PROCEEDINGS

of

1950 TURF CONFERENCE

Sponsored by the

Midwest Regional Turf Foundation

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

MARCH 6, 7 and 8, 1950

MIDWEST REGIONAL TURF CONFERENCE, PURDUE UNIVERSITY, 1950

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WEST POINT LAWN PRODUCTS

West Point, Pa.

ATTENDANCE

MIDWEST REGIONAL TURF FOUNDATION CONFERENCE

March 6, 7 and 8, 1950

Name	Address and Country Club or Company
1. Acker, Darrell	3415 W. Layton Ave., Milwaukee, Wisc.
2. Adams, George E.	127-2nd St., N.E., Canton, Ohio Tam O'Shanter C C
3. Baily, H. S.	2015 Colfax St., Evanston, Ill. George A. Dans, Inc.
4. Baker, A. S.	2529 Catalpa Dr., Dayton, Ohio Jacobsen Mfg. Co.
5. Baker, C. I.	Chicago, Illinois Chicago Park District
6. Bard, Richard	Brecksville, Ohio Sleepy Hollow CC
7. Bernhart, George E.	306 Chandler Ave., Evansville, Ind. Municipal GC
8. Becker, Richard	Fontana, Wisconsin Big Foot CC
9. Beckstrom, Carl	R. 1, Box 62 E, St. Charles, Ill. St. Charles CC
10. Bennett, Wayne F.	Box 732, Kokomo, Indiana Kokomo CC
11. Berton, Andrew A.	Ann Arbor, Michigan Barton Hills CC
12. Bertram, Erv	R. 14, Box 81, Milwaukee 14, Wisc. Westmoor CC
13. Bertucci, Adolph	Glencoe, Illinois Lake Shore CC
14. Biddulph, George	North Olmstead, Ohio Spring Vale GC
15. Bidwell, Horace	Columbus, Indiana Harrison Lake CC
16. Bockoski, Chester	6433 Broadway, Indianapolis 20, Ind. Willow Brook GC
17. Bond, R. R.	Box 350, Madison, Wisconsin Old Orchard Turf Nurseries
18. Boone, Howard	Hamilton C., Cincinnati, Ohio Hamilton C. Park District
19. Borg, Gus	Springield, Illinois Illini CC
20. Born, Willard	Toledo, Ohio City of Toledo
21. Bowden, G. L.	Wilford, Ohio Terraca Park CC
22. Boyd, Taylor	Box 21, Cincinnati 27, Ohio Kenwood CC

23.	Boyer, Harry C.	Cincinnati, Ohio Losantiville CC
24.	Brady, William	500 Kensington Dr., Madison, Wisc. Maple Bluff CC
25.	Brei, Henry	5501 Larcom Ave., Chicago, Ill. Edgebrook GC
26.	Bretzlaff, Carl	R.16, Box 641, Indianapolis, Ind. Meridian Hills CC
27.	Brinkworth	Minneapolis, Minnesota Toro Mfg. Co.
28.	Brown, Agar M.	St. Charles, Illinois Nat'l Greenkeeping Supt. Ass'n
29.	Brown, Earl R.	2604 S. Lafountain, Kokomo, Ind. American Legion GC
30.	Brown, Orville	Fort Wayne, Indiana Elks CC
31.	Brown, Vernon	3445 Western, Matoon, Illinois Matoon CC
32.	Browning, James	8151 N. Hight St., Worthington, Ohio York Temple CC
33.	Bucher, Keith	Fond du Lac, Wisconsin Takodah GC
34.	Bunnell, Raymond C.	12050 Parnell Ave., Chicago 28, Ill. Plant Marvel Lab.
35.	Bunson, Gother	Aurora, Illinois Aurora CC
36.	Burdette, Paul E.	Lombard, Illinois Seed, Fertilizer & GC Supply
37.	Butler, Albert	R.1, Springland Ave., Michigan City, Ind. Pottawattomia
38.	Cagle, J. C.	Indianapolis, Indiana Speedway GC
39.	Canale, Joseph	422 E. Walnut St., Oglesby, Ill. Deer Park Golf Club
40.	Cassier, E. W.	Sycamore, Illinois Sycamore GC
41.	Chamberlin, R. L.	Kankakee, Illinois Kankakee CC
42.	Chaplin, R. C.	R. 2, LaFrange, Illinois Edgewood Valley CC
43.	Clarke, William	2541 Prospect Ave., Evanston, Ill. Northwestern GC
44.	Coble, Clem	New Augusta, Indiana Broadmoor CC
45.	Coghill, B. F.	119th & Archer Ave., Lemont, Ill. Coghill GC
46.	Cooper, Al	State College, Pa. Penn State College
47.	Conner, Paul	91 W. 15th St., Chicago Heights, Ill. Glenwoodie CC
48.	Corlett, E. J.	3389 Dorchester Rd., Shaker Heights, O. Beechmont CC

49.	Cornwall, Ward	1015 Vernier Rd.Grosse Pt. Woods, Mich. Lochmoor CC
50.	Coval, Pete	R.18, Box 668-D, Indianapolis, Ind. CC of Indianapolis
51.	Coyne, Mike	Chicago Heights, Ill. Lansing GC
52.	Coyne, Tom	Chicago Heights, Ill. Lansing GC
53.	Dahmann, C. A.	137 E. Mitchell Ave., Cincinnati, O. Vine St. Hill Cemetery
54.	Darrah, John	R. 1, Matteson, Illinois Turf Development Co., Ind.
55.	Davis, Raymond C.	Medinah, Illinois Medinah CC
56.	Davis, Richard	West Lafayette, Ind. Purdue University
57.	Dearie, Gerald M.	Chicago, Illinois Edgewater GC
58.	Dettling, T. J.	43 E. Market St., Akron, Ohio Dettling Bros.
59.	Didier, Ray	6780 Howard Ave., Niles, Ill. Tam O'Shanter CC
60.	Dienhart, A. P.	R.R. 10, Lafayette, Ind. Elks CC
61.	Dinelli, Frank J.	1302 Clavey Rd., Highland Park, Ill. Northmoor CC
62.	Dornbrock, Don	1504 E. Backer Ave., Mich.City, Ind.
63.	Dowell, Earl	1114 State St., Lafayette, Ind.
64.	Drachman, P. E.	908 Lombard, Evansville, Ind. Evansville CC
65.	Dryfoos, Sydney L.	3108 Mayfield Rd, Cleveland 18, Ohio Oakwood Club
66.	Duehr, Edward J.	Midlothian, Illinois Midlothian CC
67.	Dunlop, Frank	Cleveland, Ohio The Country Club
68.	Dunn, Robert J.	Box 327, Crown Point, Ind. Gary CC
69.	Eaton, Max	Wabash, Indiana Wabash CC
70.	Eaton, Reason C.	Culver, Indiana
71.	Ehrich, Alfred	191st & Crawford Ave., Tinley Park, Ill. H. & E. Sod Nursery
72.	Eley, Ernest	Greenville, Ohio Greenville CC
73.	Englehardt, Peter	Box 273, Worth, Illinois Westgate Valley GC
74.	Ermer, Frank	Cleveland, Ohio Ridgewood CC

75.	Esterline, Walter	R.R. 5, Muncie, Ind. Delaware CC
76.	Fannin, Howard	Cleveland, Ohio Mayfield CC
77.	Fannin, Robert	Warren, Ohio Trumbull CC
78.	Fannin, William	Box 381, Warren, Ohio
79.	Faree, Tom	Troy, Ohio Troy CC
80.	Ferriero, Angelo	Kent, Ohio Twin Lakes CC
81.	Fifield, E.	1236 Rutledge St., Gary, Ind. Gary Parks
82.	Fisher, Alton	Elmhurst, Illinois Mt. Emblem Cemetery
83.	Fix, Harold W.	Lafayette, Indiana Purdue University
84.	Fleming, F. J.	317 Court Bldg., Evansville, Ind. Evansville CC
85.	Fontaine, L. L.	Box 636, Cherokee Station,Lsville,Ky. Big Spring CC
86.	Ford, O. C.	Fowler, Indiana
87.	Forste, Clifford	Cincinnati, Ohio Losantiville CC
88.	Funk, W. McLean	Country Club Rd., Decatur, Ill.
89.	Gabley, Howard	Racine, Wisconsin Johnson Park GC
90.	Gabriel, Sam J.	Harlem & Lake, River Forest, Ill. Cook Cnty. Forest Preserve
91.	Gantz, Ivan R.	Elwood, Indiana Elwood CC
92.	Gardner, Charles	Briggs and Stratton Corp.
93.	Genovese, Vince	Murphysborough, Illinois Jackson CC
94.	Gerber, Raymond	Glen Ellyn, Illinois Glen Oak CC
95.	Gibford, L. D.	Auburn, Indiana Auburn CC
96.	Gilley, Angus	RR 6, Connersville, Indiana Connersville CC
97.	Glissman, Harold W.	Boys Town, Neb. Father Flanagan's Boys
98.	Goodrich, Ford	2468 Eddington, Flint 3, Mich. Flint GC
99.	Graffis, Joe	407 S. Dearborn St., Chicago 5, Ill. Golfdom
100.	Grant, Gilmore	3265 Robin Road, Louisville 13, Ky. Audubon CC

101.	Grau, Fred V.	4604 Amherst Rd., College Park, Md. U.S.G.A. Green Section
102.	Graves, Stan	R.R. 17, B., Indianapolis, Ind. Municipal GC
103.	Gridley, Owen	Lakeside, Michigan Chikaming CC
104.	Griener, Clarence	43 S. Delaware St., Indianapolis, Ind. C. E. Griener Co.
105.	Grotti, Dominic	Winnetka, Illinois Sunset Ridge CC
106.	Griesenauer, G. J.	Rm. 33, Muni. Cts. Bldg., St. Louis, Mo. City of St. Louis
107.	Gruber, Calvin	Cincinnati, Ohio Hamilton C. Park District
108.	Gury, Stu	Rockford, Illinois Forest Hills CC
109.	Habenicht, Carl B.	Box 196 A, Tinley Park, Ill. H. & E. Sod Nursery
110.	Haines, George	Box 564, Lima, Ohio Shawnee CC
111.	Hair, Richard M.	Piqua, Ohio
112.	Hammerschmidt, T. F.	Lisle, Illinois Woodridge GC
113.	Hannemann, H. R.	Milwaukee, Wisconsin North Shore GC
114.	Hanson, Harry H.	R. 2, Fenton, Illinois
115.	Harasty, Louis	Cleveland 22, Ohio Canterbury GC
116.	Harris, R. B.	Chicago, Illinois GC Architect
117.	Harter, Charles E.	Logansport, Indiana Dykeman Pk. GC
118.	Harvey, Charles W.	3920 W. 71st St., New Augusta, Ind. Hillcrest CC
119.	Hayes, Thos. V.	8224 Washington, St. Louis, Mo. Meadow Brook CC
120.	Helmbold, Geo.	R.R. 6, Box 484, Dayton, Ohio Madden GC
121.	Heminger, Frank	Eau Claire, Mich. Ferguson & Sons
122.	Hess, Robert.	Linton, Indiana Linton Muni. GC
123.	Heston, Loomis	West Lafayette, Indiana Purdue University
124.	Hinz, Alvin	Church Rd., Bensenville, Ill. White Pines
125.	Hjort, Carl H.	2224 Oriole Dr., Lg. Beach, Mich. City, Ind. Long Beach CC
126.	Hocker, Orville L.	1824 Coventry Rd., Dayton 10, Ohio Supt. of Parks

127.	Hodson, Ben, Jr.	615 Brandon St., Kokomo, Ind. American Legion GC
128.	Hoffer, G. N.	Lafayette Life Bldg., Lafayette, Ind. American Potash Institute
129.	Hoover, James	Pontiac, Illinois Pontiac GC
130.	Hopkins, Virgil C.	Decatur, Indiana Decatur GC
131.	Hosfeld, A.	813 N. Main St., Rockford, Ill. Sinnissippi GC
132.	Howe, Robert	5466 N. Port Washington, Milwaukee, Wis. Wisconsin Greenkeeping Ass'n
133.	Hoy, A.C.	Butterfield Road, Wheaton, Ill. Arrowhead GC
134.	Hoyt, Walter	LaFrange, Illinois Timber Trails CC
135.	Hull, R. B.	West Lafayette, Indiana Purdue University
136.	Husted, A. W.	522 Court House, Cincinnati, Ohio Hamilton C. Park District
137.	Jackiewicz, Joseph	5900 Leader Ave., Chicago, Ill. Billy Caldwell GC
138.	Jackson, Wallace	Rockford Park Dist., Rockford, Ill. Ingersoll GC
139.	Janssen, Elmer	Rock Falls, Illinois Rock River CC
140.	Jensen, Paul	Milwaukee, Wisconsin Wisconsin Greenkeepers' Ass'n
141.	Johnson, Marinus	City Hall, Racine, Wisconsin City of Racine
142.	Jolly, George	Kansas City, Missouri Heart of America Greenkeepers Ass'n
143.	Jones, LeRoy	1904 W. Mt. Hope, Lansing, Mich. Lansing CC
144.	Kalrenin, Joe	Gary, Indiana Gary CC
145.	Kavanaugh, Marty	Cincinnati, Ohio Hamilton Park District
146.	Kiernan, William	Renalty Landscaping
147.	Killmer, Walter	2143 Maple Rd., Homewood, Ill. Ravisloe CC
148.	Kirchdorfer, Joe Jr.	Kentuckiana Greenkeepers Ass'n
149.	Kirkhart, Ethan	Youngstown, Ohio Youngstown CC
150.	Klanke, Fred	Queen of Heaven Cem., Hillside, Ill. Catholic Cem. of Chicago
151.	Knox, George P.	Homewood, Illinois Calumet CC
152.	Kohnke, Helmut	West Lafayette, Indiana Purdue University

153. Kress, Allan 3200 W.Grange, Milwaukee, Wisc.

154. Kress, Frank G. 3200 W.Grange, Milwaukee, Wisc.
Tuckaway CC

155. Kurek, William E. 412 W.McClure, Peoria, Ill.
Northmoor GC

156. Lamarr, M. Ft. Thomas, Kentucky
Highland GC

157. Lambert, Robert J. Dayton, Ohio
Madden GC

158. Lamboley, H.T. Fort Wayne, Indiana
Ft. Wayne Park Board

159. Lange, Henry Golf, Illinois
Glen View Club

160. Lapp, Amos Elgin, Illinois
St. Andrews CC

161. Lapp, Howard R. Kansas City, Missouri
Heart of America Greenkeepers' Ass'n

162. Lawson, Charles C. Rushville, Indiana
Elks CC

163. Lee. O. C. West Lafayette, Indiana
Purdue University

164. Lee, Owen R. #5, Muncie, Indiana
Delaware CC

165. Lehker, Glen West Lafayette, Indiana
Purdue University

166. Lentz, J. W. Marysville, Ohio
O. M. Scott & Sons Co.

167. Likes, Don West Lafayette, Indiana
Purdue University

168. Lindenschmidt, R. L. 1513 Dana Ave.,Cincinnati,Ohio
Hartwell Club

169. Linkogel, Albert Clayton 5,R.1, St. Louis Co., Misscuri
Westwood CC

170. Logan, Ralph G. Hagerstown, Indiana
Hartley Hills CC

171. Longheinrich, Fred Sappington, Missouri
Sunset CC

172. Loughlin, Wm. J Evansville, Indiana
Clearcrest CC

173. Lyle, Samuel 101 Robert Ave.,Ferguson, Missouri
Norwood Hills CC

174. Lyons, Wm. E. 1200 Firestone Pkway, Akron, Ohio
Firestone Tire & Rubber Co.

175. MacGregor, John 660 Euclid Ave.,Glen Ellyn, Ill.
Worthington Mower Co.

176. McColl, Scott Bensenville, Illinois
Mohawk CC

177. McConnell, John A. 474 S. Arlington St.,Akron, Ohio
Acme Service

178. McCoy, John S. Cincinnati 8, Ohio
Cincinnati CC

179.	McCracken, Carlos H.	Portsmouth, Ohio Elks CC
180.	McElroy, Nathan E.	Box 564, Lima, Ohio Shawnee CC
181.	McIntosh, Jack	Palos Park, Illinois Oak Hills GC
182.	McIntosh, Dave	131st & 80th Ave.,Palos Park, Ill. Oak Hills GC
183.	McLaren, Malcolm	Cleveland 21, Ohio Oakwood Club
184.	McNabb, Dean E.	Wilmington, Delaware Du Pont Co.
185.	Mackay, G. J.	West Lafayette, Indiana Purdue University (Fieldhouse)
186.	Malteo, Mike A.	Mayfield, Ohio Mayfield Heights
187.	Marchi, Gene	Dayton, Ohio Miami Valley GC
188.	Marinello, M. J.	Chicago Park Dist., Chicago, Ill. Chicago Park District
189.	Mariana, Alfred	Hamilton, Ohio Palter Park GC
190.	Marchmidt, Fred W.	St. Louis, Missouri Normandie GC
191.	Marczinski, L.	Arlington Heights, Ill. Rolling Green CC
192.	Mann, Jack	Ft. Knox, Kentucky
193.	Martin, James	West Lafayette, Indiana Purdue University
194.	Marvin, Philip H.	Box 29, Janesville, Wisconsin Calif. Spray Chemical Corp.
195.	Mascaro, Tom	West Point, Pennsylvania West Point Lawn Products
196.	Mashie, Emil	Lake Forest, Ill. Onwentsia Club
197.	Matteo, Michele A.	Hudson, Ohio Lake Forest CC
198.	Meetz, Ted	Michigan City, Indiana Michigan City GC
199.	Meisel, L. J.	444 S. Brentwood Blvd., Clayton, Mo. L. J. Meisel Co.
200.	Mendenhall, Chester	5301 E. State Line,Kansas City, Mo. Mission Hills CC
201.	Mendenhall, Marion	Sta.M,Madisonville P.O.,Cincinnati, O. Kenwood CC
202.	Miller, Massie B.	Dayton, Ohio Dayton CC
203.	Miller, Robert	Ft. Wayne, Indiana Foster Pk. GC
204.	Modlin, Frank J.	Toledo, Ohio

205. Monier, C. — 829 Second, Charlestown, Ill.
East Ill. State College

206. Morrer, Francis P. — Glencoe, Illinois
Glencoe Park District

207. Mott, G. O. — Lafayette, Indiana
Purdue University (Agronomy Dept.)

208. Mueller, H. W. Jr. — 854 Northern Pkwy.,Cincinnati,Ohio
Gate of Heaven Cemetery

209. Muller, Keith — Chicago, Illinois
U.S. Rubber Co.

210. Needham, A. A. — 2500 Oxford St.,Rockford, Ill.
Rockford CC

211. Nelson, Ervin R. — Culver, Indiana
Culver GC

212. Newkirk, Edward — 3235 Sutherland, Indianapolis, Ind.
Coffin GC

213. Noer, O. J. — P.O. Box 2079,Milwaukee, Wisc.
Sewerage Commission

214. Norden, Chet — Curtice, Ohio
Chippewa CC

215. Nuessle, Fred — Flossmoor, Illinois
Flossmoor CC

216. Nugent, W. C. — Brook, Indiana
Hazelden CC

217. Oates, Wm. H. — Wheaton, Ill.
Arrowhead CC

218. Otis, S. E. — Denver, Colorado
Julius Hyman Co.

219. Owens, R. D. — Peoria, Illinois
Peoria Park District

220. Packer, Edward J. — Mt. Pleasant Ave., Wyoming, Ohio
Wyoming GC

221. Parsons, M. M. Jr. — R.R. 17,Box 172, Indianapolis, Ind.
Highland G & CC

222. Parsons, M. M. Sr. — Indianapolis, Indiana
Highland G & CC

223. Payne, Kenyon — Lafayette, Indiana
Purdue University (A.E.S. Bldg.)

224. Peck, Roy — Kalamazoo, Michigan
Kalamazoo CC

225. Petersen, C. A. — 7059 S. Shore Dr., Chicago, Ill.
South Shore CC

226. Phillips, Raymond — Louisville 6, Kentucky
Louisville CC

227. Pieper, Walter — Malteson, Illinois
Flosmoor CC

228. Plein, Clarence — 527 N. Grand, St. Louis, Missouri
St. Louis Amus. Co.

229. Plent, Richard A. — 4902 E. 95th St.,Cleveland, Ohio

230. Polgar, Steve J. — 146 Highland Rd.,Becksville, Ohio
Seneca GC

231.	Polillo, George	Galesburg, Illinois Soargethaha CC
232.	Polivka, J. B.	Wooster, Ohio
233.	Popp, Paul	26th & DesPlaines Ave.,Riverside,Ill. Riverside GC
234.	Purvey, Albert	104 John St.,McHenry, Illinois McHenry CC
235.	Quarandillo, Louis	Logansport, Indiana Logansport CC
236.	Ranga, Walter	Birkwood, Missouri
237.	Randby, Chester H.	Waukegan Road, Lake Forest, Ill. Knollwood Club
238.	Randolph, W. H.	Charleston, Illinois Charleston CC
239.	Rapp, Charles	R.6, Fort Wayne 8, Indiana Ft. Wayne CC
240.	Reed, H. J.	6601 W. Gunnison, Chicago 31, Ill. Ridgemoor CC
241.	Rees, James D. Jr.	4701 N. Keystone Ave.,Indianapolis,Ind. Willowbrook GC, Inc.
242.	Reynolds, A. J.	Dayton, Ohio Miami Valley GC
243.	Reynolds, G. H.	Dayton, Ohio City of Dayton
244.	Riley, Wm. F.	2121 Madison Ave.,Indianapolis, Ind. Riley Lawn & Golf Equipment
245.	Rinaldi, Anthony L.	1915 Woodlawn Rd. Cleveland, Ohio
246.	Roach, W. J.	Wyoming, Cincinnati 15, Ohio Wyoming GC
247.	Robellaz, C. L.	R.R. 2, Lafayette, Indiana Edwood Glen GC
248.	Robie, Norman B.	Syracuse, Indiana South Shore CC
249.	Roby, Lewis	Anderson, Indiana Edgewood CC
250.	Rolfs, Ray	Milwaukee, Wisconsin North Hills CC
251.	Roseman, Warren J.	2610 Ridge Rd.,Evanston, Ill.
252.	Rosset, Gabriel	Sunset Ridge Rd., North Brook, Ill. Green Acres CC
253.	Runyan, C. R.	Sta.W.,Cincinnati 32, Ohio Cemetery of Spring Grove
254.	Russell, George F.	Louisville, Kentucky Big Spring GC
255.	Russell, Pat	Louisville, Kentucky
256.	Sanders, J. B. Jr.	Auburn, Indiana Auburn CC

257.	Schacht, Robert	Terre Haute, Indiana CC of Terre Haute
258.	Schmal, Walter	Dyer, Indiana Longwood CC
259.	Schread, J. C.	
260.	Schroeder, Clarence	R.1, Meenah, Wisconsin
261.	Schultz, Walter	Louisville, Kentucky
262.	Scobee, Marvin K.	Indianapolis, Indiana Highland G & CC
263.	Scott, W.W.	3600 N. 2nd St., St. Louis, Mo. Mallinckrodt Chemical Works
264.	Seaney, Wm. L.	Crawfordsville, Ind. Swift & Co.
265.	Self, Herbert	Ft. Knox, Kentucky Golf Course
266.	Sellers, Everett	Glenview, Illinois North Shore CC
267.	Shafer, George	Greenville, Ohio Greenville CC
268.	Sharvelle, Eric	Lafayette, Indiana Purdue University, A.E.S. Bldg.
269.	Shock, Earl	Dayton, Ohio Community CC
270.	Shockley, W. F.	P.O. Box 387, Terre Haute, Ind. CC of Terre Haute
271.	Simmons, Howard E.	Cleveland 22, Ohio Highland Park GC
272.	Simon, E. J.	Rockford Park Dist., Rockford, Ill. Sandy Hollow GC
273.	Simpson, John R.	Dyer, Indiana Longwood CC
274.	Sincerbeau, Richard	3300 N. Saginaw, Flint, Michigan Flint Park Board
275.	Slack, Wm.	Ft. Wayne, Indiana Ft. Wayne CC
276.	Smith, Colin	19512 Kings Hwy, Warrensville Hts., O. Shaker Heights CC
277.	Smith, Howard	Syracuse, Indiana S. Shore GC
278.	Stupple, Wm. H.	647 Michigan Ave., Highland Pk., Ill. Exmoor CC
279.	Smith, Wm. R.	Chicago, Illinois George A. Davis
280.	Sopko, Mike	29007 Euclid Ave., Wicliffe, Ohio Pineridge CC
281.	Soutar, Jim	Bloomington, Indiana Nat'l Greenkeepers
282.	Sprenger, Fred C.	Peoria Park Bd., Peoria, Ill. Newman GC

283.	Springer, Carl S.	Hartville, Ohio Congress Lake Club
284.	Stafford, Dwight E.	376 N. Holmes Ave., Indianapolis, Ind. South Grove GC
285.	Stampfl, John J.	Milwaukee, Wisconsin Milwaukee CC
286.	Standish, J. D. Jr.	618 Buhl Bldg., Detroit 26, Michigan
287.	Stanley, W. H.	Hoopeston, Illinois Hubbard Trail CC
288.	Staten, Earl	
289.	Staudt, Albert J.	2045 W. Pratt Ave., Chicago 45, Ill. Edgewater GC
290.	Stewart, C.E.	7658 Calumet Ave., Chicago 19, Ill. Buckner Mfg. Co.
291.	Stewart, Edward N.	R.R. 2, Hinsdale, Illinois Butterfield CC
292.	Stewart, Peter	Hinsdale, Illinois Butterfield CC
293.	Strand, Donald G.	2601 Glenview Rd., Wilmette, Ill. Westmoreland CC
294.	Strauss, Robert J.	Cincinnati, Ohio Pub. Red. Comm.
295.	Stupple, Wm. H.	647 Michigan Ave., Highland Pk., Ill. Exmoor CC
296.	Sylvester, E. J.	Piqua, Ohio City of Piqua
297.	Tait, Dave	Paris, Illinois Elks CC
298.	Tankersley, D. R.	351 E. Kyger St., Frankfort, Ind.
299.	Tarry, Jack B.	Rt. 5, Elyria, Ohio Spring Valley CC
300.	Tesmer, Walter	Breckeville, Ohio Sleepy Hollow Club
301.	Teuber, Robert	756 Elizabeth St., Flint 4, Michigan
302.	Thode, Reuben H.	Chicago, Illinois Chicago Park District
303.	Thomas, E. L.	301 West Maryland St., Indianapolis Kenney Machinery Corp.
304.	Thomas, James R.	Forest Park, Illinois Forest Home Cemetery
305.	Thompson, Jack	R.2, Tippecanoe Rd., Canfield, Ohio Tippecanoe CC
306.	Tiffany, H. M.	2750 W. 35th St., Chicago, Ill. Albert Dicinson Co.
307.	Todd, Nicholas	Montgomery, Ohio Swain Fields GC
308.	Turner, Gerald A.	Brook, Indiana Hazelden CC

309. Updegraff, W.E.

310. Urzzlinski, Frank — Toledo, Ohio
City of Toledo

311. Verhaalen, Lester — 6800 W. Good Hope Rd., Milwaukee 9, Wisc.
Brynwood CC

312. Verhaalen, Ronald — Milwaukee, Wisconsin
Brynwood CC

313. Volk, N. J. — Lafayette, Indiana
Purdue University (A.E.S. Bldg.)

314. Wachowski, P. — Lisle, Illinois
Woodridge GC

315. Wakely, Ted — Toledo, Ohio
Chippewa CC

316. Walker, Charles J. — Indianapolis, Indiana
Speedway GC

317. Warnecke, M. J. — Flossmoor, Illinois
Idlewild CC

318. Warren, B. O. — Palos Park, Illinois
Warren Turf Nursery

319. Weeks, Henry F. — R. 2, Ohio City, Ohio

320. Wessel, Arnold — Milwaukee, Wisconsin
Ozaukee CC

321. Whitcomb, James E. — R.R. 15, Box 743, Indianapolis, Ind.
Riverside CC

322. White, Maurice — Peoria, Illinois
CC of Peoria

323. Widener, Howard — R. #8, Anderson, Indiana
Edgewood CC

324. Wingo, Wilbur — Macomb, Illinois
Macomb CC

325. Winters, Alan C. — Brow Rd., R. 7, St. Louis 14, Mo.
St. Louis Country Day School

326. Wirt, James — Wheaton, Illinois
Arrowhead GC

327. Woehrle, Herman — R. 3, St. Anne, Illinois
Hieland Lodge G & CC

328. Wohlfeill, Ernest — 4530 State Rd., Saginaw, Michigan
Green Acres GC

329. Wolfe, Larry — Akron, Ohio
Resemont CC

330. Wolfrom, Clarence — 11341 Chicago Rd., Warren, Mich.
Maple Lane GC

331. Wollenberg, Edwin — 123rd & Ridgeland Ave., Worth, Ill.
Navajo Fields GC

332. Woodrow, Douglas — Janesville, Wisconsin
Janesville CC

333. Wright, Alph — Sharonville, Ohio
Hamilton C. Pk. District

334. Wright, Leland — New Castle, Indiana
Westwood CC

335.	Wyman, Allan	R.R. 2, Danville, Illinois Danville CC
336.	Yanaway, John F.	714 Ninth St., Charleston, Ill. Landscaping
337.	Young, O. W.	4075 Southern Blvd., Dayton, Ohio Moraine CC
338.	Zoller, John A.	

WELCOME

H. J. Reed, Dean of School of Agriculture
Purdue University, Lafayette, Indiana

Mr. Chairman, and gentlemen. It's a real privilege for me to welcome this group to the University. I think it's always fine when the University can entertain a group that is using the tools of science and research to improve its members' conditions and the conditions of the groups it represents. That accomplishes two things.

First, I think it's always good for a group to get together. Just by talking, you get a lot of good ideas. Lots of times that's the best part of a conference. Another thing is that in the conversations and the regular sessions you bring out a lot of new ideas. These ideas open up new fields of thinking, new ideas for research and new problems that ultimately are carried back to the wider groups, and we feel that this is very worthwhile. So naturally it's a real pleasure to have you men come.

Gerald said he didn't know if this was the fifth or the fifteenth turf session. I remember one we held back in 1937 that was composed of about 20 men. I think they were all greenkeepers. You men number about 400, so that's making wonderful growth! To me, it's evidence of the service that you are not only able to get from a conference, but it's evidence of the greater need of service for the future.

Now Gerald and the men that are working with him--Kenyon Payne and Dr. Sharvelle and Richard Davis and Earl Staten-- they get a bang out of such meetings as this. The reason is that we are bringing together a lot of very practical men with honest-to-goodness problems that need solutions. I don't know of any better way to put fellows on the spot than to tell them the real problems you have. Just put them on the barrel head. You know this theory stuff is all right. But when you solve problems, you have to solve them where they are by yourself. I think this is very stimulating, because there's challenge there. And you must be near enough right, anyhow, to do a good job. So then we appreciate the privilege of meeting with you and having you meet with our men.

I want to thank you in behalf of the University for the fine help and cooperation we have had through the

Midwest Turf Foundation. As I see it, it is going to give us opportunity for more real constructive work. And I think it's a wonderful thing when we realize that out of a small bit of research sometimes comes wonderful results. I was talking to a man not long ago-- we were discussing this question of research. Real value comes from it and sometimes when you're not thinking about it. Many years ago Dr. Hoffer of this institution-- many of you know him-- was interested in working on the breeding of corn. This was breeding for disease resistance. In so doing he and others worked out pure lines that are really the basis for a lot of the hybrid corn today. It was the beginning of our hybrid corn experiments at this institution, and this was the first institution in the corn belt doing this type of work.

Well, that was a good many years ago. The thing I wanted to say to you fellows is this: that between Pearl Harbor and Hiroshima, hybrid corn more than paid for all of the expenses involved in that great Manhattan project. That was just a little piece of research a number of years ago that was paying us almost a billion dollars a year during the war when we had to have corn. That's just one little piece of research.

The work you fellows are concerned with may have many very practical and worthwhile results that you can't see now. So I think it's interesting and challenging-- certainly stimulating--when you can come together to discuss your problems and the results of scientific work that may have some very far-reaching effects.

I will not take any more of your time. I want you to know we are glad you are here and hope your conference proves to be very satisfactory. I'm sure that as time goes on you fellows will form sort of an alumni association and one that you can be very proud of, because there is so much to be found out. When you put the plant breeder and the soil scientist and then just good practical men together, you're going to come out with results. I'm always confident of that. I hope that you have a good time.

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THE GOLF COURSE, THE GREENKEEPER AND THE PLAYER

James D. Standish, Jr.
President, U. S. Golf Association

Dr. Mott and Gentlemen: It is very pleasant to be back at Purdue again and to see so many of the same faces that I saw four years ago when as a Freshman in greenkeeping work, I came to talk to you about the USGA Green Section. There were only about 80 in attendance at that time and it is certainly very gratifying to notice the growth of the Midwest Turf Foundation to the point where over 380 now are present. I am sure Dr. Mott must be pleased as well as Dr. Grau, who conceived the idea of universities cooperating with the Green Section all over the country.

Dr. Grau can give you exact figures, but I believe we now have 20 or 25 such cooperating stations. It is interesting to note that the Georgia Coastal Plains Station at Tifton, Georgia, has been taken over by the Southern Golf Association for the benefit of their members, much as the Midwest Turf Foundation is sponsoring the work here at Lafayette. It is the aim of the USGA Green Section that eventually, groups or associations will relieve us of the necessity of direct supervision and that the various stations will be self-sustaining. Dr. Grau's position in the overall picture will be that of coordinator of research.

Dr. Mott told me, when he invited me to this conference, that I might speak on any subject I saw fit. Certainly I cannot discuss technical subjects with you, so I'm going to tell you something of the aims and activities of the USGA.

I've always felt that it would be far better for Golf if greenkeepers understood more of other golf problems and if players and club officials understood more of the greenkeeper's problems; in other words if there was a better all around understanding of what the administration of Golf is all about, everyone would profit. I had the pleasure last Fall of attending the G.S.A. Championship Golf Tournament at Medinah in Chicago and I was glad to see so many good players among the greenkeepers. I presume most of you do play golf once in a while, and I think playing will help you all in understanding what your Green Chairman is looking for in the course upkeep. Likewise, I think your efficiency will increase if you know and realize just what the USGA is trying to accomplish.

It was with such an idea in mind that about two years ago, Timely Turf Topics, issued by the Green Section was discontinued as a separate bulletin and joined with the "USGA Journal". There was quite a clamor at the time from some of the purely technical men, but I think most of you will agree that the results have been of benefit to both the greenkeeper and the club member. The circulation of the Journal has increased steadily to a monthly printing of about 10,000. Just think of the turf lore and information on all the different phases of golf that this medium is spreading.

One of the problems of circulating the USGA Journal has been to get it into the hands of the greenkeepers. All our clubs have been asked two or three times to see that their copy reaches you and if it does not, because some club official uses it, to see that an additional copy is ordered for your accommodation. If this has not been done, the price of a year's subscription is only $2.00 a year and I think it is well worth that amount to any of you.

The USGA now has passed the 1400 mark in members, the most we've ever had, and this has been accomplished by keeping the annual fee at a low rate. We are very anxious that all clubs no matter how small have the opportunity of joining in the various developments that have been accomplished. There is associate membership, of course, for public courses and we wish all courses in the States to join the USGA eventually; 1400 out of a total of 6000 courses in the United States is not doing so badly.

The USGA Executive Committee is composed of 13 members and a general counsel. Meetings are held four or five times a year and we have been spending more and more time lately on Green Section affairs. I know you all agree that we are fortunate in having the leadership of Dr. Fred Grau, who has proven to be a great organizer.

We have two offices, one in New York and one in Washington which is devoted to Green Section work. Fourteen or fifteen full time employees work for us and as salaries are continually rising while our dues have not, we are delighted when any group is organized to take the responsibilities of financing our cooperating experimental stations off our hands. To show the scope of the USGA's work I point out that our budget for 1950 is in the neighborhood of $130,000 of which roughly one-third is paid out in salaries. This money is raised from dues and the gate receipts from various events, of which we sponsor six annually in addition to the International Matches, which are,of course, rather expensive.

We have 14 standing committees with a total membership in them of between 200 and 250. These committees report at the meetings of the USGA Executive Committee and I shall enumerate some of the more important.

The Rules of Golf Committee last year made 262 decisions, of which perhaps 25% were the result of not thoroughly reading the Rules book, but 75% of them were honest to goodness questions,which demand consideration of rules revisions.

The Championship Committee and particularly its Chairman is one of our most active committees. Anyone who has attended a Championship knows how hard the chairman of this committee works in giving assistance to the greenkeeper in the placing of Holes and the selection of Tee locations. Its a big job and we are very fortunate in having the men who can do this work.

Since the war, the Implements and Ball Committee has been very active. You all know of the furor about the markings on clubs during the past few years and how so many competitors found it necessary to file down their irons to conform to regulations. Now, this work has been done and the reason for it is well understood. Elimination of the sand wedge, has been considered, but rejected and I know you will all be pleased to continue using these clubs.

The Amateur Status Committee receives about two hundred requests annually for reinstatement or clarification of the rules, arising from border line cases. We are trying to keep the sport clean and deplore any attempt at semi-professionalism.

The Public Links Committee annually conducts the Public Links Championship Meet. The same group of 15 or 20 men has composed this Committee for a long time and work most unselfishly at the tournament and give of their time and money freely to attend the event every year. They are to be congratulated on their devotion to Golf and their effective service.

The Sectional Affairs Committee is composed of about fifty men who are located at strategic points all over the country and particularly where sectional qualifying rounds for our championships are held. Most of you have probably met your local committee man and I know you have found his assistance in arranging Tournaments invaluable.

Besides the Committees I have mentioned, there are the Handicap and Public Relations Committees and a Womans Committee which handles the women's events, so you can readily see that the activities of the USGA cover a broad scope and while to you, Green Section matters are of first importance, its activities actually amount to about one-third of the work the Golf Association undertakes.

Now I am going to make a couple of suggestions to greenkeepers which will help keep your members happy, but which really are rather trivial. First, get your benches painted and in place on the tees before the start of the season. The older players need a moment's relaxation during rounds particularly at the start of the year and its a long pull around 18 holes without a chance to sit down. My second suggestion is that you give careful consideration to Ground conditions in the placing of tees and holes. When the ground is heavy after rains in the Spring, use the front tees and easy pin positions, but lengthen the course out as the turf dries and there is more roll on the ball. If you don't follow this routine, your club's handicap system will be thrown out of kilter, and much dissatisfaction will result.

The latest effort of the USGA is the instigation of the "Golf House" campaign. For a number of years our present quarters have been inadequate for our expanding activities and besides, it is inevitable that these quarters will not be available long. So we are attempting to raise a sufficient sum to purchase a modest building in mid-town New York, which, as well as providing proper administration quarters will also house our Museum of rare and old Golf items which are of general interest. The Green Section will be represented by exhibits on current topics as well as by the fine collection of books on Turf work which has been accumulated.

I am very happy to tell you that our new Turf book "Turf Management" has been completed by Professor H. B. Musser of Penn State as author with Messrs. Graffis, Noer, Farnham and Grau as its editorial board. The manuscript is now in the hands of the publishers, McGraw, Hill and Co. and should be ready for circulation by the end of Summer. It is going to be a well illustrated, 400 page book, not too technical for an interested green chairman to read and will probably sell for about $5.00.

I hope that this brief outline of USGA activities has been of interest to you and if any of the fellows here do not have USGA affiliation, either Dr. Grau or I have application blanks for membership in our pockets. The more clubs we have as members, the better the USGA will be, and I sincerely hope that any club not belonging now, will soon join.

Again, many thanks to Dr. Mott and to the Midwest Turf Foundation for giving me this opportunity to chat with you and best of luck to all with your 1950 Turf problems.

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SOIL STRUCTURE, AERATION, AND DRAINAGE

Helmut Kohnke, Associate Professor of Soils
and
Richard Davis, Graduate Assistant
Purdue University, Lafayette, Indiana

As you see on the program, our subject is soil structure, aeration, and drainage; with no mention of irrigation. From this we assume that your biggest problems are in getting rid of excess water rather than problems in irrigating. We will assume that you have an artificial irrigation system and all the water you need, so we can dispense with the subject of irrigation.

Why are we interested in soil structure? Let us consider golf greens since most of you are primarily interested in golf courses. First, the soil in golf greens must have a structure that will support a man's weight without foot-printing. It must also be able to hold the ball, let it roll true, and all those things that are necessary for satisfactory play. Second, and most important from our point of view, the soil structure must be such that grass can grow satisfactorily. What has soil structure to do with growing grass? Immediately we become concerned with aeration and drainage. The soil consists of three parts essentially (1) the solid particles, and pores between the solid particles that are filled with either (2) water or (3) air. The more water you have, the less air and vice versa. Both air and water are essential for plant growth. We must have drainage to remove excess water so that air can get into the soil. The whole problem of drainage is maintaining a proper balance of air and water.

Let us now consider some of the fundamentals governing the amount of water and air in a soil. The application of these principles will be considered later. If we take a glass tube with a very small opening (a capillary tube) and stand it in water, the water will rise in the tube to a level higher than the water surface. How much higher it will rise will depend on the size of the opening in the glass tube. The smaller the opening, the higher the water will rise. If the water in the tube is observed closely, it will be noticed that rather than being level, the surface is cup-shaped with the water next to the glass walls being highest. This action is due to the greater density (weight) of the glass which causes it to have a greater attraction for water than water particles for other water particles. This attraction is the same force that causes objects to drop to the earth, the force we call gravity.

Why should we be talking about glass when we are interested in soil? Soil has practically the same attraction for water as glass. As in the case of glass, small openings or pores will pull water up higher and hold on to water more tightly than large pores. Consequently, a silt with fine particles and small pores has a greater attraction for water than a sand with coarse particles and large pores.

Soils do not ordinarily occur in nature as individual particles, but as aggregates or clumps of particles. The pores within the clumps are small and hold on to water tightly, so they are called water holding pores. The pores between the clumps are large and water can be readily drained from them, so they are called aeration pores. Unfortunately these clumps are broken down if disturbed while wet. Walking on a green when it is wet will cause such a disturbance. Consequently it is necessary to have quantities of coarse particles (sand) in a green to insure a supply of large pores if the clumps are broken down.

If we put a column of soil in contact with a free water surface (water table) the soil just above the water level will be practically saturated with water. Both large and small pores are filled. As we go higher above the water level, the pores have to be continually smaller in order to be filled with water, As a result, the soil gets drier and drier as you get higher above the water table. The same principle holds for irrigation or rain water. The small pores hold the water and the large or aeration pores drain free. These aeration pores are very important to plant growth. An agricultural soil is considered poor if less than 10% of the total soil volume is aeration pores. Most golf greens have considerably less than this amount.

Let's look at some of the properties of sand, silt, and clay. Sand is, of course, the largest of the three particle sizes and clay the smallest. You can see from the table the importance of having sand in a green. Notice that large aeration porosity and good drainage go hand-in-hand.

Table I.

	Sand	Silt	Clay
% total pore space	small	large	very large
Water holding capacity	small	large	very large
% aeration pore space	large	none	none
Ease of drainage	easy	difficult	very difficult

Water in the soil may be broadly classed into three classes: Gravitational water, capillary water, and hygroscopic water. Gravitational water, as the name implies, moves under the force of gravity. It is the water that is free to drain and thus may be called drainage water. Soil containing gravitational water is, of course, wet. Capillary water is left after drainage is complete under conditions of good deep drainage. A soil containing capillary water but no gravitational water is moist. This is the soil moisture range where conditions are best for plant growth. Water is available in sufficient quantities but not in excess so that air is excluded. This soil moisture range, which is also known as available water, is the range in which soils can be cultivated without destroying the structure. Unfortunately, many golf greens are kept wet instead of moist. The excess water replaces badly needed air and also causes the soil to become more and more compacted. Hygroscopic water is of no practical significance to the plant. The water is held so tightly that it is not available to the plants. Soil containing only hygroscopic water appears dry.

We have a demonstration to show the effect of particle size on drainage and aeration. One funnel contains medium sand, the other contains silt. Both are saturated with water. By lowering one side of the apparatus, we exert a pull on the water in the soils equal to the distance we lower the water level. This water level corresponds to a tile. At a tile depth of 15 inches we clear pores of water and pull air through the sand. This means that if you had a green of pure sand this size, drainage into a tile 15 inches deep would aerate the upper 2 - 3 inches of the green. A deeper tile would drain enough to aerate more of the green. We are not able to pull air through the silt at 40 inches which is as far as we can go with this machine. In other words a tile 40 inches deep will not aerate this soil. We pointed out previously that a silt as such has no aeration porosity.

The effect of tile depth on soil drainage can easily be shown with two sponges. These sponges were thoroughly wet before the meeting started. You have probably seen them dripping all along, but they have stopped dripping now. Imagine each of these sponges to represent a foot of soil with a tile at the bottom. Water has stopped running out of the tile. In other words, the soil has drained all it will if the tile is one foot deep. Now we simulate putting the tile 2 feet deep by turning the sponges one over the other so that they just touch. Water from the top sponge drains into the lower one and drips out the bottom. So you see that a deep tile will drain a soil drier than a shallow tile, within limits, of course.

We have pointed out previously that a small pore holds water more tightly than a large pore. For this reason water moves from a fine soil (small pores) to a coarse soil (large pores) only with difficulty. This we have demonstrated with columns of loam soil with and without a coarse sand layer. In two columns the water has been added from the top. Exactly the same quantities of water were added to both at the same time. Notice that in the column containing the sand, the soil is wet to the sand layer but no farther, while the unlayered column is wet farther down. The water cannot move into the sand because the small pores of the loam have a much greater attraction for the water than the large pores of the sand. If we continued to add water until the loam above the sand becomes saturated, the water will practically drip into the sand and move through readily. However, the soil above the sand would remain very wet until evaporation or transpiration (loss of water from plants) removed the water.

It could never be dried by drainage.

The other two columns have been wetted from the bottom. Again one has a sand layer and the other is uniform throughout and again the water stops at the sand layer. It is the same principle that stopped the water moving downward. The large pores in the sand do not have the attraction to hold the water at this height above the water table (free water surface). The entire length of the uniform column would have been wet had we not taken the water away. This demonstration illustrates why a golf green should not be layered. It doesn't have to be a sand layer to be undesirable. A clay, gravel, or organic layer would be as bad or worse. The greater the difference in particle size (pore size) the more aggravated the situation would be.

How can you prevent layering in a green? First of all the topsoil should be thoroughly mixed when constructing the green. It is doubtful that this can be done on the green. If thorough mixing is done before the soil mixture is put on the green, you are certain that there won't be layers before the grass is planted. You should know the ingredients of the topsoil mixture so that the topdressing mixture to be used later can be made exactly the same. In this way layers can be prevented. If you already have layers in a green, anything you can do to break them up should be a help. Precautions should be taken to prevent forming other layers.

Now let's get down to the practical application of some of the principles we have been talking about. Here is an instrument designed to tell you when your soil needs irrigating. It is called the Bouyoucos moisture meter after the man who developed it. The meter measures soil moisture only in the moist range--that moisture range which we said was most desirable for plant growth. It registers 100% available water at the wet end of the moist range and 0% available water at the dry end of the moist range. Dr. Bouyoucos recommends irrigating when there is 50% available water in the soil. These gypsum blocks containing two electrodes must be used along with the instrument. They are buried in the soil at the depth where you are interested in the moisture content--in the root zone--and left there. You then come around with your meter, attach the leads, and read the moisture content immediately. The blocks have to be replaced each year as they gradually break down in the soil. This meter should be practical on a golf course, particularly on greens that are inclined to be over-watered.

All of you have seen the condition where the grass on greens wilts even though the soil is wet. This occurs in hot weather and usually on grass that has a weak root system. What is happening is that the plant is losing water faster by transpiration than it is able to absorb water through the roots. The natural tendency is to pour water on such an area. Adding water to a soil that is already wet will deprive the plant roots of what little air they have. What can we do about a situation like this? Of course the permanent cure is to develop a stronger turf by improving management practices, but something must be done immediately. The approved practice is to lightly sprinkle the wilted grass with water. In this way the grass leaves are wetted without unnecessarily wetting the soil which is too wet already. This light sprinkling effectively reduces transpiration by reducing the temperature and increasing the humidity of the air immediately surrounding the grass.

Another possible way of combating this condition of wilted grass and wet soil that might be tried is to wet an area of the approach or fairway on the side of the green where the wind will blow the cool, moist air over the green. Perhaps this method would never be practical, but it is worth a try. You would be sure not to add more water to the soil on the green to further aggravate the condition.

The problem as to what soil mixture to put on golf greens is a real and important one. Of all the things necessary for growing grass (water, fertilizer, air), air is most likely to be limiting. It has already been pointed out and demonstrated that sand is needed in a soil mixture to provide air space. It is not practical to use all sand on a green, but certainly a large proportion of sand can be used. A suggested minimum of sand is 60%. More than 60% sand would probably be desirable. The amount of sand that you should use depends somewhat on the type of soil you mix with it; the heavier the soil, the more sand you should use. This large proportion of sand in greens is not the most desirable condition for holding water and fertilizer, but it is necessary to allow enough air in the soil.

Now that we have the soil mixture, how are we going to drain it? How deep should we put our tile? Surface drainage is essential and should be provided for by properly grading the green. We will say no more about surface drainage and get to the more difficult problem of internal drainage. It has been repeatedly demonstrated that a deep tile drains a soil drier than a shallow tile, however, a shallow tile will probably drain off excess water faster than a deep tile. With these principles in mind it seems that a two-tile-depths system would be feasible. A tile 3 feet deep and a tile 1 foot deep could be alternated. The 1 foot tile would take off the excess water faster and the 3 foot tile would drain the soil to a desirable moisture content. If only one tile depth is used, a depth of about 3 feet is suggested.

What should we use to backfill the tile trenches? This is a very much disputed point. Ideally, we would like to have 3 feet of a good topsoil all over the green with the tile at the bottom on the subgrade. This much topsoil is ordinarily not economically possible. A rather common practice with conflicting reports of success and failure is to backfill with gravel or cinders to 6 to 10 inches from the surface. Based on the principles we have demonstrated here, this is not the most desirable practice. The soil above the gravel would still be wet when drainage stopped because, as we have shown with the sand layers, the coarse materials have very little attraction for water. This same area above the gravel that is too wet during wet periods would be too dry during dry periods because the water lost through evaporation and transpiration would be replaced from below too slowly. A little gravel (1 - 2 inches) just above the tile to insure against its filling up with soil is justified.

Rather than backfilling with coarse material or something else, we would suggest using the topsoil mixture. In this way you have a uniform mixture from the surface to the tile. If the mixture contains plenty of sand as it should, it will drain freely.

Some people have used and recommended a layer of coarse material under the topsoil. This is a very undesirable condition, especially if the layer is not 3 feet deep or deeper. It has been demonstrated here with the sand layers that such a layer definitely interferes with the movement of water both up and down.

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THE OPERATION AND MAINTENANCE OF INTERNAL COMBUSTION ENGINES COMMONLY USED IN TURF MAINTENANCE

Charles Gardner, Sales Engineer
Briggs and Stratton Corporation

Gentlemen of the greens and fairways, Dr. Mott of Purdue University recently requested that our company furnish a man for this program to discuss with you the operation and maintenance of the internal combustion engines commonly used in golf course and turf maintenance. Our time, which is two hours, is extremely limited and only the broad essentials and critical points can be covered. I will, therefore, steer the discussion to include as complete a coverage as possible, but sincerely request you help make this a discussion, as intended, instead of a lecture. Your questions on any point will be welcomed and, if of general interest, considered here. If of special interest to only a few, I will be available at any hour outside the scheduled program to assist you to the best of my experience. Due to my selection and the industry I represent, I will assume that the small gasoline burning engines used to power lawn mowers, sprayers, pumps, soil shredders, cement mixers, and other portable tools, are the real subject of our discussion, although the principles and precautions of operation apply to all internal combustion engines whether of small or large horsepower.

Even with these limitations, we will find considerable variation in classification of engines. The first classification and, from an engineering standpoint, the most general classification is based on the cycle on which the engine operates. Specifically, before going into any details we should know whether we are dealing with the two stroke cycle, commonly shortened to two-cycle, or the four stroke cycle, commonly shortened to four-cycle. To illustrate the two stroke cycle, I have secured a chart (Plate I) and to illustrate the four stroke cycle, I will use the cutaway model of the four-cycle engine. (See Plate II)

The Two Stroke Cycle

Our artist has depicted on this chart four illustrations, illustrating the event in a typical two-cycle engine. The type illustrated is the simplest, the three-port engine.

The two "stroke" cycle engine differs somewhat from the four "stroke" cycle engine used in your automobile and this difference is due to the method of conducting gases to and from the cylinder while in operation. The two "stroke" cycle engine employs an arrangement of ports rather than mechanically operated valves to accomplish this purpose, as shown in illustration I. On the first upward stroke of the piston, a partial vacuum or low pressure is created in the crankcase. As the piston progresses in its upward movement and it nears the end of the stroke, intake port (A) is uncovered causing fuel vapor from the carburetor to flow into the crankcase (B). The crankcase is now fully charged.

The piston on reaching the end of the stroke reverses its direction and begins the downward movement, covering or closing intake port (A). On its continued downward movement the vapor charge in the crankcase is compressed until the piston nears the end of the stroke, when the by-pass port (C) is uncovered. (Illustration 2) This instantly releases the compressed crankcase charge, which flows through the by-pass and into cylinder (D), being directed upward by the piston deflector provided for this purpose.

On the following upward stroke (Illustration 3) the vapor, now having been transferred to the cylinder, is compressed and prepared for ignition. However, during this period a second charge has been drawn into the crankcase through the intake port (A). There are now two charges, one compressed in cylinder (D) and the charge in the crankcase.

At the end of the compression stroke a spark created by the magneto jumps the gap between the points of spark plug (G) igniting the compressed fuel vapor in cylinder (D). The vapor in burning expands rapidly, forces piston (F) downward to deliver power required to turn the crankshaft. Power, however, is not delivered throughout the entire length of the stroke, some time is required to rid the cylinder of burned gases and to receive a fresh charge from the crankcase for the succeeding power impulse. As the piston travels downward on its power stroke, the fresh charge previously drawn into the crankcase is being compressed.

Notice that the width of exhaust port (E) and by-pass port (C) is considerably wider in the case of port (E). Therefore, the piston (F) on nearing the end of its stroke (Illustration 4) uncovers the exhaust port somewhat earlier than it uncovers the by-pass port.

A comparatively high pressure exists within the cylinder at this time; consequently, at partial uncovering of the exhaust port (E) the burned gases commence to flow out through the exhaust port. Further travel of the piston uncovers by-pass port (C). The compressed vapor charge now in the crankcase is instantly released, flowing through the by-pass port into the cylinder and directed upward by the deflector. The incoming fresh charge continues to force the burned gases out of the cylinder through the exhaust port and into the atmosphere to complete the cycle.

Now I have used four charts to indicate the cycle of the two cycle engine, but I did it only to illustrate how the thing gets started, once it is started only these two strokes-- the down stroke and the upstroke-- are used, and we get a power stroke every down stroke, together with a compression of the crankcase mixture, and an intake stroke and compression stroke every up stroke of the piston.

Variations of the three-port cycle engine are the reed valve engine and the rotary valve engine. In the reed valve type we simply eliminate the port (A) and introduce through another opening into the crankcase a passage through which a mixture of air and gas can be drawn from the carburetor and use a check valve, usually in the form of a series of flat springs. That would mean that on the up stroke when there is less atmospheric pressure in the crankcase, we will draw in this mixture of oil, fuel and air to the crankcase, but on the down stroke when there is compression in the crankcase, up until the time the mixture is forced through the by-pass port (C), these reed valves will be closed and make the crankcase gas-tight. The rotary valve is simply a mechanical method of accomplishing the same thing as I illustrated at first where the piston is used to uncover port (A). In this type engine a machined spot on a cylindrical section of the crankshaft is used to do the same thing. This machined spot uncovers at the proper time the passage from the carburetor to the crankcase. Has any one failed to follow me on the two stroke cycle?(answer negative).

The Four Stroke Cycle

On the four stroke cycle we have the same factors of intake, compression, power stroke, and exhaust, but we accomplish it in a different manner, by using four strokes. Starting with the piston at top dead center, when we start to crank the engine on the intake stroke

Plate I — THE TWO-STROKE CYCLE

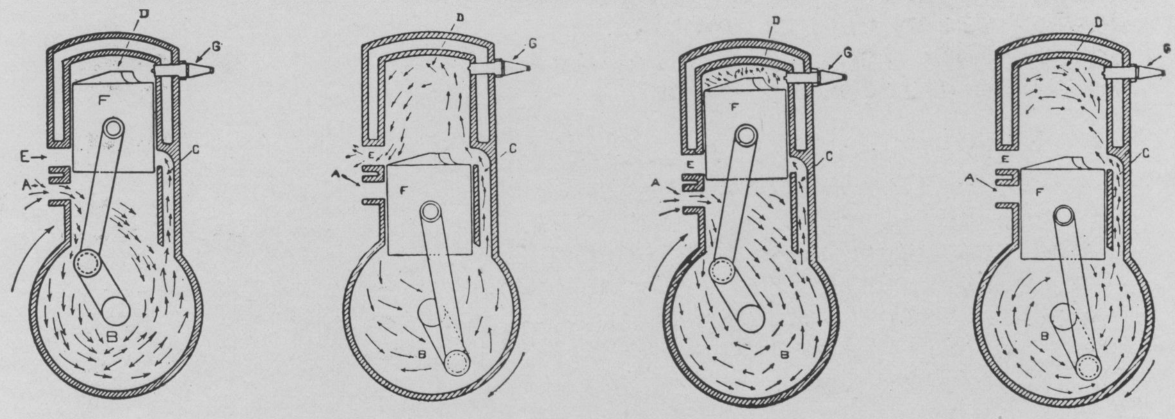

Illustration:
1 2 3 4

Plate II — THE FOUR-STROKE CYCLE

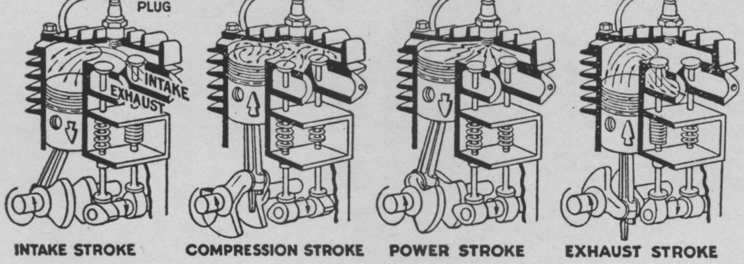

Illustration:
1 2 3 4

(see illustration 1, Plate II) the piston goes down, creating a vacuum in the cylinder which draws gas through the open intake valve into the space above the piston. This intake valve has been opened by a cam driven from a camshaft geared to the crankshaft. At the bottom of this suction stroke, as we call it, the intake valve closes so that on the compression stroke (see illustration 2, Plate II) the piston comes up with both valves closed, highly compressing the gas into the space left between the top of the piston and the cylinder head.

At a point 25 degrees before top dead center on the compression stroke, the compressed mixture is fired with a spark plug, the same as in the two-cycle engine. The momentum of the flywheel carries the piston through top dead center and the exploding or rapidly expanding gases drive the piston down, creating the power to turn the crankshaft. Near the bottom of this stroke the exhaust valve opens and on the succeeding upward stroke of the piston, called the exhaust stroke all of the burnt gases are forced out the exhaust valve, completing the power cycle. We have, therefore, accomplished the same thing as in the two-cycle engine, but we have done it by a different method or a different cycle. Has any one failed to follow my illustration of the four stroke cycle, or are there any questions on the operation of the four-cycle engine?

Question: The question is why do we fire the compressed mixture 25 degrees before top dead center?

Answer: This 25 degree advance of the spark before the piston has reached top dead center is to take advantage of the time element required to completely fire the mixture and permit the explosive action, or most violent expansion of the burning gases to occur at or very shortly after top dead center. The advantages of the two types of cycles differ. In fact, what is an advantage in one is a disadvantage in the other and vice versa. Because we get a power stroke every revolution on the two-cycle engine, it is theoretically probable that we can get more horsepower from the same size of engine, and that is true. Theoretically, we could get 100 percent more horsepower, but actually some problems arise. As illustrated in illustration 2 of Plate I, the charge of air and fuel is being directed upward by the baffle from the piston and is pushing or driving out the burned gases. In doing so, the incoming charge partially mixes with the burned gases and we say we do not get perfect scavengings. As a result, we do not get perfect power performance and as a result the two-cycle engine at best averages 1.7 of the horsepower of a similar engine of four-cycle operation that has the same bore and stroke and is operating at the same RPM. In the four-cycle engine scavenging is improved because a whole stroke is used to do it and the piston forcibly expels practically all of the burned gas, with the exception of a very necessary but relatively small volume above the piston at top dead center. We must have this clearance above the piston in both types of engines, and this clearance, incidentally, controls what we call the compression ratio. Were it not for this clearance, the compression stroke would find no place to compress the mixture of air and fuel and we would blow the top of the cylinder head off, or blow out the cylinder head gasket, or damage the piston or connecting rod. Furthermore, we would complicate the problem of ignition as the gases would be fired by their own temperature, creating backfiring or knocking.

Summarizing, the advantages of the two-cycle engine are principally that of light weight per horsepower and the absence of complicated valve gear.

The advantages of the four-cycle engine are primarily better scavenging and more flexibility in throttling. That is, we can throttle more efficiently and change from low to high speeds back and forth more effectively than has yet been accomplished in the two-cycle type of engine.

So much for the engineers classification of the internal combustion engine. I have several other practical classifications:

The first practical classification is how we cool the engine. You are all familiar with the fact that water cooling, as in your automobile, is an accepted method and in many of the light engines, including those of our manufacture, nothing but air is used. In the one system you circulate water by one means or another around the heated portions of the engine and cool it externally. In our system, we take in cold air and by means of fins on a flywheel which represent a fan, we blow cool air through the fins on the cylinder head and cylinder and around the valves to cool them. The same principles are used on two-cycle engines, some are water-cooled, as illustrated in Plate I, while others are cooled by a blast of air from the flywheel fan.

Another classification is the type of the fuel system.

Either of these engines can use a gravity type fuel system, where the gasoline is stored in a tank above the carburetor and flows by gravity to the carburetor where it is checked, when the bowl is full, by a simple float check valve. The float level controls the gasoline to within a very small fraction of an inch of the jets and thus provides for carburetion. I am not going into the carburetion details because I hope to have time enough to handle it later in the period. The other type of fuel system is illustrated by the Model 58 engine I have on display (the system was also illustrated by chart). Here the gas tank is below the carburetor, the gasoline is raised or sucked up to the carburetor by the lowered pressures of the intake stroke and prevented from returning by a foot valve at the bottom of the gas line. This foot valve may have a disc type or ball type check. By this method gasoline is made available within a fraction of an inch of the jet and provides for carburetion as in the other system. So we have another classification which is the type of the fuel system used.

Another classification has to do with the position of the component parts of the engine, and that is considerably confused in the industry today. In the old days engine cylinders were usually horizontal and these engines became known as horizontal engines. Later, when we began to build upright engines we called them vertical engines because the cylinder was vertical. Recently, however, a demand for a different type of engine has been felt, and many manufacturers are producing an engine in which the cylinder lies horizontal and the crankshaft is vertical, and to you gentlemen the application is obvious, of course-- the rotary type lawn mower or the jet pump being illustrations. The confusion comes from the fact that some builders of this type engine called the engine with the vertical crankshaft the vertical engine, and the engine with the horizontal crankshaft the horizontal engine. I personally believe it will all be worked out and we will go back to the old nomenclature that the vertical engine has the cylinder in the vertical position regardless of where the crankshaft is or that the horizontal has the cylinder in a horizontal position regardless of the position of the crankshaft. So much for practical classifications of our engines.

Operating Precautions

Let's now get into the operating precautions, which is the real topic of our discussion this morning, and we will start off by saying that one of the first precautions is not to overload your engine. The manufacturer of your equipment has undoubtedly taken into consideration the horsepower requirement of his product. However, in the course of use, dulling, poor adjustment, wear, etc., may raise the horsepower required. So, before using any type of engine, we should first take the precaution to see that we are not overloading the engine, because no engine can operate long in a satisfactory manner when overloaded. You can detect overloading on your golf course equipment, or wherever your equipment is being used, by observing the throttle shaft. If under normal operating conditions and at all times, except for very brief periods of acceleration, the throttle shaft indicates that the throttle is not wide open, your engine is not overloaded. During moments of acceleration that's perfectly O.K., but under normal operating conditions you should have a little reserve left. You should be able to speed the engine up a little by manually forcing the throttle shaft further open against the governor.

Two-Cycle Engine Operation Precautions

Because of the nature of my employment, I do not profess to be entirely up-to-date on two-cycle engine operation, but from what I have been able to learn from studying operating instructions, as written in the operating manuals of modern two-cycle engine manufacturers' publications and from older personal experience, it seems that normally the spark plug gap for the two-cycle engine is greater than that of the four-cycle engine. A consensus of opinion seems to indicate that the spark plug gap should be .030" and the plug should be cleaned. Presuming that little is known of the engine that is to be started or that it has stood for some time, you should determine that the air filter, whether of the dry or oil bath type, is properly serviced and clean. I will emphasize the precautions to be taken on air filters, if I have the time, a little later. At any rate, they should be taken care of. In the case of the two-cycle engine, if the engine has been in operation a long time, it is desirable that you occasionally remove the muffler, at least every 100 hours, and scrape the accumulation of carbon from the muffler and from the exhaust port. The magneto on the two-cycle and the four-cycle engines are identical and I would like to cover them a little bit more closely later. The carburetor for the two-cycle engine is similar to that of the four-cycle and we will skip its particulars for the moment and take it up more thoroughly later in the period. The two-cycle engine, because of using the crankcase to compress the fuel and air mixtures, cannot have a reservoir of lubricating oil, and it becomes necessary, therefore, to mix the lubricating oil with the gasoline. A consensus of opinion of the two-cycle manuals which I have studied indicate the use of one-half pint of lubricating oil SAE-30 to each gallon of gasoline. It is recommended that this mixture be made in a separate container and thoroughly stirred and mixed before pouring into the gas tank. A common practice of filling the gas tank with gasoline and then adding the oil and slightly shaking or stirring can be very detrimental to the engine. If the mixture is not thoroughly stirred, the heavier oil will settle to the bottom of the tank and be used first, creating a condition in which the fuel mixture is too rich in oil, which will cause poor carburetion in the first place and unnecessary accumulation of carbon in the combustion chamber, exhaust port and muffler. This condition will be followed later, when the oil has been used up, by several hours of operation without sufficient oil, with resulting unnecessary wear of bearings, rings and cylinder walls, and may result in severe damage. If the engine has stood for some time, a similar separation of the oil and gasoline is probable, with identical results.

Question: The question is, is it recommended that the gasoline be shut off to stop a two-cycle engine?

Answer: I believe that it is a very practical method of keeping oil accumulation out of the carburetor passages, and would permit thorough stirring of the mixture prior to re-using the engine.

Operating Precautions for the Four-Cycle Engine

In the preparations to start a four-cycle engine that has not been run for some time, or about which little is known, the following operating precautions are advisable:

The spark plug should be clean and adjusted to .025" gap. The air filter, whether of the dry or oil bath type, should be serviced, as I will describe later. The crankcase should be filled to the proper level with a good grade of oil, and I believe that practically all current air-cooled four-cycle engine manufacturers recommend SAE-20. In the case of our engines as displayed here, the proper oil level is to completely fill the filler spout with the engine standing level in normal operating position. Some manufacturers use an elevated spout and the cap is fitted with a dip stick, which is marked to the proper level, as in the case of an automobile. In any event, the oil level should be as indicated by the instructions of the manufacturer. The gas tank should then be filled with a good grade of lead-free gasoline if available, and care should be taken to see that the shut-off valve is open.

Starting the Engine

If the foregoing operating precautions have been taken we are prepared to start the engine and the process is similar in both types. If the engine is cold, and sometimes in any event, some choking will be required. Experience with the individual engine will indicate the amount of choking required, and the only precautions, of course, are against over-choking which will flood the combustion chamber with an over-rich mixture and it will not fire. General instructions would be to choke sufficiently so that the mixture is slightly over-rich, then by opening the choke either partially or all the way, crank the engine until it does start. With proper choking, the engine should start easily and if it is all right, it will start. Engines are not temperamental like people. They only have certain physical things to deal with and when these physical conditions are normal, the explosion can't help but happen.

But supposing it doesn't start. And speaking of temperaments, I know of nothing that can raise the blood pressure of an individual quite so much as one of these engines of anyone's manufacture which won't start. If you suspect that you have over-choked the engine, it can be easily cleared by removing the spark plug and cranking rapidly several revolutions. The spark plug should then be replaced and another attempt made to start the engine. But, for heaven's sakes, don't spend a half hour trying to start it. If it doesn't start, there is something wrong with it, and we can easily find out where the trouble lies by three simple procedures.

Trouble Shooting

For the engine to start, three factors are required. We need ignition, we need carburetion and we need compression. Compression can best be tested by grasping the pulley or the crankshaft in your hand and rotating it. The engine should turn freely without bind, but at one point you should definitely come up against compression sufficient to cause the piston to bounce backward. In the two-cycle engine you should get this compression point every revolution, while in the four-cycle engine you will go through one revolution where we do not have any compression and come up against the compression point in the second revolution. This should be the first trouble shooting check because it can be done the easiest and does not require any tools.

If the spark plug was not cleaned and adjusted previously, this should be done at this point, and we should proceed to check the ignition. To do this, I prefer to use a test gap, as indicated on the chart. Several manufacturers of magnetos and practically all manufacturers of testing equipment for magnetos provide such a test gap. It is a simple ring of insulated material in which three pointed screws are set so that two of them, which are to be used as the terminals, the one on the spark plug and one on the spark plug wire, are opposite each other with a gap of about 1/8" and a third one set at an angle whose purpose is a little complicated and time will not permit me going into it. Let us say that it removes the static or potential that would be built up and permits exactly the same voltage to cause a spark to jump this 1/8" gap at all times. That will be close enough for our purpose.

If you don't have such a tool, remove the spark plug wire, remove the spark plug to release the compression and hold the tip, or terminal of the spark plug wire 1/8" from the metal of the cylinder head. Rapidly crank the engine. If your magneto will cause a spark to jump 1/8" in open air, your ignition is sufficient to start the engine.

To check carburetion, the first thing, of course, is to determine that it is getting to the engine. To test this, and as I said before, this trouble shooting is a short process, proceed as follows: While the spark plug is removed pour one-half teaspoonful of gasoline into the spark plug hole, replace the plug and try to start the engine. If you get one or two explosions and then the engine dies, your trouble is definitely carburetion.

These three simple tests will tell you which of the three faults you have in your engine and why it will not start. To review, the trouble will be compression if you do not find that you come up against a compression point in testing. It will be ignition if your magneto will not jump the 1/8" gap when the spark plug is clean and properly gapped. It will be carburetion if the 1/2 teaspoonful of fuel introduced through the spark plug hole causes an explosion and causes the engine to run for one or more revolutions before stopping. If you have one or more of these troubles, the next thing is to tune the engine.

Tune-Up

We have all heard about tune-up. The automobile industry has preached tune-up to the extent that they are now tuning engines which show no difficulty. They are tuning up engines to prevent any difficulties, and the same processes can well be used on these engines. To begin the tune-up, and gentlemen this is going to have to be fast, we normally take an hour just to run through the tune-up, I am only going to attempt to hit the high spots, and because my charts will only illustrate one engine, you may have many varieties, I will not rely too much on them except to bring up some specific points.

In the tune-up procedure we will refer to certain terms; namely, inspect, test, and check. To inspect, we mean visual inspection-- look for signs of wear, cracks, stripped threads, scoring, etc. Testing would mean analyzing with proper testing equipment. Checking means to measure by means of plug gauges, feeler gauges, micrometers, etc. The procedure will be essentially the same on any model of engine, regardless of make or cycle.

Remove and clean the air cleaner. If it is of the dry type, it can normally be cleaned by brushing and oily accumulation removed with a small quantity of gasoline. If of the oil bath type, the dirty oil should be dumped and the bowl wiped clean with gasoline soaked cloth. The filter section may be washed in gasoline, but if this is done, it should be allowed to stand and drain until all the gas has evaporated. Do not use compressed air to dry these filters, as the force of the air will probably create channels through the filter material, permitting unfiltered air to reach the engine.

It is usually necessary to remove the mufflers, and these should be cleaned if an accumulation of carbon is evident. Remove the fuel pipe and blow it out to be sure it is clean and not obstructed. Remove fuel filter parts by loosening the thumb nut and removing the yoke, bowl, gasket and screen. See that the shut-off valve is in working condition. It is usually unnecessary to remove the air cleaner elbow from the carburetor, but it should be inspected to see that it is tight enough on the carburetor air horn, so that no air and dirt may be drawn into the engine which has not passed through the air cleaner. Also see that the mounting surface for the air cleaner is flat and that the gasket, if any, is not broken.

It will usually be necessary to remove the carburetor and the linkage, and this is done by loosening the carburetor mounting screws. Be sure and hold the carburetor to prevent its dropping and be careful to disengage the governor link and governor spring without bending or stretching.

If we have not previously checked the compression, it should be done at this time.

If the spark plug has not been cleaned and adjusted, it should be done at this time. If it is decided that the spark plug needs replacing, be sure and use the spark plug of proper heat range approved by the engine manufacturer. The heat range of spark plugs is just as important in small engines as it is in automobiles.

Disassemble the intake elbow by removing the mounting screws. Inspect the elbow for cracks and be sure the passage is clean and unobstructed.

Remove the fuel tank cap and see that the air vent hole is open. The plugging of this air vent hole could well create a partial vacuum in the gas tank, preventing gasoline from flowing to the carburetor. Inspect the tank for dirt or gum. Use acetone or alcohol to remove any gum and, if neither of these materials is available, certain types of lacquer thinners will assist with the removal of gum.

The majority of the ignition systems used on small engines are of the flywheel type and it will, therefore, be necessary to remove the blower housing to get at the armature and flywheel of the magneto.

If the magneto has an external coil-- that is, out side of the flywheel-- the air gap should be checked. Turn the flywheel until the pole pieces of the flywheel magnets are directly beneath the armature. Check the gap between the armature and pole pieces with a feeler gauge. We recommend .008" to .012" but other manufacturers may have other recommendations. This armature gap is important, because if too great, the magnetic field will be weakened and the spark will have insufficient voltage. If the gap is too small, the flywheel may rub, causing friction and heating and loss of power.

The flywheel is held in place with a left hand threaded nut in most cases, and it will be necessary to hold the flywheel in some satisfactory and undamaging manner and turn the nut clockwise. I like to use a socket wrench with approximately a 12" handle, very closely coupled to the socket. By holding the flywheel either with a flywheel holder or by hand or by means of a belt or strap, sharply wrap the end of the wrench handle with a hammer to start the nut. Remove the nut, washer and starter pulley, if any, and reassemble the nut flush with the end of the crankshaft. Strike the end of the crankshaft a sharp blow with a babbitt or rawhide hammer to jar the flywheel loose. Remove the nut, flywheel and flywheel key.

Most magnetos will have a dust cover over the breaker points. This will have to be removed.

Check the breaker point gap. To determine if points will need replacement, inspect the contacts to see if they are pitted or burned. They can be replaced later when we reassemble the magneto. To check the point gap, turn the crankshaft until points open to the widest gap, then measure with a feeler gauge. The standard adjustment for breaker points is .020", but recommendations of the manufacturer should be consulted.

Breaker points should be cleaned to remove all dirt or oil before adjusting. A good method is as follows: Close the points. Insert a strip, 1/2" wide, of good bond writing paper between the points. With an eye dropper place one or two drops of carbon tetrachloride or fire-proof energine (cleaning fluid available at drug stores) on the paper at the points, with a screw driver relieve the point tension enough to allow the paper to be moved back and forth between the points. Then use a 1/2" English cotton twill tape between points for final polish. After cleaning, the points should be adjusted. Turn the crankshaft several revolutions to allow the point plunger to settle. Stop the crankshaft when points are at the widest gap. Loosen lock screw slightly and move the point bracket up or down until a point gap of .020" is obtained. Then re-tighten the lock screw securely. If the proper testing equipment is available, it would be advisable to check the condenser and coil at this time to save time later. Most testing equipment is equipped with charts to indicate the proper settings and meter readings for popular magnetos. Condenser testers are common equipment in most garages.

To reassemble the magneto, assemble the dust cover and if the engine is used on a coal conveyor or in very dusty conditions, all grooves or openings in which the armature lead wires lie should be plugged at the edge of the dust cover. Use a sealer, such as #4 Korite or 3M sealer, or, if these materials are not available, ordinary battery tar may be used. This is done to prevent dust from getting on the contact points.

Contrary to general opinion, the flywheel is not driven by the key. The key is merely a locator and the flywheel is driven by friction between the tapered surfaces of the crankshaft and flywheel. For this reason, it is important that all burrs or dirt be removed so that a good fit is obtained. Assemble the flywheel to the crankshaft and with the keyways aligned, insert the key. Some types use Woodruff keys which must be assembled first. Assemble the pulley, if any, washer and nut. If the washer is the hollow concave type, the hollow side should be toward the flywheel. We recommend tightening the nut to a torque of 600 to 720 inch pounds, which means that the flywheel must be held very securely. A satisfactory field procedure is to use the 12" handle wrench described before, and after turning the nut counterclockwise as tightly as possible wrap the end of the wrench handle sharply with a machinist's hammer, while holding the flywheel. After the flywheel has been reinstalled we should re-check the air gap between the flywheel and armature, if the armature is of the external type. This air gap can usually be adjusted by turning the flywheel until the magnetic pole pieces are directly beneath the armature core. The reason for this is that the radius of the pole pieces is greater than the balance of the flywheel, due to the hardness of the metal in the pole pieces. Insert a piece of .008" shim stock, loosen the armature mounting screws and press the armature down on the shim. While holding the armature tightly against the shim, tighten the mounting screws. Then remove the shim.

At this point we should recheck the spark by spinning the flywheel and using the spark tester as described before or by holding the spark plug wire 1/8" from the metal of the cylinder head. The spark should now easily jump the 1/8" gap, but if this is not true, one of three parts of the magneto must be replaced. If no testing equipment is available, it will be necessary to replace these parts one at a time until the trouble is determined. It may be defective contact points, condenser or coil.

Carburetor and Governor

Tune-up does not normally include carburetor or governor repairs. Visual inspection should indicate whether or not it will be necessary to clean the carburetor and if it is decided that cleaning is necessary, manufacturer's instructions should be consulted before disassembling the carburetor. Acetone or alcohol may be used to clean the parts of the carburetor and most manufacturers provide service kits, which include the usual wearing parts and gaskets necessary to accomplish this repair. We advocate that at this point in the tune-up the carburetor be reassembled to the engine, being careful to properly assemble the governor spring, and the throttle shaft should be opened and closed to be sure that the linkage operates easily without binding in any position. If the governor link or spring is distorted, they should be replaced. Once the carburetor throttle action and governor have been checked, we are ready to reassemble the blower housing and external parts.

External Parts Assembly

On some models it is necessary to loosen the carburetor mounting screws so that the carburetor will drop enough to afford access to blower housing screws. After the blower housing has been attached, the carburetor can then be firmly mounted by retightening the carburetor mounting screws.

Assemble the fuel filter parts, the screen, gasket bowl and yoke. Assemble the fuel pipe. Tighten these usually brass nuts firmly, but do not strip the threads. Assemble the air cleaner elbow if it has been removed, assemble the muffler and if the engine is equipped with a foot starter or ratchet starter device, make sure that the starter sector teeth mesh fully in the center of the pinion.

Final Precautions and Tests

If previous instructions on mixing and filling the fuel tank with gasoline and oil in the case of the two-cycle engine have not been followed and filling the crankcase with oil in the case of the four cycle engine, this should be done at this time.

The engine should then be started and the spark checked, either with the testing tool or by holding the spark plug wire approximately 1/8" from the spark plug nut.

After the engine has run for from two to five minutes, retighten the cylinder head screws.

Adjust the carburetor by turning the main jet needle valve in until the engine begins to miss, then turn the needle valve out, or counter-clockwise until the engine runs unevenly. Then turn the needle in just far enough so that the engine runs smoothly. This will be approximately mid-way between the two positions. Tighten the packing nut.

Set the idle adjusting screw until engine idles at 1600 RPM. Hold the throttle in the idle position.

Turn the idle valve in or out until the engine picks up speed and runs smoothly, then reset idle adjusting screw to bring engine to 1600 RPM speed. Turn the idle valve in until engine begins to slow down, with the throttle held in idle position, and note the position of the valve, then turn it out until engine has picked up speed and begins to lose speed again and note the position of the valve. Approximately half way between these points will be a satisfactory idle valve setting. These instructions are naturally very general because carburetors of different design vary somewhat in their operation.

The next step is to set the governor speed, consult the instruction manual for proper speeds or, if within the recommended range, set the governor speed to the desired operating speed.

This concludes the tune-up of the engine, and if instructions furnished by the manufacturer are followed closely, the engine should start easily and operate satisfactorily. It may be possible that on older engines additional repairs are necessary.

Minor Repairs

Time will not permit going into even the most minor of repairs, but it could be said in passing that on the four-cycle engines the valves are identical in function to those on the automobile that you drive, and the same precautions of refacing, reseating, adjusting for tappet clearance, and the same general methods of procedure hold for the small engine as they do for your automobile. Be sure and consult manufacturer's instructions as to tappet clearances.

As the two-cycle engine has no valves except perhaps the reed valve, the only precautions are the cleaning of the valve port and muffler as explained previously.

Major Repairs

Time will not permit covering items of major repair, but it can be pointed out that bearings, connecting rods, rings, pistons and similar working parts are identical to those in your automobile. Whether two-cycle or four-cycle, manufacturer's recommendations as to ring gaps, piston wall clearances and bearing tolerances should be followed as these clearances and tolerances vary with the design and particularly in air-cooled engines are considerably different from the normal standards used in automobile repair.

Lubricating Oils

In general, the oils used should be the better grade of engine oils offered by responsible companies for use in automobiles. Care should be taken that the proper viscosity; that is, SAE-20 or 30, or whatever the manufacturer recommends, are used, and oil levels should be maintained in four-cycle engines by adding to the crankcase reservoir at least every five hours, if necessary, and draining and refilling periodically. We recommend checking the level of the oil every five hours and replacing every 25 hours of normal operation. Under some extremely dirty conditions, shorter periods of operation between oil changes is recommended.

Many of the oils offered today are detergent oils, which means that chemicals have been added to retard the formation of sludge and gum. We four-cycle people have no complaint whatsoever against the use of detergent oils, although we do not advocate premium priced detergents as it would be illogical to advocate addition of chemicals to oil that will deter the formation of sludge and at the same time recommend replacing the oil every 25 hours of operation. While not an authority, I have it from informed sources that two-cycle engine manufacturers are not recommending detergent oils because the chemicals have a tendency to increase the formation of carbon and other deposits in the combustion chamber, exhaust port and muffler.

Present Day Fuels

Fuels that we have used recently, both in our laboratory and in production, show a very serious deterioration in quality as compared to fuels in use before the war. The situation is wide-spread and this is borne out by reports we have received from the field and from other users of fuel.

Our experience is the fuels vary greatly in gum and lead content, and also in vapor pressure. One lot will be very high in gum content or in tetra-ethyl lead, and the next will be well within the desired limits. Vapor pressures which have caused suction feed engines to vapor lock have been encountered. However, these conditions are usually found in the late fall or early spring months when gasoline is changed to suit the weather conditions. In some of the gasolines we are now getting, the lead content has been up to the maximum of 3 cubic centimeters per gallon, or about three times the amount used before the war. These excessive amounts of gum and lead have a very bad effect on internal combustion engines. Excessive gum content in the fuel causes sticking of intake and exhaust valves, piston rings, as well as sticking of float pins and other parts in carburetors and fuel tanks.

Excessive tetra-ethyl lead in the fuel causes deposits in the combustion chamber and also causes burnt exhaust valves. Both of these situations result in loss of power, and drastic reduction in valve life has been noted since the war.

In my personal experience, it was nothing to operate engines under ideal conditions for upwards of 2000 hours in our laboratories, but recent tests indicate that with 3 cubic centimeters of lead per gallon, less than 300 hours of operation is the rule before a valve facing repair is indicated.

The best advice we can give is that you should use a straight run-- that is, non-cracked gasoline, without tetra-ethyl lead. Personally, I defy you to find such fuel and you will have to be satisfied with the closest approximation that is available.

Engine Life Expectancy

The life of your engine is for the most part dependent upon the care with which it is operated and the lubricating oils and fuels that are used. As I reported before, under ideal conditions, which means proper levels or quantities of good clean oil, dust-free operating conditions or careful maintenance of the air cleaners, the use of gum-free and lead-free fuels, and the adjustment and care of the equipment powered by the engines so that overload conditions are not experienced, continuous operation up to 2000 hours is practical without minor repairs. I would not recommend this length of operation without a tune-up, however. Careless maintenance of the oil level in four-cycle engines or careless mixing of the oil and fuel in two-cycle engines, the use of high lead fuels, neglect of air cleaners and otherwise dirty operation may necessitate major repairs or replacement of engines in a relatively few hours.

The time spent in cleaning and caring for the engines and the extra expense involved in oil changes and selection of oils and fuels will be well repaid in the life, dependability, and general economical operation of the engine.

Gentlemen, I see Dr. Mott waving to me from the back of the room which means that our time is up and I will have to close. I have many other things I would have liked to have told you, and many topics were only briefly discussed while some were practically skipped entirely. I hope I have touched a few of the high spots which will benefit you in the operation of your engine powered machinery, and on behalf of my company and myself I want to express my appreciation for this opportunity to talk to you. Thank you very much.

Speaker's Note:

During the four sessions of this discussion many interesting and informative questions and remarks were made from the floor. They have been deleted from this proceeding because, for the most part, the answers are to be found in the foregoing transcript and some were of only particular or personal interest.

THE WHEEL OF TURF IMPROVEMENT

Eric G. Sharvelle
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"If I can supply you with a thought, you may remember it and you may not. But if I can make you think a thought for yourselves, then indeed I have increased the stature of all of us."

To every Mr. and Mrs. Outdoor American who enjoys the pleasurable pastime of relaxing on the green sward, the verdant beauty of well kept turf is usually accepted with the casual passing reflection that this is another privilege of an advanced civilization in a democratic country. In this day of atomic energy, television, miracle drugs, jet propulsion and high taxation, the average nephew of Uncle Sam accepts these wonders of our modern age with never a thought of the blood, sweat and tears that have been the midwife attendent at the birth of these wonder children of 1950. How many who enjoy and perhaps admire the smooth soothing green of well kept turf in parks, cemeteries and on the course of every country club really give thought to the hours and years of ceaseless effort that have given us these unnaturally beautiful carpets of green for our pleasure.

The club member, the amateur golfer, appreciates a beautiful green, a well kept fairway and a smooth, well built tee. The member of the greens committee knows when greens are fair and is ever demanding a constantly rising standard of excellence. To these two fundamental members of the golfing fraternity, a green must be green, and little compromise is tolerated with the everchanging environment that constantly seeks to defeat the best efforts to keep greens green. The golfing professional knows the success of his game is profoundly affected by the way the greens play. He undoubtedly appreciates the delicate balance that must be maintained with hairspring precision to maintain this unnatural living commodity that we call "specialized or improved turf."

The maintenance of improved turf is a responsibility shouldered by the greenkeepers of the U.S.A.-- The Knights of the Sod. To keep pace with a constantly rising standard of excellence imposed by a critical public, the greenkeeper of 1950 must be engineer, chemist, botanist, plant pathologist, physiologist, agronomist, psychologist and skillful diplomat. Too few of our academic institutions have helped to bear the greenkeepers cross. In recent years there has been an awakening of these institutions to the need for specialized adaptation of biological research to the problems of maintaining improved turf. Your Midwest Regional Turf Foundation is one of these academic offsprings born of necessity. Spawned in the middle west, sired by the professional greenkeeper, sponsored by a state university and served by highly trained professional biologists, the Midwest Turf Foundation strives to supplement the working tools of every professional greenkeeper.

Few individuals outside of the professional greenkeeping fraternity have any concept of the immensity of the American turf industry. American turf is big business as is evidenced by the statistical fact that there are 15-16 million lawns in the U.S.A. with a total estimated acreage of one million acres. Furthermore, along the 3,000,000 miles of improved highways in America there are a further 10,000,000 acres of specialized turf. When one considers that the area of turf devoted to golf in the U.S.A. is equal to the land area of the state of Rhode Island and that the turf area alongside the highways of the U.S.A. is equal to the total land area in Pennsylvania under cultivation, then it is possible to visualize the scope of the American turf industry.

Improved turf is a fickle commodity comprised of many thousands of living individuals that live and grow and flourish and reproduce their kind and die like all other living things. The turf of every green, fairway, tee, park and lawn is a living, vital thing subject to the vagaries of an everchanging environment of sun, wind, rain, heat and cold. Like you and I, turf reacts unfavorably to abuse and flourishes by contrast with understanding care and attention. If we are to understand and appreciate the problems of keeping greens green, we must first reflect upon the living nature of turf and realize that just as you and I live and breathe and have our being so too turf wages its struggle for existence under the pounding spikes of the American golfing public.

In the past fifty years our civilization has seen miraculous and almost unbelievable development in the physical and biological sciences. Science is indeed the handmaiden of progress, our comfort for the present and our bulwark for the future. In the biological sciences you and I have lived to see therapeutic practices introduced to save countless lives. We have seen wonder drugs work miraculous cures. We have seen venereal diseases conquered by antibiotics. We doubtless will live to see poliomyelitis, cancer and tuberculosis banished by wonder drugs. Weeds that mar the beauty of our fairways mysteriously wither in an hour or two after receiving almost invisible doses of new herbicides. New fertilizers, new pesticides, new varieties and new practices constantly parade across the stage of modern turf improvement.

Here then is our secret of successful turf improvement. If we can weld each related phase of the biological sciences into an integrated wheel of sound practices, we will have built for ourselves the smoothly turning wheel of turf improvement. Let us build this wheel spoke by spoke, fitting each into its rightful place and surrounding the whole with a binding rim upon which our wheel will roll down the highway of success with turf.

In the biological sciences there is no such thing as autonomy of one specialized field. No one phase of biology is more important than the other for all are wedded to the mysterious secrets of life. Be we concerned with cereals, vegetables, flowers, trees, livestock, poultry or turf improvement, all who are engaged in the scientific aspects of these fields are striving to contribute towards one objective--the goal of successful and economic achievement.

Like all other things our wheel of turf improvement must have a beginning in some basic source of origin. Our beginning for the mythical wheel of turf improvement is the hardwood hub of America's God-given natural resources of woods, rivers, plains and streams. Our wheel may be considered as a many spoked wheel which if well forged will roll smoothly but will collapse if imperfect in its design and construction. There are eight essential spokes in the rolling wheel of turf improvement and the success with which each individual greenkeeper fits these spokes into their rightful place will determine the distance his wheel will roll down the highway of success with turf.

The first and fundamental spoke is the science of agronomy. The contributions of this science are basic to a sound program of good turf management, for without adapted strains of specialized bentgrasses, soils technology, and a knowledge of fertility problems, turf cannot even be started and certainly cannot be maintained without this sound agronomic foundation. Washington Bent, Old Orchard Bent, Toronto, Elk 36, Bermuda U-3, soil testing techniques and liquid fertilizers are all fundamental contributions of the science of agronomy. The agronomic spoke in the wheel of turf improvement is the most brightly burnished of them all. Fit this spoke well, for it is the pattern of excellence that other spokes must achieve in our completed wheel of turf improvement.

The second spoke in our growing wheel is the science of physiology. Plants, like grasses, live, respire and respond to a delicate balance of nutrition and will thrive on a balanced diet but will fade and die if incorrectly fed and cared for. If we can learn the inner secrets of growing plants, then we may take advantage of their wonderful potentialities and persuade them to produce finer and better turf under artificial inducement. The spoke of physiology provides this basic knowledge of when, what and how may we manipulate the nutritional and physiological environment to maintain a high degree of turf vigor under changing seasonable conditions.

The third spoke in our balanced wheel of turf improvement is the science of botany. Desirable turf grasses must be recognized by their own peculiar characteristics and unwelcome plants like weeds must be identified and weeded from the company of their more desirable fellows. Organic chemicals, the selective herbicides, are the most recent contribution of the spoke of botany. With uncanny selectivity chemicals such as 2,4-D, 2,4,5-T, PMAS and Tat-Select eliminate unwelcome weeds from the exclusive company of pure turf stands. These are the contributions of botany without which our wheel of turf improvement would hesitate and falter in its steady progress down the highway of better turf.

To further balance our as yet uneven wheel must be added the fourth spoke-- the spoke of chemistry. Many of the basic secrets of plant and animal life have been unveiled in the chemist's test tube. From the chemist's laboratory have stemmed many of the basic discoveries behind the development of new agricultural chemicals. Without the spoke of chemistry, insecticides, fungicides, herbicides and artificial fertilizers would never have reached the peak of development they now enjoy. Future development in these fields will originate in the chemist's crystal ball.

The fifth spoke-- the spoke of engineering. To implement the different phases of turf improvement the modern greenkeeper must use the man-made contrivances contributed by the science of engineering. Without surveying instruments, drainage systems, traveling sprinklers, power mowers, tractors and other mechanized equipment, the chores of turf improvement would be an undertaking of impossible magnitude. New spray equipment, new concentrate nozzles, Aerifiers, and other specialized turf equipment are the vital contributions of the spoke of engineering.

Three spokes now remain, and our wheel of turf improvement will be ready for the fitting of the rims. Omit these three remaining spokes, and our wheel will be imperfect. The five essential spokes outlined above are fundamental to sound turf practices. Basic as are these major spokes alone they will not suffice to keep our turf improvement wheel rolling over the hills and valleys of turf maintenance problems. Supplementary spokes remain to be fitted into the hub of the wheel of turf improvement to strengthen and supplement the framework created by the five essential spokes. Thus, our sixth spoke is the spoke of pulchritude-- the science of horticulture which adds a touch of beauty to every park, cemetery and country club. A well constructed green, a well laid out course, and a modern club house are essential to every country club or civic course. Add to these well chosen trees, balanced landscaping, a formal garden or a colorful bed of tulips, roses or other flowering ornamentals, and an artificial landscape of tees and sand traps and greens becomes a thing of beauty and an asset to any community.

Improved, specialized turf is a community of living individuals waging a competitive struggle for existence under unnatural conditions. Dame Nature in her infinite wisdom has erected her system of checks and balances so that one species will not dominate the earth-- so that hordes of crawling insects will not devour the fruits of the earth and mar the beauty of nature's creations. There are insect pests of specialized turf. Here is our seventh spoke in the spinning wheel of turf management-- the science of entomology. Insect pests of turf must be correctly identified for some insecticides will destroy specific insects but will be quite innocuous to other equally voracious insects. Entomology has given us the weapons of defense against these insect enemies of turf. Lead arsenate, chlordane, aldrin, dieldrin, toxaphene, methoxychlor and parathion are the contributions of the spoke of entomology. Many a green has been destroyed by visitations of white grubs or by colonies of hurrying ants. The spoke of entomology is the greenkeepers insurance against the visitations of turf destroying insects.

The eighth and last spoke of the wheel of turf improvement, but by no means the least, is the science of plant pathology. Plant pathology is the science which seeks to learn more about why turf gets sick and continually is striving to introduce better methods of reducing the toll exacted by these tyrants of the turf. Since plant pathology is one of the youngest and least developed of the turf improvement spokes it is justifiable to take the time to better shape this spoke in the lathe of practical consideration.

What are these tyrants of the turf, these spoilers of the sod, these gremlins in the grass that mar and spoil even the best kept greens. Most of our growing plants have fallen heir to a multiplicity of disorders that mar and maim and even destroy completely many of our most vital crops. It has been estimated that there are 50,000 distinct public enemies to plant life which cost the American farmer annually approximately $2,000,000,000 in lost crops, lost time, and lost materials. Many of these plant enemies have been identified as bacteria, as fungi and those mysterious biological entities that are referred to as "viruses". However, many of these public enemies of growing plants remain "incognito" and are on the wanted list of the plant doctors who daily seek to further unravel the mysteries of why plants get sick.

The constantly rising standards of excellence in the maintenance of specialized turf continually confronts the harassed greenkeeper with new problems amongst which turf diseases should be considered of coordinate importance with grass varieties, herbicides, fertilizers, green construction and all the other basic essentials of good turf management.

Turf diseases are not of recent origin for historical records indicate that grass diseases have been with us from the earliest days of the game of golf. The recognition of the causes of turf diseases is of comparatively recent origin. Diseases of turf, like human ailments are caused by specific and specialized organisms and no two diseases of turf are caused by the same fungus. Just as flu is caused by one germ, mumps by another, and diphtheria by still another, so are the turf troubles caused by different specialized molds or fungi which are profoundly affected by a rapidly changing environment.

Unfortunately turf troubles, like most other plant diseases, have been designated by a variety of common names which signify nothing as to their cause and still less for their prevention. Names such as large brownpatch, small brownpatch, dollarspot, fairy ring, grease spot, spot blight, melting-out and a host of others are all commonly used by the greenkeeping trade to describe the various turf troubles. As our first step in shaping the spoke of turf disease control, it is first necessary for turf diseases to be recognized and correctly identified if the damage that they may cause is to be minimized or eliminated.

It is not an uncommon experience to find greenkeepers applying fungicides to sick turf to correct damage caused by mineral deficiencies, insect damage, drainage effects and causes other than those for which fungicides were intended. Such practices are wasteful, time consuming, useless and generally result in additional damage without correcting the initial trouble. Thus our first step in shaping the spoke of turf diseases is to correctly identify the trouble. If you are not sure, ask your fellow worker or better still have some competent turf pathologist identify the cause of the trouble by the tools of his trade-- the microscope, the culture test tube and the scientifically equipped laboratory.

And now to smooth and sand the turf disease spoke by a consideration of the methods of preventing the troubles caused by these tyrants of the turf. The layman anxious to correct damage caused by plant diseases instinctively stampedes for the nearest drug store, garden supply store or the local purveyor of agricultural chemicals for the latest "super duper blight buster." Fungicides are useful tools in our arsenal of defense against turf diseases, but they are not the major weapons of offense.

All of the approved good turf practices are intimately associated with the problem of preventing turf troubles. The other seven spokes in the wheel of turf improvement are the real weapons of turf defense against these tyrants of the turf. Vigorous, healthy, well kept turf will suffer less from turf troubles and will recover more quickly than unthrifty, weak, poorly kept turf. Fungicides are necessary for the complete prevention of turf troubles, but they are supplementary measures which succeed when used in the right way as partners with the other spokes in the turf improvement wheel.

To glue in place our turf disease spoke, let us briefly consider these blight busters for better turf. What are they, what are they good for, and how may they be most effectively employed? Thirty years ago the greenkeeper would have had little difficulty in deciding which fungicide to use for brownpatch, snowmold or dollarspot prevention. There was no choice in 1917 except bordeaux mixture. In the last five years you and I have seen a host of new fungicides with long handled names parade across the stage of turf improvement all aspiring to the title of King of the Turf Blight Busters. The greenkeeper has been justifiably confused and to quite an extent so has the academic specialist. No greenkeeper can keep pace with the recent rapid development in organic fungicides. Every greenkeeper is asking what are these new chemicals, who makes them, how much should be used and where may they be obtained.

Last year the American Phytopathological Society attempted to answer these questions by initiating nationally coordinated turf fungicide trials. In 1950 ten states are cooperating in the nation-wide attempt to determine which are the best fungicides for turf disease control. The results of the 1949 trials are available to every greenkeeper and should be used as a guide in deciding which materials work best for what. (Purdue University, Agr. Exp. Station Mimeo. B.P. 41, "Turf Disease Control in 1950")

These then are the spokes in the wheel of turf improvement:

1. The Science of Agronomy
2. The Science of Plant Physiology
3. The Science of Botany
4. The Science of Chemistry
5. The Science of Engineering
6. The Science of Horticulture
7. The Science of Entomology
8. The Science of Plant Pathology

Each must be fitted in its rightful place and must be constantly varnished with the lacquer of recent developments. Once these spokes are fitted into the hub, the wheel is balanced and ready for the fitting of the rim. The rim of the wheel of turf improvement is the skill with which each individual greenkeeper turns his own turf improvement spokes. The rim is the binding tire of successful application of all of the sound principles of good turf management. Just as the rim holds the wheel together, so is the greenkeeper a vital factor in the success of every turf program. The greenkeeper is truly a knight of the sod worthy of every consideration and assistance from those interested in keeping greens green.

Our mythical wheel of turf improvement is now complete. Hub, spokes, and rim ready to revolve on the axle of the American way of life to roll steadily and surely down the highway of success with turf.

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TURF GRASSES

Fred V. Grau, Director
U.S.G.A. Green Section
Beltsville, Maryland

Thank you very much, Ken. It's quite a pleasure to follow Eric Sharvelle and to know that he is doing so much in turf diseases. He is going to be and is now one of the leading lights in the country on that important subject. The way the turf work has developed since I started in 1927, at the University of Nebraska, is little short of miraculous.

Kenny asked, "What is it that inspires these Nebraska boys to go out and do turf work?" I can tell you the answer. The inspiration of one man, and that man is Dr. Keim. Dr. Keim got me started in this and gave me the inspiration. He didn't know at that time that the tremendous acreages of turf exist. He didn't know it in so many figures, but he knew it was important. And he gave me the inspiration to go ahead and one of my big jobs today is not doing the work of research myself, heaven knows there are many, many more men far better qualified than I to do that work. What I would like to try to do is to inspire more fellows, particularly the young fellows, to enter this highly specialized profession. Before we can do that, however, we must raise the level of salaries to the point where those men will be attracted. We can't just say come on in and do this regardless of what you are going to get. We must make it profitable, because we are in a world of economics today, we can't escape that fact and we've got to give them that incentive to work for. Thank you. I really mean it. I'm working for you fellows as hard as I'm working for the United States Golf Association, because we are all working for the same thing, trying to give people something better than they have had before. There are no differences of opinion but if there are, they are minor and among men of integrity they can be easily overcome, and harmonized. I am going to be pretty pointed in my remarks this morning and probably fairly short because you want to get to your sections.

A great many of you have seen considerable publicity in the newspapers of the country recently following our U.S.G.A. meeting in New York on January 28, where in, the press was talking about some of these new grasses in which the Green Section had a hand in developing. We have received quite a few very highly critical comments, for releasing information about these new grasses that offer promise to golf courses, to home owners, parks, cemeteries and other turf areas before there was enough seed available. Let me defend our position and here in this regard we have the complete support of the Agricultural Experiment Stations and the United States Department of Agriculture, because before we can ask the seed grower to invest his money, his land, his time and his efforts in a new crop, he must be pretty well assured that there is a consumer demand. And that is our defense of talking about some of these newer tried and proven grasses before there is actually enough for everyone to have, because those growers must feel the consumer demand. Yes, you are going to be disappointed, I'm disappointed that there isn't enough to go around at the moment.

I am speaking primarily right now of Merion (B-27) bluegrass. Merion is the name for B-27 bluegrass because Joe Valentine watched it for 5 years on the 17th tee of Merion Golf Club, Ardmore, Penna., before he turned it over to the Green Section in 1936. We've been working with it ever since and 2 years ago we tested it at some 50 or 60 locations over the United States and Canada, I'll show you the pictures in a moment, and it has come up with banners flying. Yes, you are going to have to be satisfied with a pound or two pounds or five pounds for the next year or two years but rest assured that the seed we've had available in a short crop year of 1949 has nearly all gone back into the ground for increased acreage. That is our best answer to you that we are trying to do our level best to give you something that is going to give you better turf. Last year on June 28, a freeze hit the seed producing area of Oregon, it caught the seed in the soft dough stage, not only did it reduce the yield of the seed crops but it reduced the germination. You have seen grass seed prices sky rocket in the last few weeks simply because the seed isn't there. You are going to be awfully short on seed if you need it badly. We can't prevent those freezes over thousands and thousands of acres of grass seed crops, but it happened.

Let's move from Merion (B-27) bluegrass for just a moment to the bents. We're not devoting a great deal of time today to further selection of creeping bents for putting greens. We have enough good creeping bents today that if you will use them and treat them properly you can have virtually perfect putting greens, as many of you have amply demonstrated over the years. C-1, C-7, C-19, C-27, C-52, and C-115, and some other bents are just about what we have been asking for in the way of turf quality. At Penn State last week we learned that their breeding program is developing newer and better grasses. They show that where they took the very best of these creeping bents and grew them side by side in the nursery and allowed the seed to top cross like they do hybrid corn, the turf that was produced from the seed of some of those combinations was far better than the turf produced from the parents themselves planted vegetatively. This is one of the most revolutionary things that we've seen for a long time and some of these bents are already in Oregon for trial production to get sufficient quantities of seed so that we can distribute them to our member clubs for further trial in the field.

Noer calls me "Alta Fescue Grau" much of the time. I have been delighted to see the way many of you have tried Alta fescue, Kentucky 31 fescue, and many of you have been disappointed. From the standpoint of diseases, last year (1949) was probably one of the worst years for diseases on grasses that we have had in 20 or 25 years. Many of the new seedings of Alta and Kentucky 31 suffered badly from brownpatch. In many cases the Alta suffered worse than the Kentucky 31. I am going to show you a few pictures of that a little later. But those grasses are in the picture, they're improved and they fill a certain place in the turf picture. They don't go all the way. They are not as disease resistant as we want them, but they're definitely in the picture.

The pro's, the better golfers, and the average run of membership in golf clubs throughout the South rate a good bermuda-turf as the number one turf from which to play. At least it embodies the qualities that a golfer wants in golf turf. We started working with U-3 bermudagrass over 20 years ago at Arlington. Spent a lot of time working with it, testing it, trying it out here and there, and I realized when I came on the job in 1949 that something should be done about it, let's get it out. And in 1940 I took a plug of U-3 bermuda up to my farm in central Pennsylvania near State College, put it out on the lawn completely unprotected, and it is still there. Today that cut-cutter plug is about 12 ft. across, a beautiful combination with bluegrass and bent and it has gone through 32 below zero. We now have U-3 bermuda in Cleveland, Chicago, Northern Nebraska, Central New York State, Massachusetts, farther north than we ever supposed that bermuda should ever grow. Sure there are a lot of questions coming up about it. What if it gets into our greens? What if we want to get rid of it? While we are answering those problems as we go along, don't be too afraid, but for the moment try it in a small way, if you're not completely satisfied and if you want to get rid of it we have already done the research to tell you how to kill it over-night, so that it is gone forever. So don't be too afraid, we can tell you how to plant it but we can also tell you how to kill it. I think that is progress.

Zoysia grasses probably represent one of the more important groups of grasses for the future of turf in or over a large part of this country, because they are adapted from Florida to Canada. They're adapted from California to Maine. They cover almost every range of soil conditions, they are extremely drought and disease tolerant and insect tolerant. We've had them in this country since 1902 when plant explorers brought the seed of zoysia in. I wish more of you could come to Beltsville and see what we are doing with the zoysias. It is absolutely astounding. At the present time we are distributing small packets of seed of common Zoysia japonica to any U.S.G.A. member club or Green Section subscriber that wishes to write in and ask for a packet of zoysia seed. It is not the final zoysia that we're going to tell you you might grow. It is only a start but you can practice on this and then when the better zoysias come along in the next 2 or 3 years, you'll know how to proceed and get the most out of a small quantity of seed. We can show you and we have proven in our own practical experiments that an ounce of zoysia seed properly handled can plant 5 acres of turf. Well, maybe you say there is not much in that for the seed business, but there is. Not everybody is going to do it that way.

In the fescue program we've got some wonderful things coming on. As you will recall one seed grower, H. L. Wagner, in Oregon sent us $6,000 which we set up at

Pennsylvania State College for breeding better bents and fescues. Out of that breeding program has already come a creeping red fescue that is highly disease resistant and for the last 2 years has tolerated $\frac{1}{4}$ inch mowing. It is a beautiful putting green surface. There are others coming on. In the South, Dr. Burton at Tifton has produced out of his pasture breeding program a number of highly promising bermuda selections that promise to largely revolutionize turf in the South. Some of the new bermudas, when they're in proper shape, can hardly be told from bent. We don't have enough plant breeders working on the better grasses. But with men like Kenny Payne and Neil Wright, Scotty Forbes, Dr. Burton, and a few others, we are going to solve a lot of these problems through plant breeding. We also need the help of the pathologists, the entomologists, botanists, plant physiologists and the rest of the staff.

Here's what we think we need in turf. First, disease tolerance. At Penn State and other places last year, 5 years of research were telescoped into one because of the tremendously heavy attacks of different diseases. Last week we heard Neil Wright present the results at Penn State, and learned Merion bluegrass and Alta fescue were the two top grasses in Pennsylvania. They produced the best turf throughout the larger part of the season, because they were more disease resistant. They held their color through the drought. We need more drought tolerance in our grasses, water is running out. You've heard me talk about the shortage of water. New York is acutely conscious of it, so is Los Angeles, so are other areas. We must learn how to grow satisfactory turf with the minimum of water. It's a national emergency, just as the coal has been a national emergency. In order to have satisfactory turf on most golf courses, lawns and many other areas, these grasses must be able to tolerate close cutting. Close cutting is what distinguishes a turf from, let's say a pasture. Close, frequent cutting. I'm not going to be specific because each area has its own individual service or play requirements. And the grasses that we use must be able to tolerate almost any height of cutting.

We need better wear resistance. Fellows all over the country have been asking for better grasses for tees. How can we hold grass on a tee that is on a short hole and where they are using iron clubs? Some of you are beginning to with U-3 bermuda because unless you use a chemical to kill that grass, you cannot kill it by chopping it out with a golf club. It comes right back. That's why we are recommending to each of you that is interested in that particular problem to try U-3 bermuda on your worst tee. If it doesn't suit there, then just forget it. But try to be a part of our research team. We're handicapped in personnel and in funds. We must have your co-operation as a part of our research team because you never will be satisfied with what you see at Purdue or Beltsville, or Penn State or Missouri. You've got to see it on your own course or otherwise you are not the greenkeeper or superintendent that I think you are. You've got to be satisfied that it will work under your conditions as well as others.

We need grasses that are more weed resistant. I was one of the early ones in the game of developing chemicals for selective weed control, but still that is only one tool in the establishment of better grasses. We can't lean on chemicals for weed control as a crutch, eventually, we have got to throw that crutch away. Maybe we will use it occasionally when the muscles give out a little bit, but we won't depend upon it. Finally, we need grasses that are more naturally insect resistant although that is not too much of a problem and you see that put at the bottom of the list because with our modern effective insecticides, it is not too hard to control the insects. I've a few pictures to show you and I hope we can run through them and still be within our time.

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TURF FERTILIZATION AND FERTILIZER MATERIALS

O. J. Noer, Agronomist
Milwaukee Sewerage Commission

Gentlemen, it is hard to begin after such a flattering introduction by Dr. Grau. I am very sorry to have missed yesterday. It was impossible for me to be here and I cannot stay tomorrow. Today is my one appearance. When I received the assignment for today, my first impulse was to use color slides. That's the simple and easy way, but I have decided to forego them and talk instead.

Rather than give you a text-like discussion of fertilizer and fertilizer materials, I shall presume on your good nature and reach back through the years that I have been closely associated with turf. After all, the time will come, probably not too far off, when Fred Grau, Ken Payne, G. O. Mott, and others must carry the brunt of the turf program. That is as it should be. Today I may disappoint Gerald Mott a bit by ignoring fertilizer materials. It may be nice to have a subject for next year. So, if I do not get to that part of the assignment, I hope he will not blame me too much. This afternoon I shall paint the fertilizer picture as I see it-- based on personal experiences during the past quarter century. The discussion will be based on what I have seen-- the success of others plus my own failings and shortcomings. In my neophyte days I had many misgivings and lacked the convictions one can acquire only by experience. After making suggestions I would worry about the outcome-- good or bad. I was fearful and wondered about returning to see the outcome-- whether I should throw my hat in to see if I would be welcome. Today I do not feel that way. Confidence comes with experience, and that is as it should be. On the other hand, we ought not live in the past only and dwell upon the good old days. Youth has unbounded confidence and is eager to do the impossible. That is the first step upon which progress is built. Today we are on the threshold of even more progress than we have seen during the past twenty-five years, and it would be unfortunate if it were not so. We of the older generation must be a part of progress and not dwell too much upon or venerate the past except as it can aid progress.

Fertilization was stressed as the most important factor in turf development twenty-five years ago. That fact has not changed. Fertilizer is still the biggest and most important item in the turf improvement and maintenance program. However, other factors and conditions must be favorable before fertilizer can do its job. This applies to native soil fertility or to plant food added in the form of fertilizers. I recall visiting a club in Canada quite a few years ago. It was located between Ottawa and Montreal. Their fairways were mostly clover and knotweed despite what seemed like a reasonable quantity of fertilizer, and seeding each year with chewings fescue over a period of five to six years. It was impossible to find a single plant of fescue. About all one saw was clover, knotweed, and plantain. The fertilizer or seed did not have a chance because of poor drainage, mostly. Seepage and bad surface drainage were at fault. It was necessary to install tile drains and level the surfaces, or to change the entire program. Tiling was not feasible because of rock outcrops. Their problem was solved by switching to native creeping bent.

Creeping bent can withstand more soil moisture and more water than most other grasses. Until it was introduced into the fairways, fertilizer could not do the intended job.

A similar situation existed in Kansas City where the club bought much fertilizer but failed to get their money's worth, although there wasn't any question about the impoverished condition of the soil. Here again sidehill seepage was a fault, and not until deep holes were placed in the fairways with a post-hole digger to show the existence of seepage, was it possible to convince the club officials that there was a drainage problem ahead of everything else. This is another example of putting first things first.

I was amused last September when I attended a meeting of the McClumpha Tournament, which is held each September somewhere in Ontario Province to glorify the greenkeeper. The host club provides the dinner free, and the refreshments beforehand. Door prizes are provided by golf course supply firms. The day is devoted to the man in charge of turf maintenance. I was happy to be present and to participate in the discussion after the dinner. I had visited the club for twenty years. Each time the clubhouse manager harped on crabgrass, but not now. He said, "Noer, 1949 has not been a bad year for crabgrass, at least there hasn't been any at Toronto Golf Club." I replied, "It is fortunate that you haven't traveled extensively because you would have seen plenty of crabgrass." He remarked, "We haven't had any, and don't you remember when you first came here what a problem crabgrass was?" I said, "Yes, all you did was gripe about the crabgrass on the golf course. When you asked for a chemical killer, we told you it was not a problem of getting something for the immediate kill, but a long-time program of developing dense turf to resist invasion." After hearing complaints all season, it was refreshing to visit this club and see how crabgrass had been whipped by growing good grass.

It is not my intention to dwell at length on all the factors upon which normal and satisfactory growth depend. If you have not done so, be sure to read Chapter 1 in the book, "Hunger Signs in Crops." It is written by Dr. N. J. Volk and Dr. George D. Scarseth under the title, "Why Do Plants Starve". The article alone is well worth the price of the book. It is published by the National Fertilizer Association, Washington, D. C., and is available from them at nominal cost. I suggest that you get it.

There is much talk about soil and tissue tests. Both probably have a place in turf work. The soil tests, when properly done, are an inventory of the plant food situation within the soil, except for nitrogen. Soil testing is the best way to find out whether lime is needed. Need for lime depends finally upon the pH of the soil. When soil is well below pH 6, then there can be no question about need for lime. Its use is justified. If reaction is above pH 6.2 to 6.5, need for lime is questionable. A field test then tells the answer. Fifty pounds applied on a 10 x 100 foot strip across a fairway is at the rate of 1 ton per acre. Before seeding or before embarking on a turf improvement program, an inventory of the soil with respect to phosphorus, potash, calcium, magnesium, and reaction is very valuable. Results are no better than the samples which are submitted for testing, and they must be properly taken. In my opinion, the depth of sampling is an extremely important factor. Samples should be taken to a uniform depth of 2 inches. Uniform depth of sampling is necessary to get consistent results on samples collected at different times. It is nice to know whether the level of phosphorus is extremely low, or extremely high. The same thing holds for potash. None of the soil tests will give you any clue to the nitrogen situation for turf in my opinion. We never use them, or put much faith in them. I recall being in Baltimore and having a greenkeeper tell me he had solved the nitrogen problem. He said 60 parts per million of nitrates is exactly right. He took me to a green and said, "Two hundred parts per million of nitrate." The grass was dead and gone. There were no live roots to absorb the nitrates being formed by the soil organisms. Consequently, nitrates were accumulating in the soil. His reasoning did not seem too impressive or sound. So far as tissue testing is concerned, we must turn to Dr. Hoffer. He has and is doing more towards developing tissue tests than anybody else, so far as turf is concerned. I used the dipicrolamine spot test for potash in Florida this winter. The results correlated with fertilizer practice. Tissue testing is about the only hope for nitrogen. The Bray powder seems to be satisfactory. When the methods for nitrogen, phosphorus, and potash are perfected and calibrated to the different grasses, it will be possible to spot deficiencies well in advance of visual symptoms on the turf.

Turf disease is an important topic on every program. Fungicides, rates, frequency and methods of application are discussed. The subject is important and there is a need for fungicides to stop and prevent these diseases. On the other hand, maintenance practices play a part also. As I travel around the country, I see one man having no end of trouble with disease. The man across the road with soil approximately the same, the same kind of grass, using the same kind of fungicide gets by with less trouble and fewer headaches. Nobody can tell me that the difference is not partly one of management, principally with respect to the use of lime, fertilizer, and water.

Soil samples are received each year with a request for a fertilizer which will develop a heavier and deeper root system. I have mentioned this many times before to this and other groups. The fertilizer program is important, and plays a part so far as root systems are concerned. Many times you are told that nitrogen is the sole reason for shallow roots. It is blamed because the effects of nitrogen show mostly in the development of above ground growth. Nevertheless, each cell in the root must have nitrogen or perish. Nitrogen is an essential ingredient in protein, which is present in the cells of every part of the plant--roots, stems, and leaves. So the roots must have nitrogen just as well as the tops. On the other hand, overdoing nitrogen and unduly forcing top growth does tend to reduce root systems somewhat. But don't let anybody tell you that nitrogen is the sole and only reason for shallow roots. In my opinion, the moisture and air relationship in the soil is more important than feeding practices, so far as depth of root systems are concerned. I don't believe ninety per cent of you are one hundred per cent wrong, so far as fertilizer usage is concerned. Shallow roots have been more common during the last two years than ever before. In my opinion it is associated with soil compaction probably more than anything else. I shall not dwell on that subject further because Dr. Mott has seen fit to make a sectional topic of aeration and thus recognize it as an important phase of turf management.

Shade is a very important factor in turf growth, especially in cemeteries. Where shade is a problem, it is necessary to use a grass which is reasonably tolerant of shade and then modify the fertilizer and watering practices to provide the food and water needed by both the grass and the trees.

When I first became interested in turf, seed was emphasized more than fertilizer. When the turf was thin seed was bought and sowed. That was presumed to be the best way to get more grass. It seemed logical to put seed into the ground in order to get more grass. The fact that turf-forming grasses spread to develop dense turf if conditions were favorable was overlooked or ignored. The question of seeding rate and fertility level is an important one. Everybody doesn't realize the relationship between them. A high fertility level enables one to save on seed rates. If a low fertility level cannot support the number of plants produced by 40 pounds of seed to the acre, how can one expect to support the seedlings from 200, 300, or 400 pounds per acre? It just isn't in the picture. A. E. Rabbitt showed this truth very graphically in Washington. On plots there, 80 to 120 pounds of seed to the acre with 1600 pounds of fertilizer did better than 600 pounds of seed only. It wasn't Milorganite. I believe a 10-6-4 was used. The seed and fertilizer combination gave a better stand of grass at a cost of $57.00 per acre than 600 pounds of seed alone at a cost of $150.00 per acre. Each and every one of you should not forget these figures, especially now that even lowly Red Top is beyond reach, so far as cost is concerned. It's an over-priced seed in my opinion. Bluegrass, fescue, and bent are costly also. The thing to do on new seedings is to put on the lime that is needed first, if the soil is too acid, and use a dolomitic type if magnesium is low to eliminate any possibility of a magnesium deficiency. Then load the soil with phosphate and, if you've got to save money, do it at the expense of nitrogen. Put on plenty of superphosphate, because it is the one time when it can be mechanically incorporated with the soil and worked down to a depth of a couple of inches. It will help to produce a more uniform stand of grass, which is the important thing. On the other hand, never entirely overlook nitrogen because nitrogen is also needed, particularly on lighter colored soils. In order to secure a good stand of grass with fall seedings, nitrogen fertilization is a must in order to get the young grass well established so that it will go through the winter, particularly if one is late with the seeding.

In Wisconsin when a little 9-hole course was being built north of Milwaukee, I realized seeding could not be done until the middle of September. Based on previous experience, I made the remark "Without fertilizer before seeding, there may not be any grass next spring." Seedlings would barely germinate in the fall and without nitrogen fertilizer would not become well enough established to withstand the rigors of winter. They would heave out of the ground and be killed during the winter. There were a couple of farmers on the building committee. I had two strikes against me because I worked for the Sewerage Commission of Milwaukee. They thought the remark was made to sell them Milorganite, and told the committee, "We have been seeding grass for 20 years; who ever heard of fertilizing ahead of seeding." Their remark discredited me with the rest of the committee. The seeding was done without fertilizer. The next spring one of the influential members telephoned me and said, "Noer, your prediction has come true. There isn't one blade of grass left on those fairways. Everybody is rather discouraged." I inquired about the two farmers. He said, "We haven't seen them this spring. Now I must dig down in my jeans and pay the cost of seeding and want your advice." I said, "Mr. Gamble, I would concentrate on the landing areas and the approaches. When you get a little bit more interest on the part of the members, you can go ahead and improve the areas inbetween." The landing areas and approaches were fertilized generously with phosphate and some Milorganite. A good stand of grass was produced on the fertilized areas by July. Pictures taken then were striking, and have been used rather effectively in the last 20 years.

In discussing a turf improvement program, it is best to start with unwatered fairways or lawns where there is some grass, but where the stand is thin and not too good. Fertilizer is the most important factor, and is the main link in the chain of events which must follow in order to convert the poor grass into good turf. The first thing to do is to make a survey of the property rather than sit in the club house and decide what to do-- visit the property, look at it carefully, examine the turf, investigate drainage, soil compaction, and all the other related factors. Unless they are corrected first, fertilizer and seed, if needed, will not do a job. After correcting other factors, the use of lime and the fertilizer that is needed is far more important than seeding. There are instances where some seeding is advisable and necessary to introduce better adapted grasses. Drainage comes first, and is a matter of seepage and good surface drainage. The question whether lime is needed or not comes next. After that-- what is the condition with respect to phosphorus and potash? And if they are inadequate, apply them. Then nitrogen becomes the key to good turf.

I think some fail to realize the relation of fertility level and kind of grass. To grow chewings or creeping red fescue, we must make conditions unfavorable for the more aggressive growing bluegrass and bent. Fescue survives and grows at fertility levels which are much too low for bluegrass. It has a much lower requirement for phosphorus than bluegrass and certainly a lower requirement for nitrogen, and that also holds for water.

Mention has been made of the fairways at Belvidere in Michigan. For 25 years I have said that I had not seen a good fescue watered fairway. I visited the course after grass on the greens had been damaged by windburn. Somebody at the club said that after 20 years, the greens had better be replaced. I don't think that necessarily true. The greens were not replaced with turf. Despite what I have said about watered fescue fairways, I never saw better turf. The club has the finest playing fairways I have seen anywhere. The superintendent said the old water system was about to be discarded and a new one capable of throwing 600 gallons a minute was being designed to keep the fescue nice and green all summer long. I told him, "I don't know how you have been holding fescue. You had better leave things well enough alone. With fescue like this you had better not change your practices." If they did, it would only be a matter of time until the heavy drenchings of water would knock the fescue out. The soil was very sandy and very well drained. They used about 200 gallons of water a minute, which isn't enough to do any harm on the very sandy soil. The climate is very favorable for fescue. Bluegrass is a lime and phosphate lover. It needs more nitrogen than fescue. When it comes to bent, we find the creeping bents in the spots that tend to stay the wettest. There isn't a grass that responds to nitrogen like the bents. That holds for Colonial types as well as the creeping types. A bent does not need the amount of lime that bluegrass does, and it will survive on a much lower level of phosphorus than bluegrass. It resembles fescue in that respect.

I was on a cemetery where they did not pay much attention to grass. They were more interested in trees and shrubs. I was taken to one spot and asked to explain something. The superintendent said, "You see, over here is one kind of grass, over there is a different kind, and yet the whole area was seeded out of the same bag. How do you account for that?" I didn't know, but in the New York area it was customary for the seedsman to sell a shot-gun mixture-- 40% fescue, 40% bluegrass, and 20% red top-- so one of the grasses would survive. On one side the fescue was about 100%, and the other side was 100% bluegrass. I ventured the opinion that the soil was more acid and lower in phosphorus on the fescue side than it was on the other. We collected samples and, strangely enough, results from the laboratory supported my contention.

When broad-leaf weeds are bad, 2,4-D solves that problem for us. Where the turf is mostly fescue and bluegrass, there isn't a finer tool to use than 2,4-D, so far as these weeds are concerned, but bent may be badly damaged by 2,4-D. It is much better than the old sodium arsenite and arsenic acid that Frank Dinelli and some others used in the past. They got good results, but it was a hard task with arsenicals. I have seen courses where removal of these weeds performed miracles. Playing conditions were much better and clubs were sure there wasn't any need to fertilize. They went from a broad-leaf weed problem into one of either clover or crabgrass. When the turf is thin after taking out the weeds, fertilizer should be applied either before or immediately after to make the grass fill the voids left by the dead weeds. Seeding right after using 2,4-D is bad practice. It inhibits or prevents germination. Either forego 2,4-D or get the weeds out and do the seeding in the fall. At least three or four weeks should elapse between the use of 2,4-D and seeding. 2,4-D in my opinion is not the answer for clover or chickweed. Until something better is at hand, we must depend upon the arsenicals for their elimination. When 2,4-D is used enough times to take out chickweed, it will thin out the bent and pave the way for the invasion of poa annua. For chickweed arsenicals are best used.

After being rid of the weeds, then the problem is one of lime and fertilizer. Where turf is not watered, I favor the major use of nitrogen in the fall because that season and the spring following are the times when temperatures and moisture are most favorable.

When it comes to watered fairways, particularly where a water system is installed and believed to be the sole answer to good turf, watering alone, coupled with extremely close cutting, drives out bluegrass and fescue. Then comes poa annua, knotweed, and clover. Fairways of that kind are quite good in the spring and fall because the poa annua is doing well, but as hot weather comes along and it thins out, clover, knotweed and crabgrass take over. In the Philadelphia area and also in Pittsburgh probably more than in any other regions the rejuvenation of some of these fairways has been going on. They have made progress with arsenical treatments along with seedings of bentgrass.

In closing, I have several remarks to make about the greens. Greens are cropped like farmland. Those of you who do not top-dress as you did before, should bear in mind that potash is much more important than it was when you were using manure in your top-dressing and were top-dressing rather frequently. The clover problem is not one of finding a chemical to kill it, but to revamp your practices so that the bent will resist the clover. The reason for clover may be low nitrogen, it may be compaction, it may be overwatering. Then, of course, there is the fertility problem, so far as disease is concerned. Too little nitrogen tends to favor dollarspot, and too much nitrogen tends to encourage large brownpatch. In other words, we must use enough nitrogen in the spring to lessen dollarspot and taper off in the summer. There is a tendency toward the use of more phosphate than is needed. Dr. Sieling brought out this fact at Boston and also at Massachusetts the year before. Soil containing active organic matter prevents the formation of insoluable iron phosphate.

Liquid fertilizers are a new fad, and there is a great deal of talk about them. Dr. Hoffer did a great deal to encourage their use, and rightly so. There is no question that there are times when the grass needs a little boost, and that rates should be light. We obtained one of the products on the market. Our laboratory analyzed it and found about 2½ pounds per gallon of actual plant food-- total weight. So, at $2.00 a gallon, the cost is 80 cents a pound for the fertilizer in a gallon, or $1,600.00 a ton. Quite a good price for a lot of water, some plant food, and a few trace elements. In one gallon there was 0.6 pounds of nitrogen, 0.84 pounds of phosphoric acid, and 0.77 pounds of potash. It would take about three pounds of sulfate of ammonia to furnish that amount of nitrogen, and if the sulfate cost as much as $80.00 a ton, that would be between 5 and 6 cents for 1.3 pounds of 60% muriate of potash. It is simple to take common materials, such as ammonium sulfate and muriate of potash and make a liquid fertilizer unless you want to pay a good price for good old water and a little fertilizer. However, only a few gallons of liquid fertilizer are used in a year, so from the actual outlay standpoint, it doesn't amount to much. But I think you should know what you are buying and paying for.

Just a moment to demonstrate the effect of organic matter on ferric phosphate formation. I am dissolving ferric chloride in the pure water in this flask. Then I shall divide it into two parts. Some citric acid is being added to one of the solutions. In another flask I am dissolving sodium phosphate. When the phosphate is added to the ferric chloride, the liquid becomes cloudy, indicating the presence of insoluble iron phosphate. But in the other flask the presence of citric acid prevents the formation of insoluble ferric phosphate. The same thing can be done with aluminum chloride. Phosphate fixation is not a problem on peat or muck soils because of the organic matter in them, or in greens. It occurs principally in the highly mineral soils.

I have appreciated being here, and am sorry not to be here with you tomorrow.

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TURF INSECTS

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Introduction

Thank you, Fred. Gentlemen of the Midwestern Turf Foundation, and Friends. When Dr. Mott wrote a little while ago and invited me to come out here and address this gathering on the control of turf insects, I was profoundly pleased. I have thought of Indiana many times in my life. Wasn't there a song "Back Home Again in Indiana"? I used to be able to sing at one time and this was one of the songs I seem to remember, in part at least. As I sat in the auditorium last evening listening to one of the finest Glee Clubs I have ever heard, I could not help but think of my college days back at Connecticut University. When the first young soloist stood up and sang in a beautiful clear tenor, I thought of myself singing the high tenor for four years with the faculty quartet at "Connecticut". It was a real thrill to hear the boys last night. I want to take this opportunity to congratulate Purdue University on their wonderful Glee Club.

I was born and raised in Bridgeport, one of the largest cities in Connecticut. My father was in the hardware business. As a young man, he pursued the avocation of amateur ornithologist and naturalist. His interest in having me sell nails and hammers as well as other gadgets was obvious. However, my mother would rather that I be a clergyman. Unfortunately, my father died when I was still a lad. There were several girls in our home and I was the only boy. When I finished high school I had to go to work. After working in a cemetery digging graves for a year, I decided I wasn't "getting to first base" as it were and in order to improve my state of life, I would have to go on to higher education, wherewith I matriculated at Connecticut University.

I first studied Forestry taking my undergraduate degree in that subject. Later I became interested in Entomology and took graduate work so that I might follow the profession for the balance of my life. Just before getting my advanced degree I was invited by the United States Department of Agriculture to join the Gypsy Moth Laboratory at Melrose Highlands, Massachusetts. I accepted the offer and worked there for less than a year. Later I had a chance to go to the Experiment Station in my home state and, of course, I jumped at the opportunity. From 1929 to 1948 I worked on parasites of the Japanese beetle, European corn borer, Oriental fruit moth and several indigenous pests. While studying the parasites of the Japanese beetle we introduced a number of wasps and flies which destroy the grubs and adult beetles.

"Milky Spore" Disease

In 1938 the Federal Government persuaded us to undertake work on the "Milky Spore" disease of Japanese beetle grubs, distributing it throughout the state at approximately one-half mile intervals in the heavily infested areas. The program was continued for three or four years, during which time we studied the organism as it was being used under our conditions. It is a valuable bacterium in certain localities. I am not entirely sure that it can be used in Connecticut with assurance of effective destruction of grub population. Farther south along the Atlantic seaboard in New Jersey, Delaware, Maryland, and Virginia it assures a good control of grubs. Soil temperature in Connecticut in the spring is not high enough for the activity of the organism. It appears that 80° F. is about the optimum temperature required. By and large in a wet season our optimum soil temperature does not attain that level until after the grubs have transformed to the adult stage.

DDT

With the advent of DDT during the early years of the second World War, we thought perhaps this material could be used effectively for the control of serious Japanese beetle grub infestations in Connecticut. In consequence, we applied it to turf heavily infested with grubs for the first time four years ago this spring. It was used as a 10% dust at the rate of 250 pounds to the acre.

In speaking of the Japanese beetle and excessive grub population, I am fully aware of the fact that here in Indiana and adjoining states the Japanese beetle is not the problem that it is on the Atlantic seaboard. However, do not be too sure that you are immune from ultimate heavy outbreak of this insect. Just give it time.

The results of the first treatment with DDT were remarkable. Within a period of five weeks the grub population was reduced 75% and before the insect transformed to the adult stage in late June, the residue of the population had been destroyed. In the fall, with grub populations in untreated areas averaging 117 per square foot, there were only two to three per square foot in the DDT plot. In the autumn of 1947 subsequent to the development of another grub population, the infestation in the untreated block averaged about 75 per square foot, whereas in the treated block there were only one or two per square foot. Owing to a dry period in 1948, the population dropped normally. As a result, there was a reduced population in untreated areas, about 11 per square foot. At the same time there were none in the treated blocks. In the fall of 1949 in the untreated turf populations exceeding 15 per square foot, concurrently there were none in the treated blocks. Virtually four years of effectiveness for DDT. The United States Department of Agriculture reports control of Japanese beetle grubs may be expected for six to seven years when the toxicant is used at about 25 pounds of technical material per acre.

Toxaphene

Closely following the development of DDT and its use for the control of grubs in turf came other insecticides-- notably Toxaphene. As a chlorinated camphene, it is in some respects quite similar to Chlordane and others. We experimented with this insecticide for the first time in 1947. It was used at dosage levels ranging from 8 to 24 pounds of technical material per acre and applied to grub populations exceeding 80 to 100 per square foot. In a period of one month at the

8 pound level the reduction was from 60% to 70%. At the higher levels virtually complete control of grubs was obtained in from 4 to 6 weeks.

In 1948 at the two highest levels of 20 and 24 pounds of technical toxicant per acre, there were no grubs in the treated turf; whereas there were 80 per square foot where the toxicant had not been used. In 1949 at the two highest levels of 20 and 24 pounds Toxaphene still gave us a control of 95% to 100%. At the lower levels of 16, 12 and 8 pounds, there seemed to be somewhat of a reduction in the toxicity of the insecticide after 24 to 30 months. Toxaphene compared with DDT at comparable dosage levels has been demonstrated to give a faster kill in the first year than DDT. For example, in 31 days at 24 pounds of technical material per acre, Toxaphene provided from 95% to 100% control whereas DDT gave less than 80% mortality of grubs.

Chlordane

Chlordane was developed concurrently with Toxaphene. It kills not only as a stomach poison and contact insecticide, but also as a fumigant. Chlordane was used in 1947 at 3 levels in May; 8, 16, and 24 pounds technical toxicant per acre applied to heavy grub populations in fairways and roughs. In 4 weeks it had reduced the population at these 3 levels from 88 to 98%. Before the residue of the population transformed to the adult stage, all of the grubs were dead. In the fall of that year no grubs were found where Chlordane had been used, but grubs in excess of 100 per square foot occurred where the turf had not been treated. In 1948 there were no grubs where the insecticide had been used, but heavy grub populations occurred where treatments had been made. Although in general the grub population in 1949 was lower than in other years, there were still in many areas grub infestations in excess of 10 to 15 per square foot. (Only 10 or a dozen per square foot are necessary for complete destruction of turf.) Where Chlordane had been applied to turf in 1947 there were no grubs in the fall of 1949. At least 3 years of complete protection of turf by this chemical can be expected. It remains to be seen, however, if Chlordane will remain toxic after 3 years. Owing to the fact that Chlordane has not lost its toxicity during the years we have had it in turf, it may continue to be potent enough in the summer and fall of this year (1950) to hold potential grub infestations at a minimum.

Benzene Hexachloride

Benzene hexachloride is another insecticide showing considerable value in turf and soil. Benzene hexachloride, 6% gamma isomer was used at the rate of 1 to 5 pounds per acre 3 years ago. Rather rapid reduction in grub populations was obtained where the toxicant was used. In the fall of the first year of treatments there were no grubs where the material had been used on the turf, but many where it had not been applied. In the fall of 1949, 30 months subsequent to its use, at the 4 and 5 pound levels benzene hexachloride was still of the order of about 90% effective at the 3 lower levels (in round figures) about 70% effective.

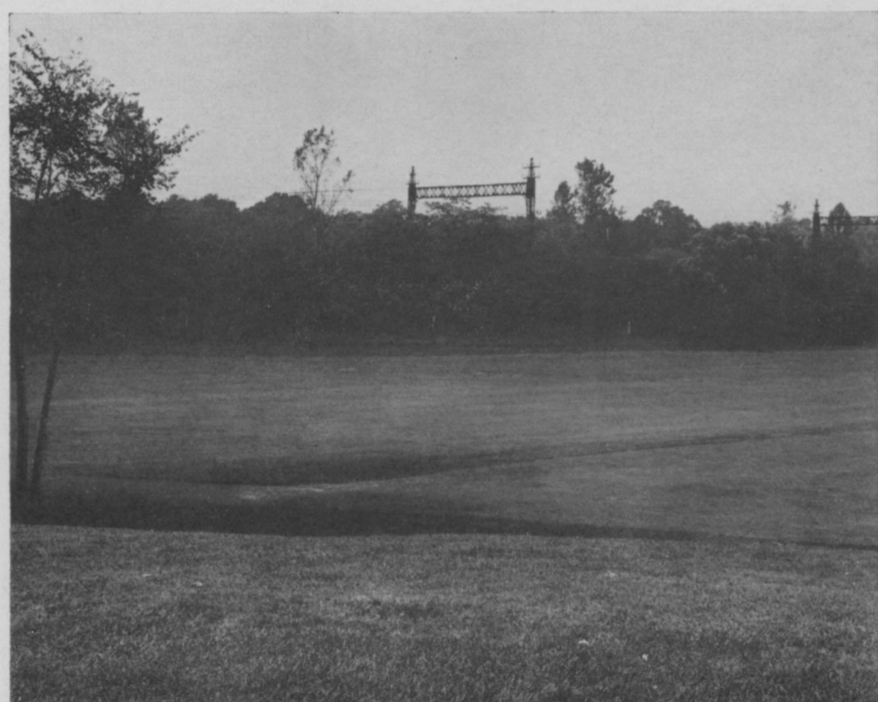
We are not advocating the use of gamma benzene hexachloride under most conditions simply because it imparts a disagreeable flavor to potato tubers, onions and perhaps other root vegetables. However, it could be used effectively in permanent turf such as prevails in our cemeteries, parks and golf courses. Occasionally a golf course goes out of business, as it were, and the property is used for other purposes, such as housing development. The back yards where the houses are built may at some time be used for gardens. In consequence it would perhaps be ill-advisable to use benzene hexachloride (where a course may in the future be used for other purposes) for fear that even 6 or 8 years later the soil could not be converted to vegetable gardening.

Parathion

Parathion is an organic phosphate. It is very toxic to animals and humans. It was used in 1947 as a ¼, 1% and 2% dust at low dosage levels of 1, 4 and 8 pounds of technical toxicant per acre. Due to its extreme toxicity it must be treated with a great deal of respect by all who handle it. Under certain conditions we advocate the use of Parathion for the control of white grubs in soil and turf. It may be employed as a low per cent dust (1 or 2%) and applied at the rate of not more than 8 pounds of technical material per acre. (If a 1% dust were used, there should be 100, 400 or 800 pounds in a treatment.) However, 1 to 4 pounds of technical toxicant per acre is all that is necessary.

So far as lingering toxicity in soil is concerned, Parathion has one redeeming feature -- it is short-lived. It hydrolyzes rather rapidly, bacteria breaks it down quickly and at the end of 6 weeks when it is used at 1, 4 or 8 pounds of technical toxicant per

SAILORS FIELD
WEST HAVEN, CONNECTICUT



BLISSUS LEUCOPTERUS HIRTUS
Voluntary Recovery of Turf (Photo 59 Days) Following Treatment for Chinch bug Control in Fairway.

(Photographs: Courtesy Connecticut Agricultural Experiment Station, New Haven, Connecticut)

acre, it is largely gone. Three to 4 months subsequent to a Parathion treatment (applied in late summer) the residual action of the toxicant is so low as to be negligible for control of white grubs.

When applied in the spring to an over-wintering grub population, it has given excellent control in 14 days. Subsequently it continues to linger in small quantities in the soil throughout the succeeding summer months, destroys the young grubs as they hatch from freshly deposited eggs. If the grubs were fully grown it would be questionable if the residual toxicant would be sufficiently potent to destroy them. In any event, Parathion can under certain conditions be used with assurance that its toxic properties will disappear rather quickly from the soil.

Aldrin and Dieldrin

Companionate materials following along after the development of Chlordane were brought to our attention by the chemist responsible for the latter toxicant. They were formerly known as compound 118 and compound 497, chlorinated hydrocarbons with strong and powerful action in soils. They now have the names Aldrin and Dieldrin. We first used Aldrin in the summer of 1948 at 1, 3 and 6 pounds of technical toxicant per acre applied to excessive grub populations in fairways. In ten days reduction of the populations of the order of 82%, 90% and 98% was obtained for the 3 levels used. The residue of the populations disappeared in the following two weeks.

Aldrin has considerable residual action in soil. Perhaps not so long as Chlordane but in any case sufficient to keep the soil entirely free from grubs for two years. Dieldrin is very much like Aldrin chemically. It has, however, an oxygen group tacked onto its structure which assures long residual action in soil, probably exceeding that of DDT. These two insecticides, both used at the levels stated for Aldrin; that is, not more than 6 pounds and preferably between 1 and 3 pounds of technical toxicants per acre, are excellent for the control of white grubs. We have applied them to mixed populations of Japanese beetle, Asiatic beetle, and certain of our indigenous white grubs, June beetles so-called in the adult stage. I understand this latter group of turf pests is quite common in the midwest and more of a problem than the Japanese beetle.

Aldrin applied at 5 pounds of technical toxicant per acre in 1948 to mixed grub populations when the Asiatic beetle was in excess of the Japanese beetle gave 93% control of the infestation in a period of one week. The residual action of the toxicant carried over sufficiently into 1949 to prevent grub re-infestation in the treated turf. Whereas in adjacent untreated areas the population was in excess of 50 per square foot.

On the first of June (1949) we applied a 2½% Aldrin dust to a heavy grub population in a cemetery. From the 26th of May until the 6th of July in the area treated not more than 3/100ths inches of rain fell. In consequence the toxicant was not washed into the turf. We followed the progress of the grub population very carefully. Mortality was negligible. However, as the insects began to emerge as adults in late June and early July, they died as fast as they came to the surface of the ground. Obviously the toxicant held its lethal properties sufficiently long (when exposed on the surface of the ground to direct sunlight) in the absence of rain and at temperatures 5 degrees above normal to kill the beetles as they issued from the turf. It was generally believed that when these and other insecticides were exposed to sunlight and high temperature for long periods of time, beyond perhaps 2 weeks, their toxic properties dissipated rapidly. Apparently this is not true for Aldrin and Dieldrin. It may be mentioned also that these two insecticides may be used freely with items such as lime and other alkaline materials simply because they are not rendered ineffective by them.

Lawn Moth

I understand the lawn moth or sod webworm problem is more prevalent here in the middle west than in the east. There are about 100 species of these insects in the United States. Perhaps several or more species may be found in most any area. It was reported as early as 1850 that they were largely injurious to rye, corn, wheat, oats and pasture land. However, the late Dr. E. P. Felt, formerly of the New York Department of Agriculture, pointed out some years ago that they were all injurious to grass.

Perhaps you all know the adult of the lawn moth is slender, varying from a half an inch to an inch long, rather dirty white, grey or yellowish in color. During the daylight hours they remain hidden in the grass or nearby vegetation. They come out in the latter part of the afternoon and hover over the surface of the turf. The moths drop their eggs freely when in flight; however, sometimes they are deposited as the moths rest in the grass. One female is capable (in some species) of depositing 300 eggs.

If you are not sure that your turf is infested with lawn moth, apply 2% Pyrethrum in water to the grass. This will bring the larvae to the surface where they are present. When they occur at the rate of 10 or 12 per square foot, the population is exceedingly heavy and control must be applied at once. In the past lead arsenate was used as a control at the rate of 2 pounds in 20 gallons of water, or 2 pounds in dry finely sifted sand per thousand square feet. Chlordane may now be applied to a lawn moth infestation at the rate of 5 ounces in 2 to 5 gallons of water per thousand square feet, using the wettable powder or the emulsion whichever is most convenient. Applied in late afternoon or early evening, the treatment should destroy all the larvae before daybreak of the following day or at least within 48 hours.

Cutworms

There are 200 to 300 species of cutworms in the world. Not all of them occur in the United States. However, some have world-wide distribution, others are peculiar to the southern states and are found nowhere else in the country; by the same token there are certain ones that occur in the northern states but are found nowhere else. Certain species inhabit arid regions and others abound where rainfall is heavy. In any event, cutworms may be extremely destructive in golf course greens as well as grassland in general.

Frequently in the early part of the day birds may be found feeding on the greens. One's curiosity is immediately aroused relative to the reason. On examining the turf it appears that it has been scuffed by the birds. Closer probing reveals the presence of cutworm larvae. Apply a Chlordane, Aldrin or Dieldrin treatment immediately, following the directions for control of lawn moths.

Ants

Frequently the cornfield ant is found in turf and open ground. It is the most abundant of all species of ants. It builds little mounds on the surface of the soil and turf. Unless they are removed and the insect responsible for them destroyed, you may find that the turf where the mounds developed will die.

Apply Chlordane to turf infested with ants at the rate of 4 ounces of 50% wettable powder or 48% emulsion in 50 gallons of water and then flush the turf to achieve quick and complete penetration of the toxicant to the heart of the colony which may at times be 2 feet or more below the surface of the ground. An early mortality is obtained; that is, complete destruction of the colony. The residual action of the toxicant should prevent re-infestation for the balance of the season. We have found that in many instances Chlordane residuality has gone well beyond 12 months in protecting turf from ant invasion.

Chinch Bug

There are ten species and four varieties of chinch bug. The species injurious to turf is known as the hairy chinch bug. It originated in Central America or thereabouts. It came into the United States by way of the Mississippi River, Atlantic and Pacific coasts. It now occurs in all parts of the country; however, it is more abundant in some areas than in others. In a hot, dry season it can be expected that severe outbreaks of chinch bug may occur. Last year was no exception to the rule. There was a long protracted dry spell during late spring and early summer. As a result severe outbreaks of chinch bug developed. Teeming millions of the species occurred in fairways, roughs and tees.

Up to within recent years and the development of new insecticides, nicotine preparations as well as other compounds were used extensively for the control of chinch bug. Results were never entirely satisfactory. With the advent of DDT, however, it was shown by the New Jersey Agricultural Experiment Station and others that this insecticide was an excellent control for chinch bug.

Chlordane, Aldrin and Dieldrin have been shown to work wonders for the control of chinch bug. They may be used as dusts, wettable powders or emulsions.

On the first of August, 1949, the greenkeeper at Pelham Country Club, Westchester County, New York, discovered, much to his dismay and my consternation, that the tees, fairways and roughs were heavily infested with chinch bug. It was imperative that the population be destroyed as quickly as possible. I suggested 5% Chlordane dust as a treatment. Every effort failed in obtaining the tons of material necessary to treat the entire course. As an expedient, I advised Chlordane emulsion as a substitute.

Two gallons of 48% emulsion in 50 gallons of water per acre were applied to one fairway in the initial treatment. In 24 hours the chinch bug population in that fairway had been destroyed. Later the balance of the course comprising 60 acres was treated using 120 gallons of the emulsion to do the job. As a result of the work, the golf course was in excellent condition before the end of the season.

Aldrin and Dieldrin will achieve the same results. Used experimentally we have shown that at less than one-half the Chlordane dosage level they will provide 100% kill of chinch bug and assure complete protection of the turf for the balance of the season.

Oriental Earthworm

My time is growing short; however, if I may have a few more moments, I would like to tell you something about the Oriental earthworm-- the so-called "Stinkworm". This pest is a terrible scourge to turf on the Atlantic seaboard. The "Stinkworm" presumably came from the Orient. When, however, we are not entirely sure; probably 17 years ago, more or less. It was first found at the University of Pennsylvania where one worm was picked up on the campus by a Chinese zoologist. He identified it as *Pheretima hupeiensis* Mich. Since then it has multiplied and spread until at the present time it is known to occur in golf course turf from Stamford, Connecticut, to Miami, Florida. It appears in its most insidious form, however, in Westchester County where within a radius of 25 miles of New York City, there are 52 golf courses about 50% of which are badly infested with the pest.

The question arose as to what might be done relative to a control for the "Stinkworm". Lead arsenate had been applied to infestations at ridiculously high dosage levels with virtually little effect on the population. From a 36-hole practice green at the Westchester Biltmore Country Club, 15 gallons of worms were gathered up on several occasions in one season without the least noticeable reduction in population. With earth castings numbering anywhere from a few to 40 and 50 per square foot and occurring not only once in 24 hours but sometimes 3 to 6 times, it became almost impossible to keep the greens in the good playing condition required.

In 1948 Parathion was used for the first time in Connecticut in an effort to reduce the "Stinkworm" population in the putting green at Woodway Country Club, Stamford. It was applied on 4 occasions totaling about 94 pounds of technical Parathion per acre. Since the treatments were made in 1948, the green has been entirely free from infestation.

At Pelham Country Club in New York, Chlordane, Benzene hexachloride, Aldrin and Dieldrin were used in an effort to suppress the pest. They were applied as wettable powders, dusts and emulsions. The emulsions were employed for the first time in the spring of 1949. Chlordane emulsion treatment was at the rate of one quart of 48% formulation in 10 gallons of water per thousand square feet. This composition destroyed the worms as fast as they came to the surface. At times about 35,000 dead and dying worms were estimated on a single green. At present we are not sure if the treatment will hold over for a year or longer for "Stinkworm" control; however, we feel confident that owing to the residual action of Chlordane when applied to soil and turf for grub control that perhaps 2 years in effectiveness may be expected when applied to the Oriental earthworm.

Aldrin and Dieldrin 25% emulsions may be used at the rate of 3 pints in 10 gallons of water per 1000 square feet. All three treatments should be thoroughly hosed into the turf with quantities of clear water subsequent to application.

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TURF EXTENSION PROGRAM IN PENNSYLVANIA

Albert E. Cooper, Extension Agronomist
Pennsylvania State College

It is a pleasure for me to be here, and a distinct privilege to talk to you. My talk will deal with some of the phases of turf work being done in Pennsylvania by the Agricultural Extension Service.

In the School of Agriculture at Penn State we have the usual three functions-- teaching, research, and extension. The work in Extension is handled through the County Agricultural Agents in the different counties, the Extension Specialists from the College assisting them. Together they supply scientific information which can be applied to local programs or problems on turf and other agricultural matters.

Funds for extension work in Pennsylvania are provided by federal, state and county governments. All parts of the extension program are carried as integral units in this work and none requires extra or special appropriation. No charge is made for these services.

In turf activities, as in other extension work, the assistance is presented informally and directly, and often in the form of special or personal help. Particular use is made of discussion and demonstration, especially for reaching large numbers of people at one time. Visual aids, especially 2 by 2 slides and motion pictures, are methods widely used. Subject matter publications, circular letters and direct correspondence also have proved helpful. Newspapers and other publications, radio, and television cooperate by making their facilities available in disseminating extension information.

A new variety, method, or practice may be developed by the Experiment Station. We will take the results of this research to the counties, and discuss them at meetings arranged by the County Agents. Some of those in attendance may be interested in setting up a demonstration on their farm or golf course, whichever the case may be. Extension will set up the demonstration to let other people see how the new idea works. Records will be kept on the project and the results announced at a subsequent meeting. This is known as a result demonstration. In this way all the people in that community have a chance to become fully informed of the new practice, or whatever it is that we are trying to teach.

Sometimes those attending demonstrations have opportunity for actual participation as well as observation. For instance, if it is to lay a contour line, every person present will be encouraged to handle the level, stretch the tape, and drive stakes. For many people it is easiest to learn by doing. Anyway, the important thing is to teach people so they can do the job themselves.

The research information which we take to the people out in the State may originate in our own Station where Burt Musser is doing a big job in experimental work in turf. It may come from stations in other states, or from the United States Golf Association Green Section, headed by my good friend Fred Grau. The people with whom we work, out on the farms and on golf courses or wherever there may be a turf problem, are a part of the extension program. We propose; they dispose. Unless they carry through on recommendations our efforts have been in vain. If they do carry out these suggested practices, they are helping us to spread information to others on these procedures. Thus, while we initially help these people, they also help us. We call them cooperators.

Some of the people I work with in Pennsylvania are the greenkeepers. We have six greenkeeper associations in Pennsylvania and I attend meetings of all of them. Often greenkeepers arrange meetings for us with the officials of their clubs. Our nurserymen are tremendously interested in turf, and I've met with them on various occasions. The garden clubs of the state have been very pleasant groups with which to work. Much can be accomplished through women's organizations. Cemetery associations also have requested a variety of information on fine turf.

In many cases, our work may consist largely of carrying information from one club to another. The days of secret processes or secret practices is a thing of the past. Meetings like this, where men like you get together and discuss your individual problems, prove that. You exchange information, telling each other what you are doing and how you do the job. One of the ways used to good advantage in the exchange of information is motion pictures.

One of the jobs of considerable importance in Pennsylvania is that of athletic field management. There has been tremendous interest in our state in improving turf on these fields. From 1945 to 1949 athletic field work quadrupled. A good many meetings have been held with school officials-- the principal, superintendent, and school board members. At one result demonstration on an athletic field in Pottsville every school district in the county was represented. Not only custodians, but those who control the purse strings were there. To get something done the person who spends the money must give his approval.

The extension turf program has seen a definite increase in demands over the years. For instance, the total turf contacts the year of 1945 were 1,874. This included 1,243 lawn and cemetery contacts, 96 golf course contacts, 215 athletic field contacts, 110 park and school ground contacts, 103 airport contacts, 160 turf weed contacts, in addition 47 meetings were held. In 1949 turf contacts were 6,205, lawn and cemetery contacts jumped to 3,095, golf contacts were 922, showing the greatest increase. Athletic field contacts were 712, parks and achools 150 and airports 70.

Turf weed contacts were 1,010. The number of meetings held were 246. The indications are that within the next couple of years the turf contacts will reach a total of more than 10,000.

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CARE AND MAINTENANCE OF TREES, SHRUBS AND PERENNIALS

Roy B. Hull, Horticulturist and Landscape Architect
Purdue University

Gentlemen: Many of you have heard some of my utterances and know that I have one obsession as regards golf courses and that is they ought to be as pleasant as possible. I firmly believe that you can recover the cost of adequate landscape development on a golf course by increased popularity and so increased income. I believe the planting, however, should be done by somebody who knows his business. I do not believe that a planting program should be carried out as a sort of reservoir of busy work for untrained men. I believe we should have on every maintenance crew on a golf course, one man at least who knows trees, and who loves trees, and who will take personal interest in seeing that every tree and every shrub he plants will grow. You had better plant your own trees with your own crew and carry out your own maintenance with your own crew. Now we need a lot more trees, a lot more shrub plantings on the average golf course than usually we have. And you men responsible for pay rolls and budgets are thinking that is one expense we can control a little, and you do the thing for which there is the greatest demand. Yet the interest in a good landscape program on a golf course is cumulative and I would guarantee that from year to year as a planting program begins to shape up, you get better and better cooperation and better and better support for that part of your budget which you expend in that direction. We play golf for two reasons-- we play it because we love the game and we play it because it takes us away from the distractions of congested communities, humdrum city life, and gives us again a little contact with nature, and the more nearly we can restore some of the original beauty in the landscape on the golf course, I firmly believe the more popular the course will be, the more satisfaction your club members will get out of using the course.

I'd like to use the first two or three pictures for a moment, please. Now I would say that a planting program ought to be based upon a good master plan. In one way or another there should be an interest aroused that would support the expenditure for professional fees for the preparation of a good master plan, with the idea that you may take a number of years to develop it-- maybe 20 years. But if you have a plan to follow, the placing of your plant masses will not be left to the judgment of some member of the crew or somebody who doesn't have in mind a picture of the thing as it is to look 20 years from now. Let's have a good plan. Let's take advantage of everything the terrain has to offer in the way of variety in the landscape. Let's remember that the golf course is not a place for a collection of odd and unusual plants. Let's make this golf course an improved local landscape which means that we use a good many indigenous materials. If we have some water, as in this case, we use things that naturally grow in the locality along that water. In the lower areas, Red Osier Dogwoods, Gray Dogwood, Winterberry, Buttonbush-- all that sort of thing. Trembling Aspen, Birches, Larches, and farther back on the better drained areas, the things that normally grow in that type of soil. You see it takes a knowledge of ecology, it takes a knowledge of plants as well. A tree must be thoroughly known by the plantsman if he puts it where it's going to be happy.

Here is one golden rule I think should follow in any planting operation: Be determined that this plant will be healthy and vigorous. There is nothing more detrimental to interest on the part of the public than a half dead planting. So spend the money and the time to plant things in a way that will insure the quick recovery from the job of moving. Be sure that a very healthy tree, let it be the most common variety, is likely to be more pleasing than a half dead exotic, however unusual it may be and however striking it may be that you may plant.

We should have backgrounds for our greens, we should have fine vistas along the fairways, and that means rather more planting than we usually have. Now I do not care so much for open groves of trees in the marginal plantings. I think we could save a lot of labor by planting in a naturalistic fashion and developing as soon as possible something comparable to a woods floor condition under those trees, which means a combination of shrubs and trees. We do not always have the opportunity to go into a woods and hew out a series of fairways but such a fairway as you see here, which is a golf course in North Dakota, has done that sort of thing, and you can guess that those vistas down those fairways are pretty fine. In this case it was probably a matter of thinning out and elimination rather than planting trees. If you were planting a bare golf course, you certainly wouldn't plant as heavily as the planting seen here. But you can see that a park-like golf course would entail pretty large volumes of planting and a certain amount of maintenance. The marginal disposition of tree masses ought to include, as I said a moment ago, plantings of shrubs. Those masses of trees should spill out toward the fairways in a naturalistic form simulating the natural woods margin and the type of materials we would use here for naturalized plantings of shrubs require, after the first two years, relatively little, if any, maintenance. You and I have seen fine natural plantings of shrubs in the fence row-- such as those seen in this picture which have never had a pruning shear, never had any cultivation. These have accumulated here year after year, the wind blown leaves that have rotted there and so finally we have something very comparable to a woods floor condition. That's something we can secure quickly by the use of organic material in our planting beds.

The approach drive to the Club House should be well planted. Imagine the driveway to your Club House on either side with Flowering Dogwoods, as is shown in this picture. Some of our smaller flowering trees, Hawthorns, Pink Dogwood, which we see here, Flowering Crabs, Shadblow, and similar materials should be used freely in the golf course planting. I think it would be good judgment to establish a small nursery where you can bring along lining-out stock. Map out each year the budget of planting and have the materials growing a year or two ahead. This would be an excellent reservoir of labor, for during the winter here in the Middle West there are periods of time when we could do some planting-- the air is above freezing and the ground is not frozen. We've had a lot of that kind of weather this year. Little by little, drawing from the reservoir of plants from your own small nursery, a considerable amount of planting could be carried out each year on a very modest budget.

We say your plantsman should be a man who knows trees and a man who loves trees. He ought to be a permanent man on the staff because he will be very useful. He will plant trees much better than a local contractor will do. He knows that his tree must have plenty of good soil to start with. He will dig large holes. He will take better care of his materials. He'll wrap all smooth barked trees and anchor against the swaying of the wind. There's very little use planting a smooth barked tree, such as the Tulip Poplar or Dogwood, without taking the precaution of wrapping the trunk to see that a part of the cambium is not killed by sunscald. The good plantsman will anchor the newly planted tree so that winds will not pull loose the root hairs as rapidly as they are formed and see that the tree is given something comparable to the woods floor to start out in at least. That is accomplished by the use of mulches, that's nothing more than rotted straw or hay that's mown in some rough corner of the course, anything that will hold the moisture in and keep the roots cool. A little cultivation for a couple of years and after that maintenance consists primarily in taking out an occasionally broken limb or doing a little corrective pruning to determine the shape of the tree. The situation which you can see here in this picture is caused by sunscald. Now a man who knows trees will realize that he can cut away that old stem and grow a tree out of the young shoot that's started up there much more quickly than he can induce the old stem to recover. Eventually, such trees if properly treated, will recover. A good plantsman will know that the bark of a tree performs the same function as the skin of his hand. It protects the interior against the entrance of organisms of disease, so when you break the skin on your hand, you disinfect and cover the wound. Similarly, when the bark of a tree is broken, we trim the margins, paint the wound with a sterilizing paint, and induce that tree to recover from injury. These are day to day jobs, they're done as they occur, and it means that somebody should be constantly checking plant materials and giving the necessary care that the occasion demands. We have here in the Middle West tremendous ice storms. You're saying, "you're telling me". You may have some fine trees. Following a sleet storm you may have a lot of injury and it throws you for a loss because it means additional maintenance. The elimination of brittle quick-growing species from your plantings is only good judgment.

I should add that young planted trees should have some water whenever the rainfall falls below normal for a couple of years. After that it's a job of simply taking out injured branches and in a fashion that will induce the tree to heal up as quickly as possible. Now if you haven't a trained man to supervise this work, he'll do it in a rather haphazard fashion. You will frequently see a broken branch removed in the fashion indicated in this picture. You know that that long rip in the bark down there is slowly healed. You know that stub will never heal, that there will remain an avenue for the entrance of organisms of decay which will creep into the interior of the tree, and that tree is doomed the day it is left in this condition. A good tree man will know that, and he will see to it that those branches are removed with a clean cut as close to the parent stem as possible, that a sterilizing tree paint will be used to seal up the pores of that wood so that organisms of decay do not enter. Eventually that wound will heal over and the tree will be little the worse for it. He knows that if it isn't carefully handled, the result will be just what we see in this picture. An avenue for the entrance of decay hollows out the interior of the tree and terminates any hope of its ever making much of a contribution to the landscape. He will see to it that where the other stub, such as you see here, is left it is reduced with a chisel, perhaps, so that the cambium can grow over smoothly and the end point will be a wound which heals over and a few years later will be but a smooth scar.

Now the good tree man will know that you can grow trees better than nature grows them! He isn't going to spend a good deal of time on corrective pruning on those naturalistic masses of trees that you plant between the fairways to form a background for your greens. He will let those grow rather naturally limiting his maintenance just to removing broken branches or branches which rub and that sort of thing. But those trees in the vicinity of the Club House, particularly the specimen trees, must be trained in perfect form. He knows that he will have to give some corrective pruning on the specimens and he will do that while the tree is young. One can remove a branch of a tree which starts out some growing season in a position where we realize that it will ultimately spoil the shape of the tree, and do it very easily with the snip of a pair of hand shears. If, on the other hand, that branch is allowed to grow for 10 years, it's a sawing job, and possibly a tackle job, and it means you waste a whole lot of wood which normally, if it had been snipped at the time it was noticed, would have gone to the rest of the tree. A good tree man knows that you can increase the growth rate of trees by corrective pruning rather than the wasteful fashion of letting the tree grow out of shape and then removing a great deal of wood at one time.

Now, the massing of shrubs should be handled naturalistically. Thorough preparations should be made. Now

I realize the difficulty of acquiring nowadays anything in the way of organic material. You can't buy barnyard manures and it is even difficult to get any straw. I think with a good development program there would be a definite policy of conserving and acquiring every bit of fallen leaves which the city hauls out or from any other source, composting them for the purpose of incorporation in proposed shrubbery depths. If you were to examine this clump of native shrubs here which is growing in a more or less neglected fence row, you will find that practically all those shrubs are very healthy. You will notice the foliage in good vigor, and if you were to do a little digging around those shrubs, you would discover that the soil is very rich in organic material, because the corn husks and the leaves have blown in there. Every thing of that character for years has rotted and gradually enriched and improved the soil structure. That is the ideal condition for growing shrubs. One sees around such areas as golf courses a great deal of wasted effort in maintenance on shrubbery masses. Sometimes we find the caretaker going so far as to trim just a manicured line, perhaps a scalloped line all along masses of shrubs, which is the worst waste of time imaginable, and then annually cultivating those shrubs. Well, nature doesn't do it that way. There is no advantage in this annual cultivation of shrubs and raking out the leaves. I would go the other way and save all the leaves that accumulate around the Club House, see that they are distributed among these shrubbery masses, and I'd let them lie there and rot. Now I'd rather see fallen leaves under a shrubbery bed than bare black earth. I'd rather see an informal soft margin such as you could get by planting under shrubs with creeping myrtle and naturalized woods flora. I'd rather see that type of naturalistic margin than the harsh, sharp manicured edging which so frequently is done, at a great waste of man hours and your shrubs will be better off if they are handled in a much simpler way. As in the case of trees, I'd rather see a single healthy common specimen that has every appearance of vigor than the most rare exotic, if it's only half alive, and obviously in a weakened condition. So thorough preparation to begin with, before the plants are planted, plowing in organic material and getting the soil in a mellow condition the year or the fall before the planting is to be made, and then mulching as much as possible with such leaves and straw or other organic material as can be found, for a few years and letting nature take care of itself so far as other cultivation is concerned. As for fertilization of shrubs, I wouldn't waste any money on it. If the soil is so sterile that you have to fertilize for shrubs, I would not plant them there. If you fertilize a shrubbery bed, the chances are you will stimulate such vigorous growth that your shrubs will grow abnormally high, and eventually it leads to more maintenance. As long as you have soil that is fairly well drained for most species and rich in organic material, there is no necessity for further maintenance other than occasional pruning in those areas near the Club House.

Now the history of a shrub is something like this: You plant it, and I would recommend planting shrubs in small sizes even though you don't get immediate effects. Two to three, three to four at the maximum. Because those shrubs will be better shrubs in three years than one, four to five. They won't cost nearly so much and it is much easier to plant them. I would recommend that we think of a shrub as something that is pruned to keep it young. Now you may have on your staff a gardener who has spent a lifetime as a gardener. In former years, I used to do a lot of work on some of the estates around Cleveland and on nearly all of those estates they had an English gardener, sometimes a Holland gardener, sometimes Italian. Those gardeners were magicians when it came to making things grow. Everyone wanted to spring something on his boss that he hadn't seen before, he had a bunch of favorite plants he'd like to put in, and he made everything grow. But they all pruned shrubs in the same manner--<u>they gave them an individual haircut</u>. It seems to be human nature to want to leave the imprint of a man's hand on everything he plants. Rarely do you find even those trained gardeners, who have spent a lifetime at it, who seem to know how to prune shrubs. Now the history of a shrub is something like this: You plant it, and it takes root and grows, and the twigs lengthen and in a few years you will have shrub of about its normal height, and it grows that way for a number of years. Each successive year, however, if you notice the twigs, the twig elongation is a little less than the year before. As time goes on some of those older canes will apparently put on no growth whatever. About that time you begin to see new shoots coming up from the ground and as they come up, there's no sun to enable them to develop their lateral buds, so they grow right up through the shrub and increase its height. That goes on if there is no pruning given from year to year until finally you have nothing but a bundle of fagots. If you prune those out, you will have what you see in the picture here. The old lilacs get more and more leggy, they bloom less and less vigorously, and finally you have a rather sad looking mass of shrubs. Now the proper way of pruning your shrub is to remove enough of the old canes from time to time so that as the new shoots form, they have some sun and some aeration so the lateral buds develop and then the shrub grows in a natural bushy form. We do not accomplish that by the annual haircut, shearing all over the outer surface of the shrub. The job is a very simple one and if done every year, it doesn't entail a great deal of labor or a great deal of hauling brush. If properly done, we get a shrub which is naturally bushy, retains its normal form, good foliage and normal flowering.

Now the pruning of shrubs, I should say, would be confined largely to the area around the Club House. Naturalistic plantings along the fence row to relieve the monotony of the long boundary, to vary the sky line along the outer boundary, would be done with things which blend themselves naturally. I refer to such things as our native Gray Dogwood, Red Osier Dogwood, Viburnums, Sumac, Hazel and other indigenous materials. This marginal planting is not like the shrubs immediately about the lawn area. They don't have to look quite so finished and, using the type of thing that blends itself from naturalistic planting, you can get along after the planting is done and the turf is established with relatively little maintenance. Now it is true that if one plants smooth barked materials, he will occasionally get infestation of scale and that means spraying. I think the equipment of the golf course should include a small power sprayer. I recently examined one (I believe it's built by the Bean people), about a 20-gallon sprayer, with a little Briggs-Stratton motor on it, with wheels. You run it up into a pick-up truck and if you find you have a nice group of flowering crab that is infested with scale, a miscible oil spray may be applied quickly and easily. I don't think you can afford to neglect infestations of this sort-- certainly you would not want the golf course to become a source of infestation for all the surrounding country.

Now let us look at the following series of pictures on pruning shrubs. Here is a shrub that hadn't had a pruning, at the time this picture was taken, for a good many years. The old canes reached old age, the elongation had become less and less until finally the new shoots came in, that came up through the middle, and they had no chance to develop lateral buds and branches and so they grew as whips. If you look at the shrub now, you recognize that it's just a bundle of canes. There will be a lot of brush carried away when it is pruned now, whereas if it were done once a year, there would be only two, maybe three, canes taken out of the shrub each year. Now in this picture we indicate how that shrub could be pruned. We've cut only those old canes, leaving the younger more vigorous. Winter, the slack work season, is a good time to prune shrubbery. However, it is best to prune flowering shrubs immediately after blooming. Now as I see it, the maintenance of shrubs, aside from those that must be kept in particularly fine shape in the vicinity of the Club House, after they're once planted can be reduced almost to a minimum. And that same thing is true of trees, removing branches as wounds occur, occasionally catching infestation of scale. You may get terrapin scale in some parts of the Middle West on such trees as Tulip Poplar, and you occasionally get European elm scale and there's a job, of course, for employing a commercial rig to come in and do the job. You can't afford to maintain a high pressure sprayer because the sprayers you have you're using for weed control, probably, and that means you can't clean them properly for the use of insecticides or scalicides and occasionally it may be necessary to bring in a commercial outfit to spray those tall trees that can't be reached any other way. That is not likely to become too burdensome if infestations are not permitted to build up.

Now I notice that Doc has included in the subjects on which I'm supposed to talk this morning some attention to perennials. I'd be interested to know how many of you plant large plantings of perennials on golf courses. It would be my idea that that would be the most expensive thing you could do. I'll grant that it would please the women folk, but where you've got a beautiful flower bed in the summer time, you've got a bare blank mess in the winter and it has always seemed to me that that would be a very extravagant luxury to try to maintain on a golf course. Naturally any plantings which you might make of perennials would be in the vicinity of the Club House and I should say if you are going to plant anything, limit it to naturalized masses of such materials along the shrubbery borders as peonies, hemrocallis, or day lily, iris, and asters for fall bloom, and not go in for any great amount of maintenance in this direction. Now if you have a trained gardener, he'll be very glad to plant flower beds all over the place. Because it's a way of expressing himself, he gains some comment, some commendation by the club members, but I feel it's a waste of money in many ways.

If you're going to have flowers on the club grounds, I would see to it that you have a well designed flower garden, and I wouldn't put it on the axis of the great window of the lounge or the dining room where they will have to see it all winter too because a perennial garden is a pretty desolate looking place usually in the winter time. I'd have it entered from the grounds but out of sight of those main outlooks. I just doubt that the expenditure involved would justify itself. Because when you have a flower garden, you have to have one man whose whole time is spent puttering around that garden, if it's a garden worthy of its name. You have to do rather constant weeding and dusting and you have to maintain cold frames to have some potted bedding plants to fill in the voids as they occur as the season goes along. It just seems to me that's a little bit beyond the function of a club.

I say I would reduce the planting of perennials to a minimum and if the popularity of flowers is such in your club that they demand some attention to perennial plantings, I'd induce them to employ a landscape architect to design a really good garden in the proper location. I would do the thorough-going preparation that you put into the preparation of a green. I'd put in adequate drainage. I'd see to it that adequate organic material is incorporated in that soil before I planted a single plant. Then I think you'd have something that would be very attractive, something that would be very popular with the club members, and something that would probably justify the cost, but I certainly, if I were responsible for the development of a club ground, would resist any such thing as heavy plantings of perennials as long as I could.

Now we have hurried through here because I heard several men say at the beginning of this period, "now make it snappy, we've got a long way to go". I have touched rather hurriedly upon some of the fundamentals cf the planting and maintenance of trees and shrubs, and we might use up a part of this period constructively by throwing it open to discussion. Possibly, you might have some questions you might like to ask.

(Question: What would you recommend for fertilizer for trees that have been planted?)

Well, I would use a complete fertilizer, any good complete fertilizer, 8-8-8 or 10-10-10. As a matter of fact, you needn't be too particular about the amount of nitrogen in your fertilizer because that being soluble, you can apply it to the surface. Actually, if you're fertilizing your lawn, chances are that enough nitrogen will get down from that to supply the needs of your tree.

As to the amounts, there are various rules of thumbs, such as amounts based on the diameter of the tree. Actually, there isn't much danger of getting too much fertilizer around your trees. I think the practical way of applying that fertilizer would be by the perforation method, after a rainy day, perhaps using a crowbar to punch holes down in the vicinity of the roots, say 18 inches deep and 18 inches apart, and you can safely put in a better part of a pint of fertilizer in each hole. Now the tree isn't going to need all of that at once but, as I say, there isn't much danger of getting your soil solution so strong that there will be injury resulting. Mr. Behlman, down at Shaw's Gardens, conducted some rather elaborate experiments of that character and he is wont to declare that it is almost impossible to give a tree too much fertilizer. I think I'd want to temper that a little. It's particularly important too if you've got some fine old specimen trees that have been there for 100 years to fertilize them, because the chances are they have used up everything in their reach and they are likely to become stag-headed if you don't do a little fertilizing.

Some one else have a question? Yes, I have some peculiar ideas about planting trees. I'd much prefer the smaller tree for a number of reasons. It will usually get planted better and it will usually be in better condition when you get it. It will cost you much less money and I have always found in 25 or 30 years of practice that I can grow as good a tree in 10 years from a 4 foot tree as most people get from a 10 foot tree. The shock of moving is not so great. You've got to wait a little longer but not too much longer. Actually, some of the nicest most rapidly growing oaks I've ever seen were grown from acorns, and grew just about as rapidly as a 6 foot tree planted at the same time. Are there other questions?

(<u>Question</u>: What would be the best time to take hardwood cuttings from a hedge for propagating for rooting for further extension of hedge?)

You can take that now as hardwood cuttings. You can even root them as semi-hardwood cuttings in the summer. Actually you can take those at almost any time you happen to be shearing and root them. You understand you will have to provide some shade in the form of lattice screen or something of that sort necessarily.