2	3	52	31	18	9	44	81	30	−2	3	−8	−9	4	17	
42B	3	4	62	38	15	8	77	54	54	3	3	−38	−21	−13		
42	3	3	56	34	17	8.6										
43	3	4	215	189	134	9	213	236	197	120	178	113	94	54	9	
44	4	4	17	17	17	5	18	20	14	32	28					
Total for Robinson sand:																
	3	4	96	112	94	5.2										
BIEHL SAND																
48	7	7	57		57	4	47	37	87	59						

[a]The leases on which repressuring was begun in 1932 (Table 1, Nos. 21E, 23, 39D, and 40) are not included in Table 4.
[b]"0" year, year before repressuring.